The Welfare of Domestic Fowl and Other Captive Birds

Edited by

Ian J.H. Duncan · Penny Hawkins

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The Welfare of Domestic Fowl and Other Captive Birds

Animal Welfare

VOLUME 9

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Animal Welfare Series Preface

Animal welfare is attracting increasing interest worldwide, especially in developed countries where the knowledge and resources are available to (at least potentially) provide better management systems for farm animals, as well as companion, zoo and laboratory animals. The key requirements for adequate food, water, a suitable environment, appropriate companionship and good health are important for animals kept for all of these purposes.

There has been increased attention given to farm animal welfare in many countries in recent years. This derives largely from the fact that the relentless pursuit of financial reward and efficiency, to satisfy market demands, has led to the development of intensive animal production systems that challenge the conscience of many consumers in those countries.

In developing countries, human survival is still a daily uncertainty, so that provision for animal welfare has to be balanced against human needs. Animal welfare is usually a priority only if it supports the output of the animal, be it food, work, clothing, sport or companionship. In principle the welfare needs of both humans and animals can be provided for, in both developing and developed countries, if resources are properly husbanded. In reality, however, the inequitable division of the world's riches creates physical and psychological poverty for humans and animals alike in many parts of the world. Livestock are the world's biggest land users (FAO, 2002) and the farmed animal population is increasing rapidly to meet the needs of an expanding human population. This results in a tendency to allocate fewer resources to each animal and to value individual animals less, particularly in the case of farmed poultry where flocks of over 20,000 birds are not uncommon. In these circumstances, the importance of each individual's welfare is diminished.

Increased attention to welfare issues is just as evident for companion, laboratory, wild and zoo animals. Of increasing importance is the ethical management of breeding programmes, since genetic manipulation is more feasible, but there is less public tolerance of the deliberate breeding of animals with genetic abnormalities. However, the quest for producing novel genotypes has fascinated breeders for centuries. Dog and cat breeders have produced a variety of extreme forms with adverse effects on their welfare, but nowadays the quest is pursued in the laboratory, where a range of species, mainly mice, is genetically altered, sometimes with equally profound effects.

The intimate connection between animals and humans that was once so essential in some spheres is rare nowadays, having been superseded by technologically efficient production systems where animals on farms and in laboratories are tended by increasingly few humans in the drive to enhance labour efficiency. With today's busy lifestyle, companion animals too may suffer from reduced contact with humans, although their value in providing companionship, particularly for certain groups such as the elderly, is increasingly recognised. Consumers also rarely have any contact with the animals that produce their food.

In this estranged, efficient world, people struggle to find the moral imperatives to determine the level of welfare that they should afford to animals within their charge. Some, in particular many companion animal owners, aim for what they believe to be the highest levels of welfare provision, while others, deliberately or through ignorance, keep animals in impoverished conditions where their health and wellbeing can be extremely poor. Today's multiplicity of moral codes for animal care and use are derived from a broad range of cultural influences including media reports of animal abuse, guidelines on ethical consumption, animal behaviour and welfare science, and campaigning and lobbying groups.

This series has been designed to help contribute towards a culture of respect for animals and their welfare by producing academic texts discussing the provision for the welfare of the major animal species that are managed and cared for by humans. They are not detailed blue-prints for the management of each species, rather they describe and consider the major welfare concerns, often in relation to the wild progenitors of the managed animals. Welfare is considered in relation to the animal's needs, concentrating on nutrition, behaviour, reproduction and the physical and social environment. Economic effects of animal welfare provision are also considered where relevant, as are key areas where further research is required.

In this volume one of the world's leading scientists in the field of poultry welfare science, Professor Ian Duncan, has joined with Dr Penny Hawkins, a leading advocate for improvements in laboratory bird management and welfare and Deputy Head of the RSPCA's Research Animals Department. Together they have brought together many experts in the field of captive bird welfare, including those that have been involved with research on improving poultry welfare as well as those with experience of other captive birds.

With the growing pace of knowledge in this new area of research, it is hoped that this series will provide a timely and much-needed set of texts for researchers, lecturers, practitioners, and students. My thanks are particularly due to the publishers for their support, and to the authors and editors for their hard work in producing the texts on time and in good order.

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Reference

FAO (Food and Agriculture Organisation) (2002). http://www.fao.org/ag/aga/index_en.htm.

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Chapter 1
Introduction

John E. Cooper and Margaret E. Cooper

1.1 Introduction

There are over 9,000 extant species of bird. All belong to the Class Aves, which is characterised by the presence of feathers and oviparity (egg-laying). Birds are vertebrate, endothermic ("warm-blooded") animals with a well-developed central and peripheral nervous system; all species have many features in common with one another, but there are also important differences between them.

Birds vary in size from the tiny hummingbirds (Family Trochilidae), weighing less than 10 g, to the world's largest avian species, the ostrich (*Struthio camelus*), which can reach 149 kg in weight. Such disparity in size is reflected by physiological differences. As a general rule, smaller birds have higher metabolic rates than larger birds, which correlates with such features as longevity (large birds tend to live longer than small birds) and the fate of medicinal agents (small birds absorb, metabolise and excrete compounds more rapidly than do large). These, and other physiological features, are relevant to the welfare of birds and are referred to in other chapters later in this book.

1.2 Implications of Bird Physiology for Health and Welfare

Some special features of birds that are relevant to their welfare are listed below.

- The high body temperature and high metabolic rate of some, mainly smaller, species makes birds susceptible to hypothermia. Low air temperatures and cold winds can be a direct cause of hypothermia in captive birds, especially if shelter is not adequate. Other anthropogenic (human-induced) factors that can lead to hypothermia include excessive application of medicinal products, especially if they are alcohol-based, to the skin surface, which increases its thermal

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conductivity, or inadequate husbandry, which can cause stress-induced feather plucking.

- The complex respiratory system of birds – the presence of air sacs and pneumatised bones as well as lungs – means that birds have an efficient, but also a very sensitive, system for gaseous exchange. As a result, the Class Aves is very susceptible to even low levels of volatile or gaseous anaesthetics and to atmospheric pollution (hence the historical use of canaries to detect noxious gases in mines).
- The key role of the plumage of birds – in flight, display, thermoregulation and protection – carries with it a susceptibility to problems associated with the integument. Disturbances in the plumage, perhaps brought about by endocrinological disorders or by preen (uropygial) gland dysfunction, can have a profound effect on the wellbeing of birds and their ability to resist infectious agents such as bacteria, non-infectious factors such as trauma and other potential stressors.
- Other anatomical and physiological features can also affect how a bird responds to pain or other noxious stimuli and hence how the welfare of birds can be promoted in captivity. Thus, for example, the presence in all birds of a cloaca (a common chamber through which faeces, urates, eggs or spermatozoa pass) means that these animals are subject to a number of disorders that can affect one or more organ systems.

1.3 Using the Five Freedoms to Assess Bird Welfare

The concept of the Five Freedoms was originally set out as a tool for assessing the welfare of farmed animals, but it can be constructively applied to captive birds kept for any reason (Farm Animal Welfare Council, 1993; Webster, 1994). In order to apply the principles objectively, however, they have to be seen in the context of how birds live, how they adapt to change and the effect on birds of stressors and other adverse stimuli. Table 1.1 lists the Five Freedoms, which provides the approach for

Table 1.1 The five freedoms

Freedom ...	Examples of compromise
from thirst, hunger and malnutrition	Broilers on restricted diets may be constantly hungry; companion birds fed inappropriate diets will be malnourished. The nature and level of the problem often depends upon the conscientiousness and knowledge of the keeper
from discomfort	Can be compromised by poor housing and husbandry
from pain, injury and disease	Poor management may mean that clinical signs are missed or that disease goes unnoticed or unheeded
from fear and distress	Unsatisfactory social grouping (e.g. in many species, too many males in close proximity) can result in fear and distress
to express a range of desirable natural behaviours	Poultry kept in the confines of a battery cage are unable to perform many natural behaviours. Waterfowl that are confined, feather-clipped or surgically pinioned will be unable to respond to the calls of free-living birds and join them on migration

the rest of this book, and sets out some examples of ways in which they can be compromised in captive birds.

1.4 Public Perceptions of Birds

Birds, perhaps more than any other animals, have provoked strong sentiments in humans. Birds can be the subjects of interest, respect and affection; many people feel an affinity with wild birds and believe that they epitomise “freedom”. This is perhaps best summed up in the words of great poets such as Percy Bysshe Shelley (“To a skylark”) *Hail to thee, blithe spirit!, Bird thou never wert* or William Blake *A Robin Red Breast in a Cage Puts all Heaven in a Rage*. In some cultures birds may be treated with respect because they have a religious or sacred role. For example, the Maori of New Zealand revere various indigenous avian species, extant or extinct, and their views are increasingly being incorporated into conservation and other programmes (Anon, 1997).

Such respect for birds is not universal, however, and may depend upon the species. Thus, owls (given the status of a God in ancient Greece) continue to be associated with ill-fortune, even death, in many parts of the world. There are many similar superstitions about corvids; for example, the raven is believed to predict death and pestilence in many cultures. This is covered in more detail in Chapter 2.

Setting aside superstitions such as these, secular attitudes towards wild birds can be divided into three main categories (Table 1.2).

Table 1.2 Three key categories of public attitudes towards wild birds

Protectionist	Stewardship	Utilisation
Birds are seen as companions, worthy of full protection under the law. They may only be kept in captivity under very special circumstances (e.g. for the care of wild bird casualties)	Birds are seen as an integral part of biodiversity worthy of a degree of protection under the law. However, they may be killed, taken into captivity or used under controlled circumstances	Birds are seen as just one component of wildlife, with no particular need for special protection. They (and other animals) are freely available to be used, taken into captivity or killed in the wild

These broad categories can help in understanding how the public perceives birds and recognising where there may be a need to protect them, for the sake of their welfare, conservation or both. In the United Kingdom the killing of wild birds is generally anathema and the confinement of domestic poultry is viewed with concern if the management method used (e.g. very intensive “batteries”) is judged to be cruel. To the *protectionist*, virtually all species of bird are deserving of legal protection that helps to ensure their long-term survival and well-being.

Stewards of birds are broader in their approach and it is less easy to classify such people. They recognise the importance of birds and the need both to treat them humanely and to conserve them in the wild. At the same time, however, the responsible killing of birds (for human good, or because they are "pests") is accepted, as is the keeping of wild birds in captivity for pleasure, exhibition or research – so long as this is done humanely.

Those who are proponents of the *utilisation* of birds do not consider that the Class Aves has any particular features that makes its species specially worthy of protection. In the eyes of such people, there are no ethical issues associated with killing birds for food, for sport or because they are "pests". Likewise, birds may be brought into captivity without any need to impose strict rules on, for example, cage sizes or trapping methods.

Within each of these three groups there is much variation and views may be influenced by peer pressure and by the media. Thus, amongst "protectionists" there are some people who consider it unacceptable to keep birds in captivity, even species like the canary (*Serinus canaria*) that have been long domesticated, while others argue that such species are now habituated to a life of captivity and so this is not an ethical dilemma. Aviculture is seen by most protectionists as "keeping birds in cages" even though some aviculturists have contributed to the captive-breeding of threatened species and captive birds can be kept in aviaries with ample room for flight and expression of normal behaviour (Cooper, 2003a).

Other areas of bird use involve more complex judgements. A good example is the keeping of birds of prey (raptors) for falconry; the human–bird interactions that this involves are discussed by Cooper (2002). Falconry raises various ethical issues because (i) birds are kept tethered, for at least part of their lives; (ii) birds are trained by exploiting their appetite for food; and (iii) if used by practising falconers, they pursue and kill other animals.

Public attitudes to falconry fall into various categories, some of which are listed below:

- unconditional support for falconry as a sport, and all that this entails, with no qualms about any of the three ethical issues above;
- support for the training of birds of prey in order to provide educational displays but some reticence concerning the use of such birds to take wild, living quarry;
- concern about both of the categories above but an acceptance of the use of falconry techniques for welfare and conservation purposes, such as the rehabilitation of raptor casualties or the "hacking back" to the wild (gradual release while continuing to provide food and refuge) of captive-bred birds;
- opposition to the use of any techniques pertaining to falconry, regardless of the circumstances.

There are many other examples that illustrate the complex perceptions of the public insofar as captive birds are concerned. The situation is further complicated by social and geographical factors. People who are poor, especially those who live in "developing" countries, may benefit from seeing some of their native avifauna in captivity in a zoo. For instance, few people in Uganda will ever see a shoebill stork (*Balaeniceps rex*) unless they view the captive specimens in the well-presented exhibit at the Uganda Wildlife Education Centre, Entebbe. Educational and recreational visits to collections may be the only opportunity that many people have to see their own indigenous species. On the other hand, in developing countries some zoo facilities may represent very poor practice by the standards set by many Western European, North American and certain other countries that have strict regulation. The keeping of farmed birds such as quail (*Coturnix coturnix*) in small cages for meat and egg production might be considered acceptable in the short-term in a war-torn zone of South America, in order to feed a starving community, or in other circumstances of poverty, but may be unacceptable elsewhere where better conditions for the birds are affordable. Each case has to be judged individually and a harm-benefit analysis, using the Five Freedoms as the benchmark for avian welfare, should always be performed – and reassessed at regular intervals (Cooper and Cooper, 2007). This can be combined with education and the demonstration of the fact that better husbandry benefits both the birds and their owners.

1.4.1 Justification for Keeping Birds in Captivity

A very small number of avian species has been domesticated for thousands of years (Cooper, 1995). Many more species have been kept in captivity, for a variety of

Table 1.3 Ethical dilemmas associated with keeping captive birds

Situation	Comments
Confinement of domestic birds, e.g. fowl and quail, in battery cages, with limited opportunity for normal behaviour, including exercise	For long a controversial subject (Appleby et al., 1992), with scientific data to support the supposition that the welfare of such caged birds is compromised. In Europe the use of cages without environmental enrichment will be banned by the year 2013
Surgical pinioning of birds, both domestic and wild, to prevent flight	Another controversial topic. In the United Kingdom birds kept on agricultural land may not be pinioned but the technique is permitted in other birds such as exotic waterfowl or flamingos, subject to the usual legal constraints relating to surgery etc.
The keeping of birds in cages, often singly	This is much debated. Sometimes singly-kept birds in cages are the much-loved companions of elderly or ill people, in which case many believe that the benefit to humans has to be taken into account
The tethering of birds for falconry, for falconry displays and for other purposes	There is a broad range of opinions on this (see earlier). In some countries, such as the United Kingdom, the production of Codes of Practice for the care of tethered birds has helped in the assessment and promotion of their welfare (Countryside Alliance and Hawk Board, 2000; Defra, 2004)
The commercial farming of "exotic" birds in alien, sometimes hostile environments	A cause of considerable controversy in recent years, especially concerning the keeping of ostriches and other ratites in cold climates in northern Europe and elsewhere

purposes including food production and public exhibition in zoos. The keeping of birds in captivity raises many ethical dilemmas, of which the following are but a few examples (Table 1.3).

1.5 Law and Ethics

There are strong precedents for moral and legal codes relating to the care and protection of both captive and free-living birds. Some of the world's great religions, for example Buddhism and Hinduism, preach respect for birds. This is still demonstrated by the tolerance shown to blue peafowl (*Pavo cristatus*) by villagers in many areas of the Indian subcontinent. In both the Bible and the Koran there are exhortations to treat wild birds kindly and to move stranded nestlings to a place of safety.

Much of the interest in captive birds has been prompted by their appeal as companions. The Roman poet Catullus wrote of a lady who kept a pet sparrow and described her sorrow at the bird's passing. Samuel Pepys, the seventeenth century diarist, had a pet canary and he too expressed graphically his distress when the bird died. The Chinese have kept birds for centuries and even today the attention given to these in markets and singing competitions is remarkable. In Trinidad, West Indies, it is legal to take and keep certain indigenous songbirds. Owners habituate them in public areas and show fondness for them.

This has to be balanced, however, against the fact that most cultures have a tradition of keeping, killing, eating and otherwise utilizing birds. Birds have served a multitude of often contradictory purposes. Thus, while in some circumstances birds are considered worthy of protection in terms of welfare and conservation, in other situations they are expected to serve the needs of society for food, companionship, sport, competition and for an extensive range of commercial purposes. The singing birds in Trinidad, for example, can provide a helpful source of income for their owners by winning singing competitions. On the other hand, conservationists are concerned about the toll on the wild population.

In the attempt to resolve this dichotomy and the conflicting views and interests concerned and to protect the birds involved, individuals, organizations and governments turned to ethics and law. This is not a new concept. In the eighteenth century, hawks imported into Britain had to be held under the equivalent of a certificate of provenance. Early conservation and hunting laws derived from the sovereign's desire to protect his supply of game by restricting the access of others. However, since the late nineteenth century, ethical and welfare concepts have received ever increasing attention and definition and have attracted constant debate in "westernised" countries.

Some people make personal moral decisions regarding their attitude towards the use of birds along the lines discussed earlier. Some turn to philosophical or theological arguments to determine the status of animals. Others, including governments, resort to legislation to address issues such as the need to conserve wild birds or to prevent unnecessary suffering during production or transportation.

1.5.1 Overview of Laws Relating to Birds

Laws that relate to birds cover conservation, animal welfare and health, livestock production, transport and trade (Cooper, 2003c). Such provisions may be found in many countries. However, there is considerable variation in the quantity and quality of such legislation and the same can be said of the enforcement of these laws. Some countries, such as the United Kingdom, Australia and New Zealand have seen a steady revision and improvement in animal legislation in the last decade or two. In other parts of the world both regulations and enforcement may be antiquated and weak; further, there may be only limited understanding of the concepts of animal welfare or effective conservation. In addition, many countries are struggling with poverty, insecurity and inadequate infrastructure as well as a lack of empathy for animals or for the concept of conservation.

The context in which bird health, welfare and conservation are practised and promoted in, for example, the United Kingdom seems "luxurious" (with recently revised legislation, positive attitudes towards enforcement, extensive education, strong motivation towards welfare and conservation, well-funded voluntary organizations) compared with the situation in many other countries. There is always room for improvements in the best animal legislation, and reform is a costly and painfully long process, but a concern for better legisation should also address the problem of animals in countries whose laws are far from meeting the modern standards.

In such countries, achieving improvements in legislation and practice is usually an uphill struggle and individuals, Non-Governmental Organisations (NGOs) and governments often try to raise standards by funding projects and providing training or making improvements a constituent part of donor country aid. However, it is important to ensure that any achievements are sustainable after the project closes or funding runs out. Another effective approach can be seen in countries with generally welfare-deficient laws and/or enforcement that seek to supply the European Union (EU) markets in say, poultry meat. They must meet EU standards not only in food hygiene and disease control but also in welfare in order to be authorized to trade in the EU. Although this creates a dual welfare standard in the country it builds up an awareness amongst farmers, veterinarians and officials of the existence of such standards. Jamaica and Botswana both export livestock products to the EU and have to operate such standards. Rightly or wrongly, showing good welfare to be profitable is often effective even if one would like to be more altruistic.

Conversely, wild bird trade legislation has been introduced by the EU to forbid the importation of wild-caught birds as a means to reduce the disease risks and ill-treatment occurring in the course of such trade and also to conserve wild populations. On the one hand, this has been considered a major achievement in the interest of wild birds. On the other, will studies be carried out to ascertain whether the trade has actually diminished or, rather, moved to an alternative destination outside the EU, possibly where protective standards are lower? Have the trappers and primary suppliers, who are often very poor, found or been provided with alternative incomes? A positive result would indicate that the ban assisted in reducing human suffering as well as the illegal trade.

The law relating to birds is generally to be found in the national laws of individual countries. National and federal laws are used to implement international conservation laws such as CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), CMS (Convention on Migratory Species) and the Ramsar Convention on Wetlands. The European Union has extensive provisions relating to birds that apply either directly in the case of Regulations (as in the case of animal transportation and CITES) or after the transposition of Directives into national law (as in the case of poultry welfare and wild bird and habitat conservation) in its 27 Member States. While this means that EU standards are applicable in the largest rading bloc in the world, the free movement of birds (and people) within the EU presents a challenge to the enforcement of such laws and calls for co-operation between Member States. Examples of current legislation relating to birds in various contexts are briefly set out below.

1.5.1.1 General Welfare

Welfare, or anti-cruelty, legislation usually provides domestic or captive animals, including birds, with protection from certain forms of cruelty and unnecessary suffering. Recent laws in the United Kingdom and New Zealand have included a “duty of care” requiring the keeper of an animal to provide for its basic needs. Thirteen Member States of the Council of Europe (CoE) are parties to its European Convention on the Protection of Pet Animals, which provides very basic welfare measures for any vertebrate animal that is kept as a companion.

1.5.1.2 Health

Animal health legislation gives governments the power to control and eradicate specified diseases in birds, particularly domestic livestock. Such legislation also regulates the importation of birds, requiring health certification and in some cases, quarantine. These laws have a welfare benefit in that they provide powers to control diseases that cause suffering and death in birds. In the case of farmed birds, legislation covers their management, including cage sizes, slaughter and transport. In the EU such national legislation is derived from European Community (EC) and CoE legislation, where there are requirements for the keeping of poultry in various systems. A relatively strict EC Regulation (which has direct effect in all EU countries) came into force in 2007 for the commercial transport of (inter alia) birds, although the requirements for private transport of pet birds are much simpler. The OIE, an international body responsible for international animal health monitoring, has undertaken responsibility for the development of welfare standards to be observed by all countries. Attention has been given to farmed livestock in the first instance (Bayvel et al., 2005).

1.5.1.3 Zoos and Research

Legislation that is designed to regulate the keeping of animals for certain purposes generally includes provisions for their wellbeing and good management. The EC Zoos Directive requires Member States to have legislation in place for the licensing and inspection of zoos and to set standards of good practice. Zoos must also be able to justify their existence by contributing to conservation, research and education. EU countries also have legislation regulating scientific research and testing that is likely to cause pain, suffering, distress or lasting harm to animals. In both cases, although in quite different ways, the laws require the provision of appropriate accommodation and environment, day-to-day care and veterinary supervision in compliance with standards established under the legislation. A number of countries also regulate zoos and animal research, whereas some others may operate under voluntary codes of practice. If the results of scientific research are to be published internationally, it is often necessary to be able to provide an assurance that acceptable animal welfare standards have been met. Good health and welfare also yield better quality research and contribute to the reduction in numbers of animals used.

1.5.1.4 Falconry

There are varying legal approaches in different countries to the sport (or use for other purposes, such as “pest” control) of falconry. In the United Kingdom it is not regulated, although there are many relevant laws that must be observed, including those mentioned in this chapter, and licences are required for flying displays and the taking of certain wild birds as quarry (Irving, 2006). Self-regulation by falconry clubs and the Hawk Board helps to maintain standards amongst responsible practitioners of the sport. Some countries (such as the USA and Canada) permit the sport but regulate falconers, whereas other countries, such as Norway, do not allow falconry at all.

1.5.1.5 Wild Birds

Many countries have long recognised that free-living birds need legal protection. Wild bird legislation makes it an offence to take, kill or injure specified free-living species and regulates close seasons and hunting methods (note that present-day laws are more complex and include many more provisions than this). Wildlife law does not have a strong welfare purpose but some offences relate to the use of inhumane or indiscriminate trapping methods. The law may also allow for the rescue and rehabilitation of sick or injured wildlife. In the United Kingdom, anyone may take and tend such a bird until it is fit to return to the wild. In some other countries, rescued birds must be taken to an authorised rehabilitator. This work is subject to other legislation such as anti-cruelty and veterinary laws and some rehabilitators practise self-regulation, e.g. through the British Wildlife Rehabilitation Council (BWRC, 1989; Cooper, 2003b). A modern, national wildlife legal framework should also legislate for a country’s international obligations. Examples include laws in relation to the international bird trade (i.e. implementing CITES, 1980) and to habitat protection and management or restoration for migratory species that pass through its territory (CMS, 2003). Obligations under the international conventions for wetlands as habitat for waterfowl (Ramsar Convention, 1979) and the conservation of biodiversity (Convention on Biodiversity, 1992) also contribute to wild bird conservation and may also have an incidental welfare benefit. For instance, CITES requires, as a condition of granting a permit, that a live animal must "be so prepared and shipped as to minimize the risk of injury, damage to health or cruel treatment". CITES also now provides for simplified procedures for the issue of permits for the international movement of biological samples taken for the health or conservation of CITES species.

The key to effective legislation and the improvement of animal welfare is sound enforcement. Many countries suffer from poor enforcement powers in their legislation, together with lack of motivation and resources (both in the government and in bird protection organisations). In the United Kingdom, however, increasing attention has been paid to amending relevant laws to provide stronger powers of inspection and enforcement together with higher penalties for crimes involving wildlife, including birds (Cooper and Cooper, 2007). Steps have also been taken to ensure more effective use of resources by the bodies, both official and voluntary, that investigate suspected wildlife crimes. The training of magistrates in the significance of these issues and the nature of the legislation has also helped. The pooling of knowledge and collaborative work of the United Kingdom Partnership against Wildlife Crime (PAW), the National Wildlife Crime Unit, international co-ordination groups and Interpol's Ecomessage system are important keys to law enforcement. These provide useful models for countries wishing to enhance the effectiveness of their bird welfare and protection legislation.

In countries where the the wildlife legislation is inadequate but there is a desire to set higher standards, codes of practice or guidelines based on "best practices" and effective legislation from elsewhere can help to raise the standards of animal welfare and could also be used in conservation.

1.5.2 Ethics

The term "ethics" has many interpretations and is used in various ways. It can refer to the philosophy used to elucidate the status of animals and what rights they should be accorded; it can provide arguments to persuade people or governments (for example, to change the law); and it can also refer to rules and codes of conduct or good practice that operate to supplement existing laws or in the absence of relevant legislation. Codes of practice are often provided under modern laws, such as those for good husbandry of farmed animals, including poultry. They are being increasingly used to provide guidance for animal-keeping and are a cornerstone of welfare laws in various countries. New Zealand has produced codes of welfare for (inter alia) the farming of poultry and zoos as well as Codes of Recommendations and Minimum Standards for welfare during transportation and for the farming of ostrich and emu under its animal welfare legislation. In the United Kingdom, codes for a range of species are currently being drawn up under the new Animal Welfare Act. Those that may affect birds relate to pet shops, pet fairs, gamebirds and animal sanctuaries. These provisions are more flexible than primary legislation in that they can better reflect ethical views on welfare and can be more easily amended to meet pressure for improvements in standards.

1.5.3 Ethics and the Law: Conclusion

In closing this section, one might address the question "does good legislation ensure good welfare?". Probably every reader will take a different view, as they are rightly entitled. One might say that no legislation, however good, will of itself ensure anything and that good welfare could, in theory, be achieved by appropriate husbandry and management alone. However, in reality, many pressures, not least that of commercial interests, make it necessary to have a wide range of tools to work towards a lasting culture of good animal welfare and conservation. Good law backed by efficient enforcement are important but so also are sensitization, education, training, political stability, decent infrastructure and acceptable standards of living for the populace. Comparable arguments can be made for conservation and the management of animal health. We live in an imperfect world; therefore, it is hoped that this book will contribute to the tools needed for the good health, good welfare and conservation of the world's birds.

1.6 The Future

Despite widespread interest in, and affection for, birds, they often fare badly in captivity and many continue to suffer in the wild. The underlying causes include:

- ignorance on the part of owners of captive birds;
- attempts to save or to make money, often misguided;
- accidental or intentional environmental pollution (wild birds);
- neglect;
- malicious cruelty;
- poor legislation and enforcement.

The way forward has to be primarily by education and that is why this book is so important. Books about birds abound and some of them contain useful information about handling, housing and care of birds but often welfare is not covered per se (Cooper, 2003c). A number of poultry texts have a strong orientation towards welfare (Sillince, 2003). Codes of practice exist for birds – for example, those by the United Kingdom Farm Animal Welfare Council (FAWC) for domestic poultry, others for non-domestic species. Some laboratory animal publications have provided useful information on the welfare of birds kept for research (Poole and English, 1999; Hawkins et al., 2001). However, remarkably little has been published specifically dealing with the welfare of the diverse avian species that may be kept in captivity.

In order to provide objective guidance on welfare that is likely to be accepted by those who keep birds, scientific evidence is required. Only in this way will the needs of the members of Class Aves be properly understood and steps taken to ensure that these needs are met, as far as is practicable, when birds are kept in captivity. To obtain such data, however, there is a need for input from all those who work with or care for birds. Both “professionals”, such as ethologists and avian biologists, and “amateurs”, such as birdwatchers, must be involved. So, also, should those who keep or tend birds in captivity – whether this is farm employees, private birdkeepers, zookeepers, laboratory animal technologists, wildlife rehabilitatiors or those who work in veterinary practices. All can contribute.

Much needs to be learned about the diverse species of bird that inhabit this planet, many of which are kept in captivity. Their welfare is worthy of greater attention and better implementation. Birds are not mammals with feathers and beaks. They are a unique class of vertebrate that has served the human race well, in so many ways, and the time is ripe to repay that debt.

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Part I
Captive Birds

Chapter 2
Human–Bird Interactions

Patricia K. Anderson

2.1 Introduction

The human–bird relationship is diverse and varies between cultures and within the same cultures over time. Humans have exploited various avian species for millennia, using them for many different purposes including their flesh and eggs as food, skins and feathers as clothing, egg shells and feathers (including whole taxidermied birds) as decorative items, feathers as quill pens or as fletching for arrows and darts. Their bones have been made into musical instruments, fishhooks and other artefacts, and their guano, feathers, and bones have been used as fertiliser. Birds have been targeted for subsistence and sport hunting. In addition, birds have served as pets, fictive family members, or tools in the hunt for other birds, fish and small mammals.[1] In addition, the idea of "birdness" is a powerful symbol cross-culturally.

Many different species of birds, especially psittacines, have historically been taken from the wild to live as companions in human households and institutions. Pigeons, among the first domesticated birds, share much of human history. In addition to being raised for their flesh, pigeons have also been used as tools: courier pigeons have been critical to military intelligence during wartime and are credited with saving many human lives. Further, pigeon breeding, showing and racing continue to be popular hobbies in many countries including the United Kingdom and the United States (Blechman, 2006; Cooper, 2002).

Birds may be found residing in institutional settings including schools, extended care facilities for the elderly and people with disabilities, and corrective facilities. Aviaries and individual pet birds have been incorporated into the Eden Alternative

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[1] Humans have been training raptors to kill and capture other birds since at least 750 BC (Cade, 1982, p. 51), and certain aquatic species have been trained to fish for humans. The earliest ornithological text, completed in 1248, is *De Arte Venandi cum Avibus* (The Art of Falconry), by Frederic II von Hohenstaufen (Lederer, 2007).

I.J.H. Duncan, P. Hawkins (eds.), *The Welfare of Domestic Fowl and Other Captive Birds*, Animal Welfare 9, DOI 10.1007/978-90-481-3650-6_2,

assisted living facilities in the United States (Thomas, 1996).[2] Some birds, including parrots and chickens, also visit institutional settings with their caretakers as part of a structured or unstructured programme in Animal Assisted Therapy (AAT) to provide interest and assuage loneliness and boredom in residents (Burch, 1996; Delta Society, 2007; Fine, 2000).

Bird feeding and bird watching are among the most popular leisure pastimes in Western societies where people expend a significant amount of money on feeders, bird food and bird watching supplies, in addition to travel associated with bird watching. Trained birds participate in shows that entertain and educate the public. Further, each year thousands of birds are also exploited in laboratory research (Hawkins et al., 2001) and millions of birds are slaughtered for food or become targets for sport and subsistence hunters. In addition, millions of birds annually suffer premature deaths from poisoning (deliberate or accidental), or crashing into anthropogenic structures such as skyscrapers, cell towers, wind turbines or house windows (US Fish and Wildlife Service, 2002a).[3] Glass windows cause more bird deaths than any other factor in the US, and birds are killed in their billions worldwide by glass strikes (Lederer, 2007). Seabirds are threatened by pollution, and in commercial fishing, countless mortalities result from "bycatch" (Birdlife International, 2007a). In addition, cars kill another 60–80 million birds in the United States alone (Lederer, 2007).

At least 135 species of birds have already become extinct since the 1500s due to human actions such as habitat destruction, hunting and collecting (IUCN Red List, 2006). However, this number is probably a gross underestimate as there are difficulties in making accurate assessments of avian extinctions (Pimm et al., 2006). The introduction of predatory invasive species, either deliberately or accidentally, as Europeans colonised "new" lands, and attempted to remake them in their own cultural templates through establishment of familiar species of animals and plants has also contributed to species decline and extinction (Crosby, 1986; Smith, 1999). Within the past 30 years alone, 21 species have gone extinct, and today an additional 189 species are termed "critically endangered", the highest category of extinction risk (Birdlife International, 2007e).

In short, birds are historically and culturally an important part of most people's lives, whether they are consuming their flesh or their eggs, wearing their feathers or bodies, living with them, watching them or thinking about them, and conversely, humans have profound impact on the lives of birds. In this chapter, I consider how cultural beliefs influence human–avian interactions and how these perceptions may affect the welfare of birds.

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[2] Unfortunately, these facilities often also have unmonitored, free ranging cats who can terrorize the avian inhabitants, and the facilities are often understaffed and or lack consistency in who will care for the birds (Coultis, D., personal communication, 2007).

[3] Because climatic change presents an even greater threat to survival of world bird populations than wind turbines, the use of turbines as an alternative energy source is supported by the Royal Society for the Protection of Birds, even though they kill birds (Lederer, 2007).

2.1.1 Culturally Shaped Attitudes Toward Birds

Social scientists have long noted that the way in which people perceive reality is culturally mediated. Although social constructions may seem to be "facts" because they are part of the normative order of society, they vary because they are assigned different meanings depending on the context. Thus, "different groups in society have quite specific relationships with animals, the principal lines of differentiation being gender, class, occupation, ethnicity, nationality and region" (Franklin, 1999).

Even the elementary question of what constitutes an "animal" varies according to cultural and chronological contexts (Ingold, 1994b). For example, under Linnaean taxonomy humans are classified as animals, while most dictionary definitions of "animal" exclude humans and indeed define the term in opposition to human. Further, anthropologists have long recognised that many non-western small scale cultures see no or little distinction between human and nonhuman species and may consider humans to be equal or even inferior to other animals (Ingold, 1994b). Thus, our beliefs about nonhuman species, like other cultural phenomena, are accordingly diverse and are learned and passed on from generation to generation. Consequently, human–avian relationships are correspondingly complex.

In Western society, there has been a historical tendency to view all nonhuman animals anthropocentrically, as objects to be used for human benefit (Serpell, 1996). To some extent, these beliefs persist in Western society today (Arluke and Sanders, 1996). This anthropocentric hierarchy was first formally recorded in the ancient Greek concept of the *Scala Naturae,* a hierarchy of all living things, including humans. Greeks were placed at the top beneath the Greek gods, while people perceived as inferior were placed on the lowest level of humanity. This hierarchy was revived by scholars in medieval Europe as the "Great Chain of Being" and was used to justify slavery and other social inequalities. God and the angels were placed at the top of this immutable hierarchy. Beneath angels were humans, beneath humans were nonhuman animals, beneath them were plants, and at the very bottom, minerals.

Animals, including birds, were all ranked below humans, and birds were placed below mammals. However, "a charming attribute of the chain of being is that it allowed every class to excel in a particular" and thus the beasts exceed humans in strength. Further, in most accounts of the chain of being "there is within every class a primate", meaning a type of animal placed at the top of the hierarchy because of particular attributes that it possesses (Tillyard, 1966). Thus eagles rank above all other birds in the Great Chain of Being.

Despite the great advances in science that have indisputably demonstrated our kinship with other living beings, beginning with Darwin and continuing with cognitive biology and genetics, the human/nonhuman hierarchy is perpetuated by an ideology grounded in a philosophy of dominion (Arluke and Sanders, 1996; Scully, 2002). Divine charter thus morally justifies the exploitation of nonhuman animals, and humans may deal with animals as they see fit.

Various philosophers of science have further reinforced this anthropocentric attitude, the most dominant being the seventeenth century philosopher, René Descartes (Sanders, 1999; Serpell, 1996). Influenced by creationist ideology and the recent technological development of reliable clocks, Descartes established the rationalist perspective that came to be the accepted dogma of the natural and social sciences, with the greatest value being placed on the most intelligent beings. To Descartes, animals were mindless, soulless machines who were not motivated by thoughtful intent because only humans were able to pass the "conversation test":

> "For it is a very remarkable fact that there are none so depraved and stupid, without even excepting idiots, that they cannot arrange different words together, forming of them a statement by which they make known their thoughts; while, on the other hand, there is no other animal, however perfect and fortunately circumstanced it may be, which can do the same. It is not the want of organs that brings this to pass, for it is evident that magpies and parrots are able to utter words just like ourselves, and yet they cannot speak as we do, that is, so as to give evidence that they think of what they say (Descartes, 1976)."

Thus, to Descartes, birds and other animals could not think since they lacked the ability to speak meaningfully. Further, without thought, they were incapable of experiencing emotion, and were also without souls, both uniquely human qualities.

Today, however, there are abundant anecdotal and clinical data to indicate that parrots are capable of understanding what they say in human languages if taught the meaning of words contextually (Anderson, 2005, 2006; Pepperberg, 1999). Further, there are data that indicate that many different species of birds are capable of complex problem solving (Barber, 1993). In addition, reclassification of the avian brain as being more complex than previously recognised demonstrates that it is not so different from that of mammals (Meredith, 2005; Reiner et al., 2004).

Even within the history of Western civilisation, certain scholars have recognised the continuity between humans and other animals. For example, St. Thomas Aquinas wrote about 400 years before Descartes, "These powers [of thought and feeling] in man are not so very different from those in animals, only they are heightened" (quoted in Walker, 1985). In addition, Descartes' contemporaries, including Voltaire and Hume, passionately contested Descartes' assertion by affirming that the mental abilities of animals were different from those of humans in degree, rather than in kind, a central tenet presented by Charles Darwin in his *Descent of Man* (1871). A year later Darwin further expanded on the theme of evolutionary continuity in his publication of *The Expression of the Emotions in Man and Animals* (1872, 2006) in which he based his position on anecdotal accounts from correspondents and careful observations of his own cats, dogs, and horses, in addition to other animals. Darwin was convinced that animals have subjective experiences, feel emotions including happiness, sorrow and jealousy, and can even display deceit and a sense of humour. He noted that birds "ruffle their feathers when angry or frightened" and cites a Mr. Jennings Weir who notes that when frightened, birds "closely adpress all their feathers" which greatly diminishes their size (Darwin, 2006).

However, despite these insightful authors, many scientists have traditionally considered it naïve anthropomorphism to believe that nonhuman animals experience thoughts and emotions similar to humans. In behaviourism, a perspective that dominated scientific attitudes toward animals in the twentieth century, scholars reverted to a Cartesian anti-mentalism (Sanders, 1999). To behaviourists, the actions of nonhuman animals are either instinctive or the consequence of conditioned response. Behaviourism as a perspective came to dominate ethological studies of the behaviour of animals in their natural settings, and any scholar who attributed thought or emotion to their subjects was derisively condemned by their colleagues as being anthropomorphic or sentimental (e.g. Kennedy, 1992). According to the behaviourist perspective, nonhuman animals behave rather than act.

More recently, evolutionary continuity between humans and nonhumans has been reaffirmed through the perspective of cognitive ethology, which has as its central tenet the assumption that animals are aware (conscious) and are, at least at times, engaged in thought (Griffin, 1976; 1992). Despite this, the anthropocentric hierarchy is still perpetuated through language, by the genderless and inanimate category in which animals are classified. It is not "proper" English to engender an animal; instead anyone's computer grammar checker will quickly tell you that a nonhuman animal is not "him" or "her," or "who," but "it," thus implying that animals are unfeeling objects.[4]

However, most of those familiar with birds, who train birds, live with birds, or otherwise interact with birds on a daily basis, note that they are individuals with personalities and thoughts of their own (Anderson, 2005; Barber, 1995; Howard, 1953; Stanger, 1966; and others). Those who have owned more than one companion bird are quick to point out that each has his or her own unique personality (Anderson, 2005).

This topic is further explored below when we consider the complex phenomenon of anthropomorphism and human–avian interactions.

2.1.2 Varying Attitudes Toward Birds

Attitudes toward birds are diverse within any human population. In addition attitudes toward animals are inconsistent within individuals, in what Rowan (cited in Herzog, 1993) calls the "constant paradox," and indeed, "inconsistent behaviour toward animals is omnipresent in Western society" (Arluke and Sanders, 1996). Thus, people who favour conservation of wild species and humane treatment of all animals may have no qualms about consuming meat, and in fact, are most likely to eat meat (Franklin, 1999).

Feeding and watching wild birds at feeders is a popular leisure pastime within Western societies and is extolled by birdseed and bird feeder vendors as beneficial to wild species (e.g. Kaytee, 2008). Bird feeding is also a means to supplement the diet of wild birds in areas of dense human population where the natural habitat has been fragmented or destroyed (Lincolnshire Wildlife Trust, 2007). Franklin (1999) classifies bird watching as a modern leisure activity and an indirect form of "animal

[4] Peer-reviewed journals such as *Society and Animals* and the *Journal of Applied Animal Welfare Science*, which are attempting to change attitudes toward animals, require authors to engender animals as correct English in their instructions for authors. In addition, the journal *Anthrozoös* allows authors to chose whether or not they engender nonhuman individuals.

consumption". When feeding wild birds, there are certain potential harmful effects, however. Species may become dependent and lose the skill to forage on their own and suffer when the feeders are empty and the humans move or otherwise discontinue feeding. Indeed, Martinson and Flaspohler (2003), speaking of North America, consider bird feeding to be the "largest wildlife management activity in northern temperate regions". Feeding wild birds can also make them vulnerable to predators, such as hawks and cats (Cornell Lab of Ornithology, 2007). In addition, bird feeders are more likely to expose healthy birds to infectious disease, because sick birds are more likely to look for an easy meal, or to tainted food if feeders are not properly maintained (Kirkwood and Macgregor, 2000; Cornell Lab of Ornithology, 2007).

Despite the fact that bird watching and bird keeping are popular pursuits, Anderson (2003) also notes an apparent general Western cultural ambivalence regarding birds stemming from their biological distance from humans. Mullan and Marvin (1999) observe that, "People [attending zoos] just do not seem to be able to relate to birds". Armstrong notes that "Our pleasure in certain animals popular as pets appears to lie, to some extent, in the subconscious acceptance of a resemblance between their faces and our own" (Armstrong, 1970). In addition, Lawrence remarks that, "the cognitive system that we impose upon all creatures that is at least partly determined by similarities and differences between them and *Homo sapiens* – exerts considerable influence over the treatment of animals" (Lawrence, 1995, p. 80).

Serpell (1996) suggests, in a discussion of linguistic classification of animals used as food, that a tension is expressed in the tendency to classify animals more closely related to humans by separate English terms distinguishing their status as meat from the living animal, a form of "verbal concealment". In contrast, there is a tendency to call fish and poultry, animals that are more distantly related, by the same term. Therefore fish is simply fish, and chicken remains chicken, while cattle become "beef," and pigs become "pork", suggesting a feeling of moral ambiguity towards how people react to food animals that are perceived as closer to humans. People perhaps do not have these qualms with the consumption of birds.

The looming threat of avian influenza may also negatively influence human perceptions of birds. The British Broadcasting Corporation (BBC) reported that public hysteria resulted after the news that an infected, wild-caught imported parrot was found in quarantine in Britain. Reportedly, many parrot owners were dumping their pets in shelters or throwing them out the window for fear that their family pet, who has a remote likelihood of ever contracting the flu, would somehow infect them and their families (BBC, 2006). Irresponsible reporting can also contribute to public hysteria against pet birds. A BBC article entitled "*Pet birds may harbour killer flu*," refers to wild caught ring-necked parakeets imported, for the pet trade, from Pakistan to Japan. These birds died, not from the H5N1 strain of avian influenza, but from the H9N2 variety, a less virulent form that causes only mild symptoms in humans (BBC, 2001).

Such scenarios are not unique to the UK. The night after ABC television in the United States aired a fictional "worst case scenario" programme, "*Fatal Contact:*

Bird Flu in America,"[5] one of my students reported that someone abandoned a budgie in a cage on the sidewalk and that their family had taken the bird in.

In fact, the risk of pet birds contracting the H5N1 virus is very low, if no contact between pet and wild birds is allowed (see Fig. 2.1), including contact with wild bird faeces (Defra, Animal Health and Welfare, 2007). However, it is important that bird owners get their birds from reputable vendors, since wild caught birds can still be smuggled across borders illegally without the benefit of proper quarantine to make certain that they are not infected.

Fig. 2.1 Defra poster providing authoritative information on the avian flu and allaying fears about pet bird keeping

[5] The programme aired Tuesday, 9 May 2006.

2.2 Birds as Symbols

Birds cross-culturally have long been powerful symbols linking the natural to the supernatural worlds, since they are transformational creatures who can metamorphose from egg to bird and transcend earth and sky. The earliest known surviving art dates to the Upper Paleolithic period where birds occasionally appear in both portable, and less frequently, in parietal art on the walls of caves (Clottes and Lewis-Williams, 1996). The most numerous avian species represented are water birds, including swans, geese, ducks and herons (Bahn and Vertut, 1988).

In pre-industrial society, birds are associated with shamanic transformation, clairvoyance, and the ability to prophesy and communicate with the supernatural (Clottes and Lewis-Williams, 1996; Eliade, 1964). In shamanic cultures birds are regarded as psychopomps (conductors of souls to the afterworld) and "becoming" a bird while yet alive confers the capacity to "undertake the ecstatic journey to the sky and beyond" (Eliade, 1964). In addition, ancient Maya kings dressed as birds during accession rituals celebrated by human sacrifice (Taube, 1987).

The souls of dead humans were reincarnated as birds, according to ancient beliefs in United Kingdom, an idea that persisted in Europe, at least into the twentieth century (Armstrong, 1970). However, birds such as crows, ravens and magpies were condemned as diabolical by the missionaries who brought Christianity to Britain; men who considered "all things black – except their own robes – as typifying the powers of darkness", and thus black birds came to be considered familiars of witches (Ingersoll, 1923; Sax, 2003). Consequently, the raven, who was once identified with the Norse god, Odin, became identified with Satan throughout northern Europe, and all the Corvidae are known as "Devil's birds" in the folklore of the North (Ingersoll, 1923).

According to Ingersoll (1923) the common adage "A little bird told me," may be linked to a world-wide folk belief that at one time all birds had the gift of human speech. In fact, Ingersoll notes that "Breton peasants still credit all birds with the power of using human language on proper occasions".

Birds do possess several similarities to humans; both birds and humans are bipedal, have musical ability, can form abstract concepts, can use intelligence flexibly for problem solving and "play with joy and mate erotically" (Barber, 1995). Thus, birds in general, especially parrots, with their potential to learn and speak human language cognitively, are problematic because these special qualities tend to blur the boundary between human and nonhuman animal, and in so doing cause disquiet. Armstrong notes that, "suspicion or fear tends to be evoked by real or imagined similarities between the characteristics of other animals and our own. People are apprehensive of anything which appears to have some human qualities without being human" (Armstrong, 1970).

Birds continue to serve as powerful symbols in post-industrial society, but with ambivalence. The bald eagle, for example, both the living bird and representation, has long been a powerful symbol of American nationalism (Lawrence, 1990). However, this special status and federal protection do not confer immunity to the bird, as noted by Lawrence (1990) who describes the illegal killings of several eagles by ranchers erroneously convinced that the animals were predating their livestock. Further, between 200 and 300 bald eagles were deliberately killed over a three-year period in South Dakota to supply a black market in Native American artifacts (US Fish and Wildlife Service, 1983). A quick Google^{TM} search of the web reveals other instances of eagle killings across the United States. Depending on the context and the gender, ethnicity, and socioeconomic class of the individuals involved, the eagle takes on different meanings and may be perceived as merely a marksman's target, a threat to livestock, or as a means of profit, rather than a symbol of nationalism.

Interest in the keeping of one species of bird does not mean that people necessarily extend consideration to all avian species, particularly if they are believed to be a threat to their preferred birds. For example, a multi-state investigation by the US Fish and Wildlife Service resulted in the charging of members of roller pigeon clubs in California, Oregon, and Texas with the fatal beatings and shootings of federally protected raptors (US Fish and Wildlife Service, 2007), who were perceived as threats to their free-flying pigeons. Further, an acquaintance, who is an avowed hunter and conservationist, recently confided to me that she would really like to "shoot those darned hawks," as there are "too many" and they "could kill [her] pet chickens."

Birds, especially colourful tropical birds, are popular symbols used in advertising and parrots may be found advertising beer, casino gambling (Fig. 2.2), clothing stores and restaurants. In these contexts they may symbolise the exotic, the tropical, the luxurious, and the wild. Neither the actual bird nor its welfare are important; it is the idea of the tropical bird that imbues the viewer with a feeling that they are outside their normal social boundaries and can perhaps behave outside the accepted social norms.

Fig. 2.2 The image of a stylized fantasy bird on the side of the steamboat welcomes entrants to the floating steamboat/casino, Isle of Capri Hotel and Casino, Bettendorf, Iowa. Images of both fantasy birds and actual macaws appear outside and inside the hotel casino complex. Photo taken by author

2.3 Birds as "Pests"

How is an organism determined to be a "pest"? According to *Webster's Third New International Dictionary* (Merriam-Webster, 1986), pest is defined as, "*esp*: a plant or animal detrimental to man or to his interests." This definition indicates that "pest" is an anthropocentric cultural construction, and it is clear that cultural beliefs and cultural context influence the determination of what is a pest species (Leach, 1989).

Humans tend to arrange animals into hierarchies or what is described as a "socio-zoologic scale". According to this scale, animals are categorised into "good" versus "bad" animals, depending on their relationship to humans. "While phylogenetic systems of classification rank animals on the basis of biological distinctions, socio-zoologic systems rank them according to how well they seem to 'fit in' and play the roles they are expected to play in society" (Arluke and Sanders, 1996).

"Good" animals (farm animals, pets, animals used as tools) are those that serve humankind without choice and consequently have elevated moral status because they "willingly accept their subordinate place in society" (Arluke and Sanders, 1996). Because they are compliant with human desires, they help to reinforce societal norms and are valued for their contribution. In contrast, "bad" animals have a low moral status because their place relative to human society is unclear, or because they become closer and more visible to humans and thus are seen as potential threats to the order of society (Douglas, 1984). "Since these creatures are perceived as both symbolic and real threats to the social order, they may be killed" (Arluke and Sanders, 1996).

"Vermin" or "pests" are animals that come into human territory, thereby crossing arbitrary human-drawn boundaries, and thus are believed to potentially contaminate individuals or the environment:

> "Although vermin are not usually a physical threat, people often have feelings of disgust or hatred toward them because they are thought to be literally or symbolically 'dirty.' They are believed to pollute what is regarded as pure and create disorder out of order. Segregation, avoidance, or destruction are frequent responses to them" (Arluke and Sanders, 1996).

Thus, birds who appear in agricultural fields or in other socially constructed spaces may be seen as problematic, even though they are simply engaging in natural foraging activities without knowledge of human need to profit from their crops. In other words, their activities should more properly be regarded as neutral or natural, not as calculating or vicious. Further, they may be completely innocent of charges and in fact may be engaging in the eating not of the crop, but of crop damaging insects or seeds from weed bearing grasses found growing in the fields (Dyer and Ward, 1977; Mott and Stone, 1973).

One salient example is the case of the Carolina parakeet (*Conuropsis carolinensis*), a native species of parrot that once inhabited most of the eastern United States (Forshaw, 1977) and was considered to be a threat to orchard crops (Audubon, 1999; Lawson, 1967). It is noteworthy that alleged agricultural damage by the Carolina parakeet was never accurately measured. Further, damage from birds is greater in poorly managed than in well-managed crops (Bucher, 1992; Spreyer and Bucher, 1998).

There is a worldwide tendency for farmers to overstate bird damage, especially when the bird is as conspicuous as a parrot (Dyer and Ward, 1977; Bucher, 1992; Spreyer & Bucher, 1998). From an anthropological perspective, birds are often culturally constructed as pest species with little or no scientific basis for these accusations, yet irresponsible and damaging statements are repeated, prompting agriculturalists to demand lethal control measures, as occurred in the case of the Carolina parakeet. In reality, the Carolina, as illustrated by Audubon feeding on a cocklebur plant (Audubon, 1953), favoured the seeds of this plant that grows in disturbed soils in and around agricultural fields. Consequently, at least one farmer considered the bird to be a "friend" to agriculture for its consumption of cocklebur seeds, a "weed" that is a nuisance to farmers (John Mason Peck, 1831, cited in McKinley, 1960).

The Carolina parakeet was the loser in the human-bird conflict, as the species became extinct in a relatively short time following European colonisation of North America. The last known captive Carolina parakeet, "Incas," died after 32 years at the Cincinnati Zoo on February 21, 1918 (Laycock, 1969). The demise of the native parakeet was due to several factors, including persecution by farmers and the clearing and settling by humans of its preferred habitat, fertile river bottom forests. Saikku concludes that this habitat destruction, combined with persecution as a "pest", the cage bird trade and scientific collecting, jointly caused the extinction of the species (Saikku, 1990).

Humans, who tend anthropocentrically to reconstruct environments according to cultural design, have introduced thousands of animals, plants, and microbes into nonnative ecosystems globally (e.g. Crosby, 1986; Smith, 1999). According to Van Driesche and Van Driesche (2000) few introduced species actually become ecological problems, since most do not adapt, and of those that do, "only one or two cause significant harm". However, some do cause major harm to birds by either predating on them or competing with them. Some of the most harmful to birds include rats, pigs, cats, and snakes (Birdlife International, 2007d). The brown tree snake has recently decimated the avian population of Guam; and introduced pathogens such as West Nile Virus, avian botulism, and avian cholera threaten populations on other islands (Birdlife International, 2007c). In the past 500 years, over 65 species of birds have been lost to invasive species, making "making this the most common contributory factor in recent losses to the world's avifauna" (Birdlife International, 2007c).

Habitat destruction caused by human expansion, however, has certain and disastrous results and is the most serious threat to avian species (Steadman, 1997). Unfortunately, humans are relatively slow to recognise and react to the current acceleration of mass species extinction and the global destruction of habitat, while the importance of earth's remaining biodiversity remains under-studied. Of the 1.7 million species recorded, only 5% are considered well documented and the relationships between many species remain unknown (Broswimmer, 2002).

Some of the most vulnerable victims of human expansion are birds and at least four species have been lost from North America within the past 200 years (great auk, Labrador duck, passenger pigeon, and the Carolina parakeet)[6] (Steadman, 1997). Historically, the avian species at greatest risk are highly endemic populations that inhabit remote islands, but the number of threatened continental species now exceeds the number of threatened island species (Steadman, 1997). According to Birdlife International's Red List, "1,221 species are considered threatened with extinction" and an additional "812 bird species are now considered 'Near Threatened'". In short, conditions have deteriorated steadily since 1988, when the conservation status of avian species was first comprehensively assessed, and 22% of the world's bird species are now threatened with extinction (Birdlife International, 2007d).

2.4 Birds as Objects

The shift from hunting to farming "produced a fundamental change in human relationships with animals," from an essentially egalitarian state to that of master and slave or servant (Serpell, 1996). Domestic animals are dependent on humans for survival.

Since the process of domestication began, humans have interfered with the reproduction of animals and manipulated them for human benefit, often with little regard to their welfare. However, within the context of industrial capitalism, animals have come to be "totally incorporated into production technology" (Noske, 1997). The animal industries have become increasingly mechanised, automated and "rationalised" since World War II, while intensive chicken farming caught on even before (Noske, 1997; Singer and Mason, 1980; Striffler, 2005).

Members of capitalist societies are taught to equate capitalism with progress and civilisation. Although we may not think of the term "capitalism" on a daily basis, there is little doubt that it profoundly affects the way one sees the world, by influencing our "material, spiritual, and intellectual life," and "values" (Robbins, 2002).

Under capitalism everything is assigned a value, including humans and animals. Historically, there has been a tendency to believe that an animal that is not productive cannot be kept, but must be sold for market value or slaughtered for human consumption. Pet keeping, of course, breaks with this tradition, and some criticise pet keeping as an extravagance, when there is still human suffering and poverty in the world. "Food" animals, however, are not fictive family members but are considered objects to be exploited, with little or no legal animal welfare protection

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[6] Until recently, the ivory-billed woodpecker was included in this list. Apparent sightings of a bird or birds were reported from Arkansas in 2004 (Birdlife International, 2005). However, if it survives, its numbers are thought to be quite low and it is still classified as "Critically Endangered" on the IUCN Redlist (Birdlife International, 2007b). Ironically, a new species, the Imperial Woodpecker, is now suspected as being extinct (Birdlife International, 2007b).

allowed for them in the United States, as this would be seen as questioning the rights of the farmer. There are certain social and psychological barriers that are erected between humans and the animals they manipulate, in order to create a strong boundary between human and animal, the consumer and the consumed. This boundary is an even deeper chasm when the animals being considered are birds; animals that are perceptually distant, biologically.

Social scientists have long observed that there is a tension in the way that certain animals bred for human consumption are viewed. The relationship is one of ambiguity, and the "paradox of livestock was marked by their spatial separation from humans" (Franklin, 1999). Historically food animals were part of early cities, albeit as residents destined for human consumption, but during the early nineteenth century food animals and their place of slaughter became relegated to the rural areas outside cities, and hence isolated from the public view. Slaughter houses were tastefully renamed "*abattoirs*," the French euphemism "to fell," and became part of the processes of rationalisation and production lines (Franklin, 1999).

With the mechanisation of agriculture and slaughter, the whole animal carcass was no longer always viewed in the window of the local butcher, but increasingly often as plucked, cleaned and dismembered parcels of body parts in the supermarket. Although carcasses are still on display in butcher's shops in the United Kingdom, in the large chain supermarkets in the United States, apart from the bones, the only memory that these dismembered body parts were ever part of an actual bird may be a highly stylised picture or cartoon character on the wrapper. In processed chicken sold by fast food chains such as Kentucky Fried Chicken and McDonalds, even the bones are removed so that the consumer can be totally detached from the inconvenience and the reality of the death of the individual bird. The meat may be promoted as "Popcorn Chicken" or "McNuggets™", suggesting that these products are not really meat. Striffler (2005) observes that Americans have "come to know chicken in the form of nuggets, fingers, strips, and wings. And along the way we have gotten a lot fatter." Ironically, chicken was promoted as a relatively cheap and healthy meat in the 1970s and 1980s United States, but it is now part of the burgeoning obesity problem in the manner that most Americans consume it. Nor is it cheap (Striffler, 2005).

In late modernity, cheap meat has been widely available and concerns have shifted from acquiring sufficient protein to personal regulation of animal protein and fat intake (Franklin, 1999), in addition to concerns about food safety. However, as Franklin notes, idealised representations of farm animals persist in children's literature such as the "free-ranging mother hen and chicks roaming safely around the open farmyards". Franklin sees this discontinuity between representation and reality not as a rejection of factory farming, but as the:

> "... impossibility of recommending the new intensive production systems as suitable human moral tales for children. In late modernity, the mythic farmyard of children's books is replayed in the proliferation of hobby farms, backyard menageries and city farms, and through the purchase of free-range eggs, hormone free beef and 'stress-free' meats of all kinds. While battery egg production has been the basis of a moral issue for many years, the

> public has been carefully screened from other forms of food production systems and, as a result, has continued to accept intensification uncritically" (Franklin, 1999).

Various authors have noted that the literature associated with the raising of livestock for human consumption reflects the perceptual distance between human and nonhumans who are objectified as inanimate production units (Harrison, 1964; Noske, 1997; Serpell, 1996). There is no guilt in treating food animals like nonsentient objects if perceptually they "do not" feel pain or emotion.

Dr. Donald Broom has done much research into animal welfare conditions in the United Kingdom, and points out that the intensive breeding for meat production in livestock has profound costs for the animals. These include skeletal failures caused by the extra weight, so valued by the producer for high meat yield per animal. For example, the leg bones of poultry often break, resulting in excruciating pain for the animals (Broom, 2006).

Students taking my anthrozoology course are usually shocked at the revelation that the meat that they consume is from animals raised under such inhumane conditions. The pleasant fiction of "old McDonald's farm," however, persists for the mainstream.

Even pet birds are expendable to many. During my study at the veterinary clinic, a client who had a gravely ill cockatiel was urged by her husband to forget this bird, and "just get another one"! Like other pets, birds can be bought and sold, and killed at the owner's pleasure when they no longer fulfil expectations. Some owners simply release their birds into the wild with the belief that they will survive or even be better off, when in fact they are exposing the bird to predation, infectious disease, potential starvation, and/or death from exposure. If the bird survives to procreate with other rejected pets of the same species, then they may form new populations of naturalised birds who may potentially compete with native species for food and nesting sites, or come into conflict with humans who perceive them as an inconvenient menace, or become targets of eradication efforts or "sport" for marksmen.

Within the context of consumer culture humans tend to treat animals as consumer goods or inanimate artifacts (Sabloff, 2001). Consequently, in addition to being "created" by humans, these "artifacts" are not sentient beings, are expendable, and have no moral standing apart from their status as property. Pet stores also encourage the idea that pets are expendable and replaceable, with profit in mind. Sabloff suggests that the new pet "starter kits" sold with birds and other small animals tend to encourage the idea of the pet as dispensable, and replaceable; you can always buy another:

> "These shops also sell 'starter kits,' items that tend to bolster the idea of a living pet as a toy or a project and of caring for the pet as something of a game. Starter kits consist of a brightly packaged assemblage of rudimentary paraphernalia for housing and feeding (and sometimes 'amusing') one's newly acquired pet fish, bird, gerbil, or hamster. When the child has used up the contents of the starter kit he or she is meant to obtain refills with which to maintain the animal. However, this kind of boxed presentation, suggesting the end of the game or project once the contents are used up, tends to encourage subliminally the

> notion of throwaway pastimes, muting the reality that the animal in question has a lifespan and needs of its own surpassing the limited resources in the box" (Sabloff, 2001).

The concept of the "expendable" bird even permeates the veterinary profession. In clinic, an avian veterinarian confided to me that a veterinary colleague had visited with their client and patient during consultation on a hyacinth macaw, a rare bird that often sells for upwards of $11,000 USD in the United States pet trade. During the consultation, the referring vet stated something to the effect, "now here's a bird that you will really treat well (unlike a little budgie who costs much less)". The avian veterinarian told me that he answered that he treats all birds equally well, from budgie to hyacinth macaw, regardless of the bird's monetary value.

Colour breeding is another way in which the bird may be objectified as a consumer product or human artifact. Breeders selectively breed birds for colour mutations that would not normally survive in nature, due to increased vulnerability to predation. Most parrot species are green or mostly green to blend in with vegetation, a natural camouflage. However, breeders have incentive to breed for colour due to the challenge of developing a new mutation, and also because the colour mutations tend to sell for a much higher price than do birds of a normal colour. For example, a natural green hand-raised Quaker parakeet may sell for $200 USD, while the rare lutino (yellow) colour mutation sells for approximately $2,000 USD. Blue Quakers, who are now more common than previously, sell for around $500 USD.

Although there has been little research on how colour breeding can affect the welfare of companion birds, it can be objected to on three major grounds: (i) it reduces the bird to a consumer trend or collectible object, and the naturally coloured birds may be rejected as "run of the mill" (Anderson, 2003); (ii) it could potentially threaten species conservation and the long term genetic diversity of both domestic and wild parrots (Ken Welle, personal communication, 2002); and (iii) it can result in the selection of other traits that are detrimental to welfare (see also Chapter 5 this volume).

A further way in which humans have objectified animals, including birds, is through the breeding of animals for neoteny. Large domed heads, and large eyes as well as behavioural infantilisation, are characteristics of neoteny or paedomorphosis (Lawrence, 1986). Certain pigeon breeds are classic avian examples of physical neotenisation, particularly the Short-face Tumblers who were developed in Europe. The Budapester and the Vienna have disproportionately large round eyes, as do the Ancient Tumblers (see photos in Green-Armytage, 2003). As in dog breeding, where neotenisation has caused whelping complications and breathing difficulties in some breeds, among other problems (Serpell, 2003), birds may also suffer from selective breeding practices for breed standards. "In many cases, the shape of the head and beak [in the Short-face Tumblers] causes feeding problems, particularly with the young, and help from humans or from pigeon foster parents may be needed" (Green-Armytage, 2003).

2.5 Interacting with Birds

Our interactions with birds should be tempered by the fact that first and foremost, most birds are prey animals and humans are predators. Consequently, we must be aware of how a prey animal views the world in order to prevent stress and accidental injury to birds under human control and care. Prey animals tend to be neophobic, an adaptation which helps them survive in the wild but which can cause great stress in captivity (Wilson and Luescher, 2006). This is an important welfare issue with farmed domestic fowl; stockperson–bird interactions are covered in more detail in Chapter 9 this volume.

Recent studies at the University of California-Davis (Meehan et al., 2004), reveal that orange-winged Amazon parrots whose cages were placed near a doorway began feather plucking, an abnormal stereotypic behaviour related to stress. When the same birds were moved to a more secure location, they ceased plucking. Thus, cage location is critical in assuring the welfare of birds, even psittacines who have been captive reared. Further, orange-winged Amazons housed with conspecifics were less likely to develop abnormal behaviour such as stereotypies, and were more easily adapted to novel situations. In addition, introduction of environmental enrichment reduced and even reversed feather picking (Meehan et al., 2002).

Sudden movement can be frightening to a prey animal, particularly if the bird is already nervous from being exposed to novel people, objects, sounds or settings. I remember one veterinary intern that caused my parrots considerable anxiety as she attempted to interact with them by speaking loudly and, flapping her hands in quick and large exaggerated movements, actions which cause stress in birds (Cooper, 2003).

Cooper (2003) discusses a list of stressors and their potential impact on the welfare of captive birds, reminding us that, "all animals have 'fright, fight, flight' distances that vary according to the species and background: a hand reared parrot will tolerate much closer contact with humans than will a recently imported tragopan".

Additional stressors listed by Dr Cooper, with additional commentary by current author, include the following.

- Exposure to noises or sounds in the household (including vacuum sweepers, television and other electrical equipment) or outside (e.g. fireworks, road works and other construction).
- Exposure to other animals, even conspecifics. For example, a male canary that is kept close to others of the same sex may suppress their singing and sexual activity. Nonavian species, such as dogs walking past an aviary or cats that climb on bird enclosures, can also be threats, and although some birds may adjust, others may not.
- Unsatisfactory social groupings. A social bird accustomed to gregarious living may be stressed if isolated, whereas a raptor, that in the wild is solitary except when breeding, may do better alone. Parrot chicks should not be reared alone, as

this may predispose them to phobic behaviour as adults (Wilson and Luescher, 2006).

- Incorrect lighting. Whenever possible, birds should be exposed to their natural photoperiod. Too much light or too little light can be stressful and the amount of light required is relative to a species' natural adaptation. Related to light is the amount of roost time a species receives and this should also be similar to what the bird would experience in the wild. Pet birds are frequently housed in family or living rooms, and even though the cage may be covered, the bird is unable to sleep securely if a television is blaring and people are talking and moving about. In addition, aviaries in extended care facilities for people with disabilities and seniors may be kept in a lobby or other public area that is illuminated all the time. Neonate parrots are often housed in glass aquariums with fluorescent lighting in pet stores, and this may cause stress and weight loss as neonate parrots normally would develop in the darkened environment of the nest cavity (Welle, 2000). In fact the over-exposure to light in young parrots can predispose them to phobic behaviour, and fluorescent lighting, in particular, should be avoided with phobic birds, due to their ability to perceive flicker (Wilson and Luescher, 2006) (see also Chapter 6 this volume). Over time, sleep deprivation can lead to behavioural problems and impaired welfare.
- Temperature extremes. Excessive cold or heat, or abrupt temperature changes can be stressors, although adult birds are endothermic. Thermometers should be installed and checked daily to make certain the temperature is appropriate. In addition, proper levels of humidity, specific to a species natural adaptation, should be maintained.

Further, Dr. Cooper (2003) advises that those working with birds should avoid:

- the wearing of white or brightly coloured clothing; neutral colours are preferred;
- speaking in a loud voice and making exaggerated gestures;
- working under bright lights, especially with nocturnal species;
- long periods of restraint during examination of birds.

When working with psittacines, whose cognitive abilities are comparable to those of primates, it is important to remember that these are very intelligent and sensitive beings. In fact, Pepperberg suggests that working with parrots is closer to paediatric medicine than veterinary medicine. In an address to the annual conference of MidAtlantic States Association of Veterinarians, she described the handling of her star pupil, Alex, when he was hospitalised with aspergillosis:

> "I spoke with the technicians who cared for him. . .. The technicians told me that if they explained what they were doing, he would stop fighting them and, if not submit entirely, at least give only token resistance" (Pepperberg cited in Wilson, 2000).

Visual boundaries between birds and predator species can help reduce stress (see also Chapter 3). At a recent parrot show I attended, a raptor exhibit, including a corvid (African raven), had been set up in the centre of the exhibit hall, and a cage full of Quaker parrots was in plain view of the predators. After much aggravated and loud panicked distress calls, the owner of the parrots covered the sides and backs of the cages so that the predators and parrots were no longer visible to each other. The raptor exhibitor also placed the raptors on short perches on the floor so that they were hidden to other parrots in the building. The parrots subsequently became much calmer and the building much quieter.

Prey species tend to have vision that is very good for detection of movement peripherally, and therefore the eyes tend to be located in the sides of the head, rather than binocularly like predators. Parrots often turn their heads or bodies sideways, as visual resolution may be higher in the lateral or monocular field, rather than the frontal field (Graham et al., 2006). Therefore, when working with nervous birds it may be better to look at them sideways or with one eye so as to emulate a bird's field of view and to avoid the impression that you are stalking them.

Subtle changes in a bird's environment can be cause for alarm, as in the wild these changes may indicate that a predator is nearby. In my research, many companion parrot owners report that their birds have distinct dislikes of certain colours, a preference that varies with individual birds. When someone changes their appearance, such as in cutting or colouring their hair, wearing a hat, painting their nails or wearing new articles of clothing, they may appear as a stranger and potential threat to birds. Further, the addition of an illustration or even a stuffed toy with prominent eyes within a bird's field of vision can also trigger stress and anxiety, as the large staring eyes may be perceived as those of a predator. Companion parrot owners are cautioned to introduce new objects – toys, cage appointments, and other things, gradually – so that the birds are not frightened (Doane, 1998). Glendell (2007) encourages companion parrot owners to handle a new object, and especially put it to (but not actually in) one's mouth a few times while naming it, before offering it to the bird.

Wilson and Luescher (2006) note that bullying a parrot into accepting something new will only result in increasing the bird's fear, while gradual desensitising to the stimulus is the most productive and humane strategy.

Birds will certainly be fearful of predators who they can see through a glass boundary. Tragically, as reported on an Internet list serve of which I am a member, a parrot recently died due to self injury in trying to escape a hawk who hovered outside the window where the captive parrot was placed, trapped in a cage. A transparent curtain over the window will still allow the bird to see out, while restricting the vision of predators. Doane (1998) cautions bird owners to turn off wildlife programmes depicting predators such as swooping hawks or owls as these may cause the birds to react with fear. Other birds will react to the sound or appearance of snakes on television, as reported on another Internet group.

In addition, sounds from the routine cycling of heating or cooling units may cause distress and the introduction of a low, constant source of "white noise" may help to reduce stress levels in captive birds by muffling sudden, loud background noises (Anderson et al., 2003).

In the wild, shadows may presage a predator attacking from above or behind, and I have noticed, even in my domestically reared parrots, that late in the day when shadows lengthen, they become nervous and wary, and may even begin saying "night, night," to encourage me to put them to roost for the evening.

Further hazards to captive birds include windows, mirrors, and light coloured walls, all of which appear as open spaces to birds who may be unable to detect the solid matter until they strike it. Additional dangers in the home include open vessels of liquid, including pots of water or oil, and open toilets, and fumes from non-stick cookware, air fresheners, and caustic cleaners, all of which have been known to kill birds. In addition, smoke from tobacco, marijuana, candles and fireplaces may also be potentially toxic to birds with their sensitive respiratory systems.

2.5.1 Communicating with Birds: Intersubjectivity

Barber (1995) suggests that people tend to dismiss birds as a group as complex robotic automatons, rather than as individuals, each with unique personalities and life histories. Why do people treat birds so dismissively, and how can the public be persuaded to see things from the avian perspective? Barber outlines a series of reasons why people tend to treat birds as mechanomorphs: (i) few people ever become acquainted with an individual natural bird because most wild birds fear people; and (ii) because of the assumption that all birds of a given species and sex are interchangeable.

When scientists describe the behaviour of a specific bird, it is perceived as representative of a species, not as an individual living a life with a history and experiences. Sabloff (2001) suggests that this perception is encouraged by the atmosphere of the pet store, where animals sold as pets usually arrive already weaned and often singly, and therefore the store personnel rarely see them interacting with their parents or other conspecifics. Instead the animal nature of the future pet is "muted" to transform it into a living toy or pseudohuman. Thus birds are caged and their wings trimmed so that they are deprived of natural flight.

The mechanomorphic model of behaviourism derives from the Cartesian model and the assumption that birds "resemble programmed robots, that the behaviour of conspecific birds of the same sex and age does not differ significantly", and that "if you've seen one, you've seen them all" (Barber, 1995).

Birds communicate with both their bodies and voices. Anyone who has spent much time thoughtfully in the company of birds has probably begun to recognise certain patterns of behaviour that reflect their varying moods and emotions. Indeed, being familiar with a companion bird's body language can save someone from a painful bite! Even well socialised companion birds who enjoy being touched by their human companions have times when they do not wish for human interaction and will signal this to their owners through their posture, feather position, dilation of pupils, breathing, and vocalisations (Heidenreich, 2005).

Can there truly be interspecies communication? Is it possible for humans to understand what is going on in the mind of a bird? The field of cognitive ethology assumes that nonhuman animals have conscious experiences at least some of the time (Griffin, 1976). Recently some social scientists have tackled the problem from the perspective of social theory, and the sociologist, Leslie Irvine (2004), has devoted a book toward defining animal selfhood. Other sociological studies include Alger and Alger (2003) who studied feline behaviour in a shelter setting and believed that they were able to understand the moods and thoughts of the cats they observed, as well as Sanders's studies of human–canine interactions and canine self-hood (Sanders, 1993, 1999).

Several authors have published books and DVDs on bird behaviour. Glendell (2005, 2007 and see Chapter 4 this volume) and Heidenreich (2005, 2006, 2007) apply scientific positive reinforcement and shaping techniques to modify psittacine behaviour and encourage more positive human–parrot interactions. Rach (1998) has devoted an entire book to understanding companion parrot behaviour and body language.

Bateson (1972) suggests that for humans to communicate meaningfully with other species, they must first learn the metaphor system of other animals. However, for them to do so they would first have to understand animals in their natural life cycles and behaviours. Sabloff (2001) observes that few pet owners consider this sort of information essential to properly care for their pets.

2.5.2 Anthropomorphising Birds

One way that humans relate to other animals is through the attempt to imbue them with human qualities and social identities. This can have positive attributes for the animal by according them a special social status as family member. Thus "Freddi," the macaw, who resides in an American household, participates in family meals, especially holidays such as Thanksgiving, and has a voice in deciding who his owner's daughter shall wed, as the future prospective spouse will likely become the long-lived bird's adoptive "parent" (Anderson, 2003). In the same family, the parrots also helped decide that a couple experiencing marital difficulties should reconcile, since during a trial separation the parrots cried for the missing spouse by name so plaintively, that the couple decided that the birds knew best (Anderson, 2003).

Birds increasingly are popular pets and may become every bit as important to their owners as cats, or dogs, and, in some cases, human children. One participant in an avian companionship survey confided to me, "I actually like my parrots better than my kids, but don't tell them that!" Socially, birds may be accorded many of the same family rituals as human family members, including celebrations of birth or hatch days, seasonal holidays, and a funeral upon death with burial in a human-style cemetery with grave stone and carved epitaph (Fig. 2.3).

However, human family members cannot be so easily disposed of through euthanasia, re-selling or re-homing as birds can be.

Anthropomorphism can also be extremely damaging, when caretakers ignore the unique needs of a nonhuman species by treating them like humans. In analysing the results of a survey on avian companionship, I found that most of the participants who said that they took their birds to an avian veterinarian for regular "well

Fig. 2.3 Tombstone of "Pete (1973–1983)". "The most adorable talking mynah bird in all the world! Loved by Mino, Helen, David, Debbie & 'Bubbie'". In Pet Haven Cemetery, Peoria, Illinois. Photo by author

bird" checkups also admitted to feeding human snack foods high in fat and sugar (Anderson, 2005). This is a potential health concern since many captive birds may develop hepatic lipidosis or other life threatening diet related diseases. In discussing anthropomorphism in class with students, one student volunteered the sad information that one of her friends decided that their parrot should "get high" with them, but the bird died from the effects of the marijuana smoke. During my observation in the veterinary clinic, a distraught owner drove several miles without a valid driver's licence to get medical care for her visibly ill Amazon parrot. She told the vet that money was no object for her friend, but also told us that the bird's favourite foods were "orange sherbet and hotdogs," perhaps questionable foods even for humans. Also in the clinic, a mother and daughter discussed offering a candy bar to their African grey parrot as a treat for the indignity of suffering a veterinary exam. The daughter wanted to give a whole candy bar, but the mother said that the bird should only have half! Discussions of offering alcohol, another highly inappropriate and potentially fatally toxic substance for animals, sometimes also crop up on the avian interest lists that I monitor.

It is important that birds be recognised as having their own unique dietary and physiological needs. They are not really "little humans in feathers," as some owners remark. Avian veterinarian, Dr. Kenneth Welle (personal communication, 19 December, 2007) describes treating birds anthropomorphically like human children, with human motives and needs, as the most common error that bird owners make in misunderstanding their birds.

2.5.2.1 Birds as Fictive Children

Many owners see their birds as direct substitutes for human children and refer to them as “fids” or “feathered children” (Anderson, 2003). This trend is encouraged by popular publications such as *Bird Talk* where many of the featured topics echo nearly the same themes found in popular magazines devoted to human infant care, e.g. “weaning stress,” “toilet training,” “first words,” and so on.

Of course birds do not produce or consume milk like mammals (although certain altricial species such as doves and flamingoes produce a substance called “crop milk” for feeding their young), but prior to weaning, many species of nestlings must be fed a partially digested diet regurgitated to them by their parents. In captive parrot breeding operations for the pet trade, young birds are usually taken from their parents and hand fed manufactured formula until they are of age to wean to adult foods. The purpose of this is to socialise the young birds so that they will be better human companions and pet products. Further, a breeding pair can be more rapidly set up to produce more chicks once the nestlings have been removed.

A popular myth that has been perpetuated by some unscrupulous parrot breeders is the idea that birds will bond better to their new owners if they finish hand feeding and wean the young bird themselves. This practice has unfortunately led to many premature deaths and maladjusted birds, as the process of hand feeding is potentially dangerous due to the precise temperature requirements, exacting standards of cleanliness, and necessity of properly administering the formula so that the chick does not aspirate the preparation into their respiratory system and suffocate (Jordan, 2007). Crop burns, sour crop, crop stasis or aspiration of formula are all potential dangers that even experienced hand feeders may encounter. The American Federation of Aviculture has responsibly adopted a policy encouraging its membership to refuse to sell unweaned babies (AFA, 2008). “The very best parrot breeders and bird stores no longer sell baby parrots that are still hand-feeding, preferring to wean them prior to sending them to their new homes” (Wilson, 2003).

Another problem associated with weaning is the tendency of some parrot owners to keep their parrots perpetual babies by refusing to wean them. The owner will insist that the bird refuses to eat an adult diet so that the bird continues to act like a dependent chick, constantly soliciting their owner’s attention for food. This problem is often seen in cockatoos, birds who may crave attention and are very soft and cuddly (Kenneth Welle, personal communication, 2006).

In a recent ethnographic study that I did in clinic with a veterinarian who specialises in avian and exotic medicine, I witnessed this phenomenon. A client brought her 4 year old adult male umbrella cockatoo to the clinic because she said he was not eating normally. The bird should have been weaned when he was a few months, not years old. In fact, the bird had been previously successfully weaned in less than a week by clinic staff. However, back at home the owner had continued perpetuating the bird's dependence on her. The poor bird was clearly very confused, and though he was a sexually mature male, behaved submissively like a young baby.

While the vet spoke to her, the woman stroked the bird as she held him on her lap, which the bird shared with a small terrier dog. The vet exhorted her to properly wean the bird. He told her that if she didn't begin to behave appropriately toward the bird, it was a matter of time before she would have to re-home or euthanase the bird, due to excessive screaming or misplaced sexual frustration and aggression. The woman nodded apparent agreement as she inappropriately continued stroking the bird, even after she was cautioned that it was a sexually stimulating behaviour. In private, both veterinarians expressed their sadness and disgust at the client's lack of concern with the problem she was creating. The avian specialist opined that the owner's behaviour was like a "human mother French-kissing her own child"! The vet treating the cockatoo agreed, saying, "I told her that she was molesting that bird"! Both predicted a sad end for the cockatoo.

Another way that people may anthropomorphise their companion birds is through dressing them in clothing that resembles human costumes. For example, the "Avian Fashions" website sells flight suits in many different themes for all size of birds, from budgie to large macaw (Avian Fashions, 2008). The "flight" suit features a diaper (nappy) that captures the droppings and keeps them from touching the bird, and thus sanitises their bodily excretions like those of human babies. "Flight" suit is an ironic name, since the purpose is to prevent flight from the owner, rather than allowing the bird to fly. Costume themed flight suits include "Santa Claws", "Tux with Tails", a patriotic "Uncle Sammy", the "Birdy Bunny" and the "Disco Birdy" and holiday themed costumes such as Halloween and Christmas. Most of these "flight suits" are used to restrain the birds by tethering them to their owners so that they may be taken outside. Owners apparently think it "cute" to dress their birds up to share human holidays. However, this can be very stressful for the bird, particularly if this is done with an adult bird who is unfamiliar with such attire.

One contributor to the *Quaker Parakeet Sentinel* (Patterson, 2005) reported that he tried to dress his goodwill ambassador "Cookie," the Quaker Parakeet, in an outfit to advertise the merchandise he sells through his travelling store, and poor Cookie responded to the indignity by promptly flopping on her side and emitting a plaintive cry. No matter the number of times Cliff righted her, she immediately flopped over on her side, complaining loudly until he removed the offending garment. The normally good-natured Cookie was standing her ground. No one was going to dress her up in one of those ridiculous suits!

Some pet owners refer to their avian companions as "little people in feathers," or "little green man in a feather suit". The metaphor of kinship obscures the fact that birds are not humans but have their own species-specific physiological and psychological needs. Pet product manufacturers tend to also promote the kinship metaphor by promoting pet products that seem designed for people, rather than pets.

"A bird 'sandwich' turns out to be a seed combination made to resemble two slices of bread held together by a filling. All of these commodities tend to make one forget that are meant for use by animals and greatly encourages the idea that the pet is really a human being" (Sabloff, 2001).

2.5.2.2 Failure to Recognise the Prey–Predator Relationship

Another harmful way that owners may anthropomorphise their birds is through allowing them to interact or "play" with predator species pets such as cats or dogs. These owners seem to assume that the animals have developed a friendship and that the animals will play like well behaved human children with no danger to the birds. Even when cautioned by more experienced bird owners, these headstrong owners insist that their birds will come to no harm. It is a matter of time before instinct results in the predator pet killing or severely injuring the bird and the tearful owner brings the tragic news to share with the list. One owner naively thought that her pet rat could play with her bird and was quite astonished to hear that rats are predators, and that the introduction of rats by European ships during the colonial period is attributed with the destruction or endangerment of many bird species on islands. Another bird owner reported that their pet cockatiel had been killed and consumed by a pet turtle.

Unfortunately, this tendency is encouraged by such irresponsible television programming as the Animal Planet programme, "The Planet's Funniest Animals" (Discovery Communications, 2007), where viewers send recordings of "amusing" things their pets do and the ABC programme, "America's Funniest Videos: Pets and Animals" (ABC, 2008). On several occasions I have seen footage of birds interacting with cats and dogs with no restriction or protection from their owners. A cat owner was filming baby blue jays when the parent birds begin attacking her cat who was allowed to roam at large. As one watches the film the owner laughs, while the parents frantically try to protect their babies from the invader. In another video, a dog is allowed to jump repeatedly at two budgies in a cage who try to get away from the dog ("Kasha the Neurotic Bouncing Dog") but cannot escape.

Pet owners with multiple pet species sometimes seem exceptionally naive about the impact of predator pet species upon birds. Recently, as I sat in clinic awaiting my appointment with my two parrots, I heard fearful honking and wild wing beating against the door in the neighbouring exam room. Based on the nature of the vocalisations, I mistakenly thought my neighbour was a goose, unused to human contact. However, the poor bird turned out to be a pet Amazon parrot whose owner had recently introduced young, rambunctious cats to the household. The bird had been getting no sleep as the owner allowed the cats in the same room, even allowing the cats to climb under the cage cover and crouch over the poor bird at night! It was small wonder that the poor bird had frayed nerves. Further, the owner misinterpreted the plaintive loud "honking" of the bird as an "attitude" or dominance behaviour, rather than correctly interpreting it as fear. A separate, cat free, sleep room for the bird was prescribed after a lecture on avian behaviour.

Avian and exotics veterinarian, Dr Margaret Wissman, lists "Other Animals" as number five in the top ten killers of companion birds (Wissman, 2006). Other birds also need to be considered, particularly when there is a size difference between different species.

2.5.2.3 Attributing Human Motives to Birds

A further deleterious way that people may anthropomorphise birds is through attributing human motives to their natural behaviour, a phenomenon occurring in both scientists and lay people. The ornithologist David Bohlen (1989), for example, writing about the naturalised Monk parrot populations in Illinois, states:

> "These parakeets are considered fruit and farm pests in their normal range and therefore are being eliminated when they occur in Illinois. But in fact their *maliciousness* toward people has yet to be demonstrated in the Northern Hemisphere" [emphasis mine].

In the last statement, antisocial human qualities are attributed to a nonhuman species, hardly an objective assessment. Spreyer, senior author of the life history of the Monk parakeet (Spreyer and Bucher, 1998), contends that authors rarely treat the bird objectively (Spreyer, 1998): "Unfortunately, some of today's ornithologists continue to ignore the facts and maintain that the parakeet is a looming threat, having still to prove its innocence". Ironically, Bohlen (1989) does not mention the introduced parrot as a possible substitute for the extinct Carolina parakeet, in contrast to his assessment that the deliberately introduced Old World Ring-necked pheasant has taken the place of the prairie hen in Illinois (Bohlen, 1989). The pheasant, although equally non-native to Illinois or even the "New World," fits the sociozoologic status of a "good" animal, as it is a bird that is popularly hunted by hunters and is even bred and released by the thousands for this purpose by the Illinois Department of Natural Resources.[7]

The title of the book, *Our Bird Friends and Foes* (Atherton DuPuy, 1925), a popular scientific book on birds introduced by the dean of American ornithology, Robert Ridgeway, also describes birds as capable of being friends or enemies, again attributing human qualities (Fig. 2.4). In his discussion of the mocking bird, DuPuy sees the bird as a human ally: "They constantly fight on man's side in the great battle of the animal kingdom, that between man and insects". Further, in his discussion of the mourning dove, "Doves eat few insects, so cannot be set down as allies of man in the warfare against this great menace". However, "Doves, year and year out, are great weed-seed eaters, and as such work constantly to keep down the same plants that man fights with hoe and plow. They are thus his good friends and allies and as such deserve good treatment" (DuPuy, 1925).

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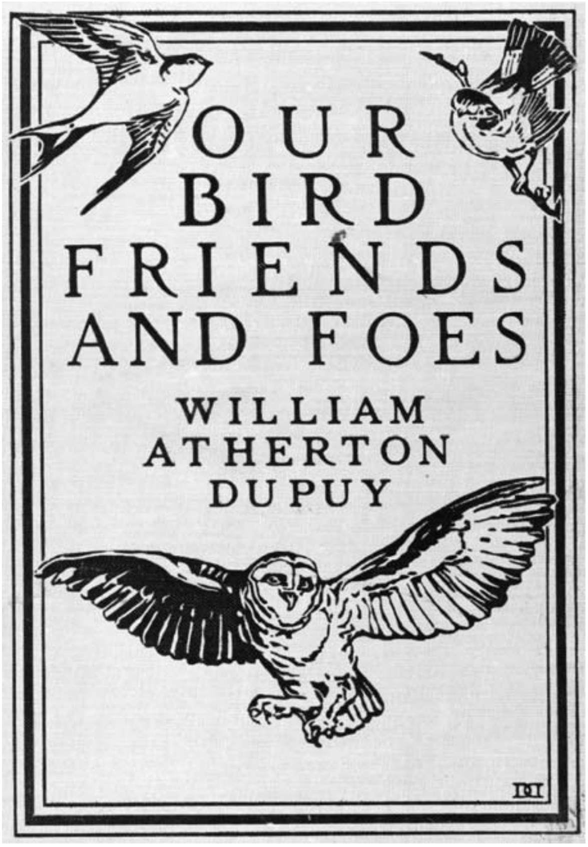
[7] Illinois, in 1904, became the first in the United States to operate a state operated game farm for the production of captive pheasants to be released for hunters. About 90,000 pheasants are raised and released annually at state operated Department of Natural Resource controlled hunting sites in Illinois.

Fig. 2.4 Book title with anthropomorphic and anthropocentric title. Photo by author



The natural subsistence activities of the birds are thus interpreted as having a moral value, so they may be characterised as "good" animals when they are useful tools to human kind or as "bad" animals when they cause conceptual or actual problems (Arluke and Sanders, 1996).

On an individual level, people do not naturally understand avian body language and behaviour and it must be learned as in any communication system. Consequently, I have observed that many who are inexperienced with birds frequently misinterpret bird behaviour by attributing anthropomorphic motives. In posts to Internet avian list serves I often see companion parrot owners refer to "vicious" or "mean" behaviour by their parrots. Parrot behaviourist, Mattie Sue Athan, works with parrot owners to correct their misunderstanding of how they relate to their birds and cause them behavioural problems. After working with parrots for more than 30 years, Athan revealed that the only birds she could not help had owners who failed to understand that they were causing the problem behaviours (Athan, personal communication, 2007). I have also witnessed people reacting negatively to my own birds.

For example, while a friend was visiting, I thought I would introduce my Pionus parrot to him. When I walked into the kitchen where he was seated, the bird flew from my hand toward him then veered away. The (rather large male) friend panicked, and threw up his arms while shouting, "Don't let it [sic] on my head, don't let it on my head!" My sweet and shy Maximilian Pionus, who was quite distressed at seeing a stranger in her home, had tried to escape a perceived danger. My friend misinterpreted and assumed that the bird intended to attack him.

On another occasion, a relative who was visiting my home walked suddenly into the bird room, and the Pionus, who was confined to her cage, began thrashing against the cage bars, trying to escape this sudden frightening intruder and potential predator. To my astonishment, the relative (who had grown up on a farm and worked with and owned many species of animals during her life including poultry and doves), instead of correctly interpreting the bird's behaviour as a fright response, shouted, "Oh my God, look how mean that bird is! He [sic] wants to kill me!" In both cases, a natural fear response was misinterpreted as aggression.

Another example is the case of the fearful Amazon parrot, described above, whose "honking" fear vocalisations were misinterpreted by its owner as aggression or an "attitude," rather than frayed nerves resulting from being stalked nightly for a month by a group of cats who allowed the poor bird no sleep.

2.6 Educating the Public About Avian Welfare

Barber (1995) boldly predicts that in the future, the gradual realisation by people that birds are not machine-like drones, but instead conscious, intelligent beings, will cause a revolution in the way in which humans perceive themselves and their relationship to other species:

> "Science, religion, and philosophy will be fundamentally different. No longer will scientists assume that humans are the only intelligent life on planet earth; on the contrary the next generation of scientists will be increasingly aware of the conscious, intelligent life that covers the surface of the earth, beginning with the nearby birds and extending out to the other living beings" (Barber, 1995).

Although his prediction may be naïvely optimistic, Barber makes an important point in his work, *The Human Nature of Birds*. People tend to be more positively attracted to animals that are charismatic, those that are awe-inspiring, or those that can be easily anthropomorphised, or in other words, those who can be perceived as more similar to humans. Consequently, the giant panda, and marine mammals such as whales and dolphins are considered charismatic, while birds tend to be perceived as less so (Mullan and Marvin, 1999).

Anthropomorphism is a cultural construction and like other cultural phenomena, is correspondingly complex. To attribute human motives and human dietary needs to birds can jeopardise their welfare, but to dismiss birds as complex automatons is absurd, based on the mounting scientific evidence otherwise, and potentially equally harmful. That is not to anthropomorphise birds, but to emphasise the qualities that they do share with humans. Indeed, what precisely sets humans apart from other animals is becoming less clear, and the human/nonhuman boundary further blurs with each successive scientific study demonstrating continuity of life forms (Noske, 1997). As Darwin (1872, 2006) suggested, the differences between humans and nonhumans is a matter of degree rather than a clear-cut boundary.

Many different species of birds make and use tools, an attribute once considered unique to humans. Symbolic thought, the ability to make and use symbols to flexibly express thoughts and ideas, has been demonstrated in the ability of parrots to learn a human language and use it appropriately when taught to do so (Pepperberg, 1999, 2006). The famous grey parrot Alex, Pepperberg's late star pupil, even made novel word combinations, to descriptively name almonds "cork nuts," and apple as "banerry" because he thought apples tasted like a cross between a banana and a cherry (Arlene Levin, Remembering Alex List, December 2007). Further, the vocalisations of songbirds and parrots have been recognised to exhibit regional dialects or variations (e.g. Nottebohm, 1969; Wright and Dorin, 2001; Wright and Wilkinson, 2001), suggesting that these are systems of communication that are learned, and passed on like a cultural tradition, similar to human languages, rather than innately programmed calls. Wanker et al., (2005) observe that spectacled parrotlets (*Forpus conspicillatus*) make unique vocalisations or name-tags for individual chicks and their mates.

Monogamous pair bonding, altruistic behaviour, the exhibition of complex emotions – grief and joy – the ability to mate erotically, and musical ability have all been discussed by Barber (1995) as attributes that birds share in common with people. During Victorian times, birds were pointed to as positive role models of fidelity and the proper family for human children (Grier, 2006). Lawrence (1997) notes that birds are very popular animal symbols because of their enviable attributes:

> "They are superb navigators, finding their way over long distances, even in fog or at night. They are builders par excellence, constructing complex nests and bowers – tasks that require skill and appear to involve conscious intent and prior planning. Some species engage in spectacular courtship rites with elaborate displays and dances. Birds demonstrate faithfulness in incubating their eggs, and show nurture, and even altruism, toward their young. Their unusual capacity for flight sets birds apart" (Lawrence, 1997).

Although we may consider that birds should be allowed to exist in their own right, people in western societies are brought up under a culture of capitalism to attribute greater value to beings who make important contributions, particularly economic, to the world. Under a "sociozoologic" scale (Arluke and Sanders, 1996), "good animals" are those who make a contribution to society. Therefore, in addition to emphasising common attributes, educators should emphasise the important contributions that birds make to ecology, agriculture, and culture.

Birds make tremendous contributions to this world as pollinators, and broadcasters of seeds that help to keep whole ecosystems vital. Woodpeckers and other insect and invertebrate feeders help to control insect populations, and large carnivores help to regulate populations of mice, voles, rabbits, squirrels and fish. Spruce budworms cause severe damage to northern and western forests each year, damage that would be more severe if not for the five out of six budworms that are eaten by migratory birds (US Fish & Wildlife Service, 1999).

Detritivores or scavengers such as vultures, crows, and eagles keep areas clean by consuming dead animals. In addition, almost all birds are prey to other species, and hence an important part of many food chains. In short, birds are essential to a healthy earth. It is clear, that even within the context of capitalism, birds more than "pay" their way and can be viewed as "good" animals from the perspective of the sociozoologic scale (Arluke and Sanders, 1996).

If it is your role to educate others about birds, be passionate, knowledgeable, and interesting! Know your audience and shape your vocabulary and presentation accordingly. Do not speak over your audience's comprehension level. On the other hand do not be patronising. Use both accounts of birds in general and individual birds to illustrate your points. Be enthusiastic! Although his scientific credentials might not bear scrutiny, few could fault the very popular late Steve "Crocodile Hunter" Irwin on his enthusiasm in publicising the plight of non-charismatic wildlife.

Scientists are schooled to be objective and dispassionate about their subject matter by making no attachments to individual animals, assigning them impersonal numbers instead of names. However, in speaking to the public, it is important to be enthusiastic. Birds are amazing beings and you should let your feelings show. If you are not passionate about your topic, how can you expect to hold your audience's attention?

2.7 Conclusion

Human attitudes toward birds are varied and relate to culture, gender, age, education, socioeconomic status and experience. Within Western societies, dominant attitudes toward animals are deep-seated in perceptual boundaries between human and nonhuman animals, despite scientific evidence of continuity of life forms. Aristotelian and Cartesian philosophies and Judeo-Christian doctrine all serve to reinforce this ideological boundary between humans and animals. Behaviourism further lends scientific validity to this disjuncture by assuming that animals simply react to their environments, rather than have conscious thoughts, feelings, and emotions.

Further attitudes complicating human–avian interactions are based in the perceptual biological distance between humans and birds. The threat of zoonoses also compromises attitudes toward avian species. Perceptually, birds as a group are transformational creatures with the power to morph from egg to bird, and to fly to the heavens. Consequently, they are regarded with some anxiety, and are often associated cross-culturally with the supernatural. Even within Western society, these concerns linger from deeply rooted cultural traditions and attitudes toward birds.

If a bird is able to have conscious experiences, learn his or her name, learn to manipulate human caretakers, and otherwise appear to make conscious decisions, then what does this imply about human–bird relations? Historically many human–bird relations have, in general, been exploitative and incessantly cruel. It could be argued that, because of their superior intelligence, psittacines and corvids suffer the most at the hands of humans, but this leads us to the anthropomorphic trap. We are constantly holding nonhuman animals up to us as a yardstick of human superiority. Other species will never win, with this approach, because no species is exactly like us; in fact each species is unique from all others (Ingold, 1994a; Hull, 1984). A more fruitful approach is to ask the question posed by utilitarian philosopher Jeremy Bentham, "Can they suffer?". Certainly they can and they do. If they can suffer, it can be argued that it is our ethical and moral obligation to give them the best lives possible in captivity, and the most "humane" end possible. Currently most birds are unfortunately treated rather badly at the hands of humans.

The key to bettering human–avian relations is education. Programmes in schools, humane education, adult continuing education courses, community and media outreach, are all potential ways that positive images and accurate information about birds can be conveyed and misunderstanding be dissolved. Birds play profound roles in the ecology, history and present of the world, and the earth would be bereft and moribund without them. We must recognise that we are anthropocentric as a species and that predominant cultural attitudes toward birds are shortsighted, and in the long run will do irreparable harm to the planet and jeopardise human existence. Birds have a right to exist for their own sake, not for our own.

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Chapter 3
The Welfare Implications of Housing Captive Wild and Domesticated Birds

Penny Hawkins

3.1 Introduction

Most captive birds spend their entire lives confined in accommodation that has been designed by humans. While this is obvious, it is important to recognise that the requirements of birds and humans are fundamentally different and so there will inevitably be conflicts of interest with respect to housing and care. In some situations, human interests such as low cost, ease of cleaning and easy observation and access are unfortunately given priority over the birds' requirements. There can also be conflicts between the birds' needs; for example, the requirement for group housing in a stimulating environment can be at odds with the need to reduce the risk of disease. While a degree of compromise will always be necessary in practice, it is important to ensure that every effort is made to identify and overcome obstacles to providing birds with an interesting environment that allows them to behave normally and feel secure. Birds therefore need advocates who are willing and able to balance all of these different factors, consider husbandry from the animal's point of view and help to set up an animal-centred housing system that really will benefit the birds held within it.

Birds are kept for many different purposes in farms, zoos, breeding facilities, laboratories, sanctuaries or in the home as companions, but the basic needs of each individual are the same regardless of the context in which s/he is used by humans. Lower standards are often accepted in law and by society for animals used to produce food as opposed to, for example, companion animals (Appleby, 1999; Young, 2003), but the justification for this is usually economic and should always be strongly questioned. *All* animals housed by humans should be provided with accommodation that allows them to express a range of normal (desirable) behaviours, including exercise and appropriate social interaction, and that protects them from conditions that could lead to physical or mental suffering.

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Inappropriate husbandry can result in poor physical condition and disease, and also has the potential to induce boredom, frustration and social stress in birds, which can lead to undesirable behaviours such as stereotypies (addressed in Section 3.7.3.2). These behaviours are regarded as undesirable because they cause injury to the bird performing them or to others, or because they indicate that animals are, or have been, unable to cope with their environment. It is the underlying *causes* of such behaviours that are truly undesirable, however, and so the behaviours themselves should be regarded as symptoms of a serious welfare problem that is (or was) probably caused by inappropriate husbandry. It is also possible that animals who persist in stereotypic behaviours may be acutely frustrated and distressed by their inability to change their behaviour (Garner et al., 2003). Urgent action is therefore imperative if any of these types of behaviour become evident and the ultimate aim should be to correct the fundamental causes of the behaviour, by comprehensively reviewing all aspects of housing and care (Hawkins et al., 2001). Simply preventing the injurious behaviour, for example by singly housing or beak trimming birds, is not an acceptable solution (Young, 2003). Such measures may be necessary in the short term, but only if there is no other option and they will prevent greater suffering and mortality.

Even in the absence of immediate and serious welfare problems, regular husbandry review is essential to ensure that animals are kept according to current good practice and without causing them avoidable stress or suffering. The ease with which the *status quo* can be challenged will depend on the attitudes of those responsible for implementing and resourcing animal husbandry, since different people can have widely ranging perceptions regarding animals' basic needs and what constitutes good practice in housing and care. Providing practical examples of good housing may be sufficient to convince some, whereas others will demand scientific justification before they will consider reviewing husbandry. The amount and quality of scientific and practical information available varies considerably between species. This is sometimes used as an excuse not to improve housing, yet with some research and consultation it is usually possible to make an informed judgement on adequate space allowances, appropriate group size and composition and the kind of environmental enrichment that should be provided.

It is also essential to recognise that it may never be possible to provide some species with housing that will adequately meet their needs. For example, migratory birds regularly become physiologically and, apparently, psychologically prepared for long flights that are clearly impossible in captivity (Styrsky et al., 2004). The impact of such behavioural and physical thwarting on the welfare of these birds is largely unknown at present. These factors are highly relevant when deciding whether it is justified to keep a particular species captive in the first place.

This chapter provides guidance that will help to improve existing systems or design new facilities that will maximise welfare and minimise stress. Companion birds represent many different species, which are adapted to a broad range of habitats and can have widely differing needs. Guidance here will therefore be confined to setting out the fundamental principles that define best practice for housing birds, with some examples to help set these in context.

3.2 Basic Principles of Good Practice – A Summary

Housing for birds should promote their physical and psychological welfare, facilitate and encourage appropriate behaviours, and minimise the occurrence of undesirable behaviours. Good housing will therefore:

- allow sufficient space for exercise and appropriate social interactions;
- provide good quality space;
- simulate appropriate wild conditions;
- encourage a range of behaviour and a time budget broadly similar to that observed in the wild; not induce undesirable behaviours, or else distract birds from performing them;
- include compatible conspecifics (for social species);
- promote good health (Young, 2003; Hawkins et al., 2001).

This section will provide some further explanation of these key points and provide an overview of factors that need to be considered.

3.2.1 Sufficient Space

Providing adequate space is critically important, not only to accommodate the resources necessary to provide a stimulating environment (see below) but also to ensure that individuals are able to exercise adequately and to interact socially without conflict. In many cases, captive birds can never be given too much space, yet in practice there have to be limits. Setting such limits can be problematic because of the competing factors and interests – welfare, practical husbandry, economic – which have to be taken into account. There are unfortunately few standards for bird husbandry that give the animals' basic needs due priority. This chapter provides some guidance on setting more animal-centred space allowances and includes recommendations for some species that are commonly housed by humans.

3.2.2 Good Quality Space

Simply providing more empty space for animals is of limited value unless suitable objects and resources are added that will facilitate a range of activities in different areas (Young, 2003). The species, type of housing and the previous experience of the individuals concerned should dictate what is provided in practice. It is also essential to strike a sensible balance between providing stimulation and allowing for other requirements such as free flight (where appropriate) and the ability to catch and monitor the birds. Many species will benefit from perches, swings, branches, dust baths, water baths or ponds, while refuges and barriers can provide feelings of security and allow subordinate birds to escape. Some objects may be used by captive birds although they do not occur in the wild, e.g. Kong™ toys and other commercially available toys intended for companion birds or for other animals such as cats. Such objects should not be discounted just because of their artificial nature, although they should be used with care since they may have been designed to appeal to humans rather than the species in question (Morris et al., 1995; Young, 2003).

3.2.3 Simulating Appropriate Wild Conditions

Reproducing or simulating relevant features of the natural habitat of the species is crucial if a broad range of appropriate natural behaviour is successfully to be encouraged (Carlstead and Shepherdson, 2000; Anonymous, 2001). Some consideration of the biology and behaviour of the species will be necessary to determine which habitat features are critically important and how best to provide or simulate them. Where does the species roost and nest; in tree cavities, branches or on rocks? Does it use features of the environment in courtship or feeding behaviours? For example, the domestic pigeon is descended from the rock dove, *Columba livia*, which roosts on rocky outcrops (Hawes, 1984). While it would clearly be impractical to replicate a cliff face for captive pigeons in most situations, providing shelves and nest boxes on a vertical wall will encourage natural behaviour and so benefit the birds (Hawkins et al., 2001). There are more obvious solutions for other species, such as providing several nesting platforms and suitable nesting materials for groups of spoonbills (*Platalea leucorodia*) who nest in colonies (Fig. 3.1). Again, this principle applies to strains that have been domesticated for many generations as well as to wild and more recently domesticated birds.

3.2.4 Relevance of Behaviour and Time Budget in the Wild

As a matter of principle, animals should be free to display a range of natural behaviour that is appropriate for their species (Farm Animal Welfare Council, 1993; Petherick, 1997; Anonymous, 2001). Information on the behaviour of a species in the wild, such as ethograms and time budgets, is sometimes available and can provide useful guidance to help determine appropriate behaviour in captivity (Poole and Dawkins, 1999). This also applies to domesticated animals; for example, modern breeds of domestic fowl have become successfully re-established in the wild and found to display wild-type behaviour despite thousands of years of domestication (McBride et al., 1969; Andersson et al., 2001). However, it is important to remember that not all "natural" behaviours necessarily promote welfare – a bird fleeing for her life from a predator or losing a fight will almost certainly experience a level of distress. The goal should therefore be to protect animals in human care from such obviously negative experiences as far as possible, while allowing and encouraging them to perform behaviours that are likely to promote positive welfare (or reduce negative mental states) such as exercise, foraging, hiding and play (Young, 2003). It is also important to be aware of the way in which the activity of a species varies with circadian and seasonal rhythms and to give due weighting to facilitating all

Fig. 3.1 Relevant features of the natural habitat have been provided for these spoonbills in the form of several nesting platforms, sticks for nesting material and an adjacent body of water (not shown) (picture: Jane Cooper)

behaviours, not necessarily just the ones that the animals perform most frequently. As an analogy, many humans spend most of their time in the bedroom and least in the bathroom, but few people would want to live without a bathroom (Young, 2003).

3.2.5 Compatible Conspecifics

Some avian species are largely solitary, whereas many others are highly gregarious throughout their life cycles and respond poorly to solitary housing in captivity. Different species may also form flocks at certain times of day, e.g. when foraging or roosting, or times of year, such as during the breeding season (Kirkwood, 1999). The requirement of social animals for group living should be taken very seriously indeed. However, if groups are not formed, housed and maintained appropriately, individuals of even the most strongly social species can injure or kill other birds by fighting or injurious behaviour such as vent pecking (Duncan, 1999; Green et al., 2000; Anonymous, 2001). It is essential to research the social behaviour of each species when determining group size and composition with respect to sex and age. Groups must be formed at appropriate life stages, i.e. usually very early in life, kept stable, and housed in good quality environments with sufficient space (see above). Even where all of these requirements are fulfilled, there will inevitably be agonistic interactions between individuals, which will range from short, non-injurious encounters (such as a dominant bird pecking a subordinate, who then moves out of her way) to more serious fights. It is important to accept this yet ensure that the animals are protected from unacceptable levels of injury and stress as far as possible. This should be achieved by good and careful husbandry, not by singly housing birds and denying them the company of their own kind (Hawkins et al., 2001).

3.2.6 Promoting Good Health

Good health is certainly necessary for good welfare, but it is very important not to confuse health with welfare. Too much emphasis on high health standards can result in designing sterile, barren environments in the belief that this is required to reduce disease risk to an acceptable level. Animals housed in such an environment will be healthy and disease-free, yet their welfare will be poor because they are suffering from stress, fear, boredom or anxiety. It should be possible, in all areas of animal use, to strike a balance between adequate monitoring and health maintenance and providing an acceptable standard of welfare (Hawkins et al., 2001).

3.3 Considering Natural Habitat and Behaviour

When designing or evaluating accommodation for birds, it is good practice as a basic principle to first consider the type of habitat in which the species occurs. This is consistent with the assumption that welfare is good when animals are in harmony with their environment. Natural selection has resulted in animals designed to live in a particular, species-specific environment of evolutionary adaptation (EEA) and each species has evolved a number of adaptive behavioural and physiological control systems that enable it to live in such environments (Anonymous, 2001). These systems are partly autonomic but also partly under the control of cognitive and emotional systems.

It is generally accepted that animals living in an environment that contains key elements of their species-specific EEA will perform a wide range of natural behaviours, will not experience housing-related stress and will have a good standard of welfare (Anonymous, 2001). There is a good deal of easily accessible information available on the natural habitat and behaviour of birds, produced for a range of technical levels from popular publications to the scientific literature. It is also increasingly common for publications on domestic birds to include information on the behaviour and ecology of their wild ancestors.

Beliefs that domestic animals are fundamentally different to wild-type birds and fully adapted to the environment that humans have provided for them should always be critically questioned (Jensen, 2002). It is generally the case that animals are simply not able to express natural behaviour in an impoverished environment that does not provide adequate space or resources, but will readily do so as soon as they are transferred to a more appropriate environment. This has been repeatedly demonstrated in domestic fowl (McBride et al., 1969; Andersson et al., 2001) and in domestic mammals including pigs (Stolba and Wood-Gush, 1989), rabbits (M Stauffacher, personal observations) and inbred strains of laboratory mice and rats (Dudek et al., 1983; Berdoy, 2001; Berdoy, 2003). From the available evidence, it is clear that all birds should be given the benefit of the doubt and should be provided with resources that replicate or simulate important features of their EEA.

It will not always be immediately obvious what is, or is not, important to a bird, since birds and great apes (e.g. humans) inhabit very different sensory and cognitive worlds (Hawkins et al., 2001). However, some environmental features are easy to identify and verify, such as water for ducks, and consideration of the way in which species interact with their environment and use the resources within it will provide further guidance. Some examples of habitat features and behaviours to consider when reviewing the literature to inform housing design are set out below.

3.3.1 Range Sizes

Under most circumstances, an individual or group's home range in the wild will be far larger than the accommodation that can be provided in captivity. This is a potentially serious welfare issue; for example, a positive correlation has been defined in mammalian carnivores between minimum home range size and both stereotypic behaviour and infant mortality in captivity (Clubb and Mason, 2003). It has been suggested that these behavioural and health problems are due to confinement in relatively small spaces and also to living in an environment that is not necessarily barren, but is predictable and lacks novelty. The relationship between range size in the wild and the potential for poor welfare in captivity has not been evaluated for birds, but many species range over large areas and take in and assimilate a great deal of information about their environment. Range size is thus a factor that should be borne in mind when determining space allowances for birds.

3.3.2 Locomotion

Birds move by flying, walking, running, swimming and diving. Ideal housing will allow them to perform all of the locomotory behaviours that they would do in the wild, to ensure appropriate levels of exercise and to permit a range of natural behaviours. Flight in captivity can pose particular problems in larger birds, who may have to be prevented from flying to avoid injury (see Section 3.6.5). Any restriction on the ability of birds to exercise in a species-specific way must be very strongly questioned; if such restrictions cannot be overcome then the justification for keeping the birds *at all* should be challenged.

3.3.3 Distances Between Individuals

Normal social behaviour for many species involves maintaining appropriate distances between individual birds (Keeling and Duncan, 1989; Channing et al., 2001). Housing that does not permit this will cause acute and chronic stress that could lead to aggression and other injurious behaviour and is also a serious welfare problem in itself. Precise information on acceptable inter-bird distances will be difficult to find or unavailable for many species, apart from those that are intensively reared such as domestic fowl. Nevertheless, it is important to take social behaviour and spacing into account when deciding on space allowances, especially if there have been problems with agonistic behaviour.

3.3.4 Trees and Other Perches

The requirement for perches for most species seems obvious, especially for passerine birds. However, perching serves different functions and the optimal nature and layout of perches in captivity needs to accommodate each of these. This is covered in more detail in Section 3.5.1.

3.3.5 Cover

Some predominantly ground-living birds, such as quail, are highly dependent on the cover and refuge provided by vegetation such as grasses and shrubs (Buchwalder and Wechsler, 1997). Species that make use of cover in this way are very likely to require some kind of natural or artificial cover in captivity and could suffer significant stress if this is not provided.

3.3.6 Water for Swimming and Bathing

The way in which a species interacts with water in the wild should be used to inform good husbandry practice. Ducks and geese are obviously wetland specialists (to varying degrees), so should not be housed without adequate water for bathing at the very least. Many other species are also motivated to bathe in water and would benefit from water baths in captivity (Hawkins et al., 2001).

3.3.7 Food and Foraging

Good nutrition is essential for health, but it is also vitally important to consider feeding habits in the wild when deciding on the presentation and nature of food, the time at which it is presented, and to suggest suitable treats (Young, 2003). Birds have relatively few taste buds but nevertheless appear to have an acute sense of taste (Welty and Baptista, 1988), so giving treats can improve welfare and encourage birds to seek human contact, if this is appropriate. Note that dietary preferences are shaped by previous experience and care is needed when introducing novel foods – the standard diet should also be available, in case birds are neophobic and reluctant to eat anything new (Association of Avian Veterinarians, 1999).

Many species spend a significant amount of time foraging and should have the opportunity to forage in captivity, for example by finding food scattered in the litter, grazing, picking seeds that have been pushed into a piece of soft fruit, or using artificial foraging devices (Burgmann, 1993; Association of Avian Veterinarians, 1999). Pecking and foraging on the ground is especially important for species that inhabit forest floors covered in litter, such as many gallinaceous birds. There is a strong case that much injurious pecking is misdirected foraging behaviour (Duncan, 1999; Anonymous, 2001; Blokhuis et al., 2001), so it is vital to provide foraging and pecking substrate for these species. It has been suggested that gentle feather pecking is part of the normal social behavioural repertoire of young chicks, since more feather pecking is directed towards unfamiliar than familiar peers and introducing unknown chicks stimulates pecking (Riedstra and Groothuis, 2002).

3.3.8 Object Manipulation

Both tool use and play occur in a number of species in the wild (Marler, 1996). Locomotory, social and object play have been observed in parrots and corvids (Skutch, 1996), so these birds will have a particular requirement for toys in captivity. Passerines such as thrushes, finches and ravens and non-passerines such as vultures are known to use tools in the wild (McFarland, 1993); tool-using species may also benefit from objects to manipulate or devices such as puzzle feeders to provide extra interest. Many other species will use such objects in captivity, so the provision of toys and other objects for manipulation should not be restricted only to those species that are known to play and use tools in the field.

3.4 Providing Appropriate Housing in Captivity

As a general principle accommodation for captive birds should be as large as possible to permit exercise, appropriate social interaction and the provision of environmental stimulation. Pens or aviaries are thus usually preferable to cages, although small passerines can be provided with an acceptable quality of life if they are housed in large, enriched cages. Space is very important but is not the only consideration; the shape, construction and siting of housing for birds also needs careful thought if it is to promote natural behaviour and good health. Many birds will benefit from being housed with outdoor access or even wholly outdoors provided that appropriate shelter is provided for them, so the feasibility of outdoor access should be fully explored wherever possible (see also Section 3.6). Environmental stimulation is fundamental to good housing for birds but is not always given the priority that it deserves; this is considered in Section 3.5.

3.4.1 Pen or Cage Construction, Including Materials and Flooring

The main requirements that need to be considered when selecting materials for the flooring, sides and roof of an aviary are preventing escape, preventing injury, providing physical comfort, achieving the required level of hygiene, providing adequate ventilation, and providing good shelter and security – both from the elements and from actual or perceived predators (Kirkwood, 1999).

3.4.2 Construction and Materials

Animal housing should generally be constructed of smooth materials with no sharp projections for hygiene and safety. Aviaries are usually constructed with some solid sides, to help birds feel secure, and some mesh sides to allow light in and permit them to see and be seen. Mesh roofs provide a view of the sky and help to keep the aviary clean by allowing rain in, but do not provide shelter from rain or intense sunlight so a solid-roofed or internal area for retreat will also be necessary (Kirkwood, 1999).

Solid sides may be constructed of wood or metal; metal is easier to clean, maintain and disinfect but is colder in winter (Inglis and Hudson, 1999). Smooth, hard materials such as metal can also be noisy, both in terms of noise reflection and sounds caused during husbandry procedures such as opening and closing doors and changing food hoppers. Careful enclosure design and husbandry may be necessary to avoid unduly stressing and disturbing the birds. If the aviary is made of wood, it is absolutely essential to ensure that it has been properly treated and will be regularly inspected so that it does not rot or permit the growth of harmful fungi, such as *Aspergillus*. Some species, including many Psittacines, will chew wood, so it is vital to make sure that such species have adequate wood specifically for chewing and that all preservatives are non-toxic.

Suitable grid size, thickness and materials for the mesh sides should be very carefully researched to avoid discomfort or even serious injury. Soft nylon mesh is preferable to wire mesh for roofs and walls because it is more pliant and so less likely to cause injury on impact. However, it is critical to make sure that grid size, thickness and tension are correct for the species in question to avoid entanglement of the limbs or head, which can cause serious damage and distress to birds (Kirkwood, 1999). If wire mesh is used, it should be welded rather than twisted so that sharp ends do not protrude (Inglis and Hudson, 1999).

The level of hygiene required, and the bearing that this has on the choice of materials and the nature of the birds' housing, depends primarily on the purpose for which birds are housed. Very high levels of hygiene and exclusively indoor housing may be required for some purposes, for example veterinary practices, quarantine accommodation and scientific establishments undertaking disease studies or housing specific pathogen free (SPF) birds. In such cases it may be necessary to use specialist paints or laminates for the walls and floor and to install a sealed concrete floor with adequate drainage so that the room can be washed with a high pressure hose (Duncan, 1999). Such measures can restrict the choice of materials for housing and perches etc., but this does not ever justify housing birds in barren, boring conditions. Birds, particularly some Psittacines, produce large amounts of feather dust so their housing should be well ventilated, but never draughty. Adequate rates of air change depend on stocking densities, but in general should not fall below twelve changes per hour.

3.4.2.1 Flooring

Birds should be housed on solid floors, with adequate drainage and appropriate litter if necessary (Hawkins et al., 2001). Suitable substrates vary according to the species being housed, so it will be necessary to research what the typical substrates are that are used by that species in the wild, and how and why the animal uses it. This is especially important for species that forage on the ground (Young, 2003). Sandpaper cage liners are widely available but should not be used for any species as they abrade the feet and may be ingested for the grit after they have been contaminated with faeces (Coles, 1991). Rough concrete floors without any other substrate are especially likely to cause foot trauma and infections, such as bumblefoot (Forbes and Richardson, 1996). Chipped bark, white wood shavings, wood chips or sand are suitable for most Galliformes; gravel over a concrete base for many species including Psittacines, Corvids and birds of prey; and absorbent paper, regularly changed, in indoor aviaries housing small Passerines such as tits (Hawkins et al., 2001).

Some species have highly specialised flooring requirements, and the wrong type of flooring can cause serious welfare problems. For example, in sea birds hard flooring can cause foot lesions, feather damage, pressure sores and staphylococcal infections. Flooring substrate for seabirds should be textured or uneven so as to spread the birds' weight over the weight-bearing surface of the lower limb. Suitable materials are pea gravel, textured rubber or plastic matting, clay, cat litter or swimming pool "anti-fatigue" matting (Robinson, 2000). Similar materials are suitable for waterfowl, who can also be housed on plastic artificial turf, smooth rubber matting or deep pile rubber car mats (Universities Federation for Animal Welfare, 1993) that are comfortable and easy to clean. It may be worth trying materials such as these for other species if flooring causes foot or leg problems. Within outdoor enclosures, flooring may be grass, gravel or concrete, depending on the requirements of the species and the purpose for which the birds are kept. For example, concrete floors may be necessary for faecal collection for scientific or veterinary reasons (Inglis and Hudson, 1999), but frequent and regular foot monitoring will be required.

Birds are sometimes housed on metal or plastic grid floors, ostensibly for improved hygiene, ease of cleaning or the prevention of foot problems. However, grid flooring does not promote natural behaviour (such as foraging, see Fig. 3.2) or good welfare and so it should be avoided wherever possible.

It is sometimes asserted that birds' welfare is not impaired on grid floors, but there is no scientific basis for this. Birds can certainly exist, grow and breed when housed on grid flooring but this does not mean that their welfare is good. Domestic fowl have been demonstrated to have a strong preference for solid flooring

Fig. 3.2 Pigeon pen with various enrichments including good foraging (picture: Anita Conte)

(Farm Animal Welfare Council, 1997), and the consensus is that animals' welfare will be impaired if they are not provided with resources that they strongly prefer. Although little research has been done to evaluate this in other birds, mammals, such as the laboratory rat, also prefer and will work hard to gain access to solid rather than grid floors (e.g. Manser et al., 1996; Krohn et al., 2003). Birds should therefore be given the benefit of the doubt and housed on solid floors; this is especially important for those that spend a significant amount of time walking, such as gallinaceous species. Suitable substrate will not only to help avoid foot lesions but also encourages foraging behaviour (see Section 3.5).

It is undoubtedly true that faeces will fall through grid floors so that they are less likely to be ingested or stick to the feet. However, regular cleaning and replacement of soiled litter will achieve the same effect while allowing birds the physical comfort of a solid floor and the ability to move and interact with other birds normally (Hawkins et al., 2001). Solid floors with litter will also require the expense of providing litter and the extra human resources to clean out cages more frequently and thoroughly, which may be the real (economic) objection to changing from grid floors. With respect to foot injury, birds are prone to foot problems such as overgrown claws, faecal accumulation and foot lesions on any type of flooring. Good husbandry and frequent monitoring of birds' feet is therefore always necessary, regardless of floor type.

There are some cases in which birds cannot be kept on solid floors, e.g. when it is necessary to collect faecal output for scientific purposes. In such cases, it is good practice to provide birds with a solid resting area (e.g. occupying a third of the floor space). Faecal collection can be maximised by ensuring that perches are sited above grid areas (Hawkins et al., 2001).

3.4.2.2 Security and Shelter

There are two aspects to security; (i) how physically secure the birds' housing actually is, and (ii) how secure the birds *feel*, according to the way in which they interpret their environment. Most birds are highly mobile and adept at escaping, and attempts to catch flying birds can cause stress or injury if carried out by people who have not been properly trained or do not have the right equipment. Bird housing therefore needs to be very secure to prevent escapes and also, in the case of outdoor housing, to prevent predators from gaining access. A double-door system is highly advisable for large pens and aviaries housing flying birds. All bird housing, whether indoor or outdoor, should be regularly and frequently inspected to ensure that there are no possible escape routes (Kirkwood, 1999). All outdoor enclosures should be supplied with appropriate shelter to make the birds feel safer and to protect them from adverse weather. In general, aviaries should be sited so as to protect the birds from prevailing winds, but the orientation of the enclosures will also depend on the species. For example, in northern temperate climates it is advisable to have a southwest exposure for aviaries housing tropical pigeons, but northeast for ptarmigan (ILAR, 1977).

The appropriate number of solid and mesh sides in each case will reflect a compromise between the birds' needs to feel that they have a safe refuge and that they are in an established social group. Birds are likely to feel safer, more secure and less stressed if their cage or pen has just one rather than all mesh sides, but this will restrict their ability to see into adjacent pens containing conspecifics if pens are located in a row and/or opposite one another. In practice, judgements on enclosure materials and layout will depend on factors such as the behaviour of the species, previous experience of individuals, number of birds and species housed and so on. Many birds spend much of their time above ground level (except for terrestrial species such as quail) so housing at ground level should be avoided for such species (Coles, 1991). However birds' accommodation is laid out, it is important to ensure that caretakers are able to see inside the housing and that birds are still exposed to, and therefore able to habituate to, humans. This is especially important where frequent intervention and observation is required, for example if birds are under veterinary care or are the subject of scientific procedures.

Aviaries should be screened from paths and from each other, using hedges, fencing or close-weave netting (Inglis and Hudson, 1999). This is especially important if it is not possible to avoid housing predators and prey species close to one another. However, there is an obvious conflict of interests where birds are required to be seen by the public, for example in zoos, "pet" shops, bird shows (in particular) and some rehabilitation centres, since being closely viewed by unknown or even familiar humans is likely to cause stress (Carlstead and Shepherdson, 2000; Young, 2003). Careful thought should therefore be given to the way in which humans are able to approach aviaries (Young, 2003). It is good practice to ensure that they can only be approached from one side and to place the birds' shelter in such a way as

Fig. 3.3 Large flight pen with good natural screening in the form of a hedge together with screened doors which protect the birds from external disturbance (picture: Jane Cooper)

to give them a clear "safe area" if they become afraid (see Fig. 3.3) (Inglis and Hudson, 1999; Carlstead and Shepherdson, 2000). If it is necessary to enter the enclosure regularly to clean and maintain it, sticking to a regular, defined "service route" that avoids nesting and roosting areas will reduce stress to the birds (ILAR, 1977). For comprehensive guidance on appropriate barrier design and materials see Young (2003).

3.4.3 Space Requirements

In common with all other animals, birds need enough space to perform a wide range of behaviour including appropriate social interactions and exercise. Good bird housing should include sufficient space for environmental enrichment and there should be no signs of social stress caused by insufficient space and/or overstocking. Few studies have evaluated appropriate space allowances for captive birds, and so judgements on enclosure sizes and stocking density tend to be based on what is perceived to be best (or acceptable) practice. Views on what constitutes best practice, and which factors need to be taken into account to determine this, can differ considerably. To be in a strong position when advising on bird housing, it is essential to set out clearly what you would expect the animals to have and be able to do, then use this as a basis for determining whether the current or proposed husbandry will allow adequate space. For more guidance on this, see the resources listed in Section 3.8 of this chapter.

If it is not possible for birds to be housed in aviaries or pens that are large enough to meet their needs, then the next best option is to allow birds regular access to a flying area (Hawkins et al., 2001; Young, 2003). This could be a room in a bird keeper's home, an aviary (which may be portable) or a designated room equipped with perches, dust- and water baths, foraging materials and toys as appropriate to enable birds to exercise and play (Huber, 1994; Nepote, 1999). It is important to remember that aviaries or flight rooms will need to be long enough for controlled flight that will also enable birds to exercise appropriately; if space is limited then long, narrow flights are preferable to wider, shorter enclosures. Birds should only be introduced to flight rooms in established groups and will require monitoring to ensure that subordinates are not bullied (Nepote, 1999). Training birds to return to the hand or to a catching box containing a treat will reduce stress when they need to be returned to their holding accommodation (Hawkins et al., 2001). This has successfully been achieved with pigeons in a laboratory setting (Huber, 1994), so deserves consideration with other species and contexts, including owners' homes.

Suggestions that bird accommodation is improved by allowing more space or reducing stocking density may be met with the response that the housing meets with relevant legislation, e.g. relating to farming or the use of animals in scientific procedures (Home Office, 1989). It is important for inspectors or others concerned with promoting good welfare to challenge this, since legal minimum space allowances and maximum stocking densities are not best practice, but are *minimum* standards and often disproportionately weighted towards the requirements of industry rather than the needs of the birds. As such, they often lag behind new knowledge about animal behaviour and welfare needs.

Minimum standards may be based on the size or body mass of the birds (Home Office, 1989), or on the space that individuals require to perform "comfort" movements, but this does not allow for exercise or social interaction and should not be used to calculate space allowances for long term living accommodation. For example, the space required for domestic fowl to perform comfort movements is 2,000–2,500 cm^2 (0.2–0.25 m^2) (Dawkins and Hardie, 1989), yet individuals will walk up to 2.5 km per day and fly to and from elevated places if they have the opportunity to do so (Keppler and Fölsch, 2000). Domestic fowl perceive the area that they require to flap their wings as larger than it actually is (Bradshaw and Bubier, 1991), and it is reasonable to assume that the same will be true of other species as a behavioural adaptation to avoid feather and wing damage. Laying hens are motivated to walk and explore their surroundings during the early stages of pre-laying behaviour and develop stereotypic pacing if they do not have sufficient space (Duncan and Wood-Gush, 1972). Fowl also maintain social distances between one another depending on social attraction and repulsion forces (Keeling and Duncan, 1989), which have been found to be 2 m or more in feral domesticated birds (McBride et al., 1969). Taking all of this into account, an area of 0.2–0.25 m^2 per individual is clearly not adequate to permit a range of behaviours, especially exercise and social interaction.

In the case of farmed birds, minimum legal space allowances (if they exist) are likely to be inadequate and cause poor welfare, so it is good practice to use voluntary, higher welfare standards as guidance. Codes of practice for laboratory birds (again, if they exist) are likely to include higher space allowances than for farmed birds, but may also fail to fulfil the birds' basic needs. This means that the welfare of birds housed according to legal standards is not necessarily good. To express this another way, complying with a standard does not absolve those housing birds from paying due consideration to animal welfare and providing more, better quality space if necessary.

One would expect companion birds to be provided with a good quality and quantity of space, both to enable their keepers to enjoy watching a broad range of bird behaviour and also because they are valued as individuals more than birds used in other contexts. However, due to lack of awareness about birds' behavioural needs, unwillingness to accept that a loved companion may be suffering (Young, 2003) and the continued availability of small, cheap cages, companion birds may also have to endure inadequate housing. For example, one leading "pet" store's website says that cages should measure at least 2–3 times a bird's wing span by 3 times a bird's length from head to tail tip. For a budgerigar, this works out at approximately 0.17–0.37 m^3 (50–75 $\times$ 50–75 $\times$ 66 cm). However, it is possible to order from the same website a cage that is just 0.027 m^3 (30 $\times$ 23 $\times$ 39 cm); an order of magnitude smaller. This is not sufficient to permit an appropriate range of behaviours or to supply adequate enrichment, so it is important to encourage people who keep birds in such small cages to buy bigger ones and/or to allow the birds free flight in the home (preferably both).

3.4.4 Group Size and Composition

Ideally, most social species should be housed in stable, compatible groups, or pairs at least. To minimise the risk of aggression, groups or pairs should be formed at an appropriate age, usually very early in life, and then kept as stable as possible (Hawkins et al., 2001). A good quality, interesting environment is also imperative and this is addressed in the next section of this chapter. Where birds are to be housed in groups of more than two, it is good practice to research the optimal group size and composition for the species in the wild and see whether this can be replicated in captivity.[1] It is not possible to give general guidance when dealing with such a large number of species, so the rest of this section will set out some of the issues that need to be researched and considered.

Some species are especially gregarious and live in large flocks, such as species of waterfowl and many small passerines. Living in flocks confers two main benefits: a reduced individual risk of predation and enhanced location and exploitation of food.

[1] There may be constraints to this, for example if birds have to be prevented from breeding (see Section 3.6).

The drive to be surrounded by a large number of other birds is therefore extremely powerful and the distress experienced by individuals of such species on separation is likely to be correspondingly strong. Some species are also highly sensitive to kin relationships within flocks (Marler, 1996), especially geese who form long-term, stable family groups (Ely, 1993; Choudhury and Black, 1994).

However, territoriality during breeding seasons can lead to aggression within even stable groups. For example, male waterfowl will defend females against other males and lone males may also forcibly copulate females, which can result in injury and death. Female geese will defend their feeding resources and some geese drive other families away while rearing goslings (Owen and Black, 1990). Space allowances can be set up to take these types of seasonal behaviour change into account, by ensuring that sufficient space, resources and refuges are all available before the breeding season occurs. This will require research and consultation with other keepers of the species before any birds are acquired.

It is also necessary to check for each species whether it is most appropriate to house birds in large groups, as some should be kept in single pairs only (Forbes and Richardson, 1996). As a general rule, however, the amount of time during which any individual of a social species will be left alone should be kept to an absolute minimum. Singly housing strongly gregarious birds such as Psittacines in the belief that this will facilitate talking is not acceptable on ethical or welfare grounds, since pair housing parrots increases the birds' behavioural repertoire and improves their welfare (Meehan et al., 2003). In the case of laboratory birds, it may be necessary to provide birds undergoing experiments with a visible companion (Stephenson, 1994), so that the minimum group size will be three (then two birds will be left in the holding accommodation while the other one is undergoing procedures).

The type of hierarchy that occurs in the species in the wild is also of key importance. Some gallinaceous birds such as the domestic fowl, quail and turkey form stable hierarchies under certain conditions and may be highly resistant and aggressive towards intruders (Duncan, 1999; Mills et al., 1999). The composition of groups of gallinaceous birds generally needs to be given careful thought and should usually comprise either one or a few males with a larger number of females, or single-sex groups, in captivity. Other species are more loosely organised; for example adult starlings are generally dominant over juveniles, and males over females, but there is no strong social structure and birds can be housed in large, mixed-sex groups (Feare, 1984).

The nature of social hierarchies also determines how easy it will be to introduce new birds into an established group. For particularly aggressive species, it may be necessary to begin acclimatising birds to one another by initially allowing birds to see and hear one each other through double-mesh walls only. Individuals of species with weaker hierarchies such as starlings can usually be introduced relatively easily provided that sufficient space and a good quality environment, including plenty of perches if appropriate, is provided (Hawkins et al., 2001). New birds can also be introduced into an existing budgerigar colony with few problems, which reflects the lack of a strong hierarchy in wild flocks (Wyndam, 1980), yet other Psittacines require a far more gradual introduction. Again, research and consultation is essential before adding new birds to a group of any species, to help prevent and overcome problems with aggression.

Birds are sometimes housed in mixed-species flocks, often in zoos or wildlife parks, and this practice should be critically considered on a case-by-case basis. Mixed flocks can occur in the wild, e.g. zebra finches may be found flocking with other small passerines (Zann, 1996), but housing some species in mixed flocks in captivity is not recommended; for example Amazon parrots should be housed in single species groups to prevent stress and aggression. Some Psittacines may even become stressed if they can see or hear other species in adjacent aviaries (Pilgrim and Perry, 1995). As a general guide, decisions regarding mixing species should be made on the basis of the behaviour of both species in the wild; any available evidence that the species can be housed in captivity without causing stress, undue competition or behavioural problems; and the reason for wishing to house the species together. If this is primarily economic and there is any probability that either species will suffer as a result, each species should be housed separately or not at all.

Some people resist group housing individuals of the same species, on the grounds that single housing is necessary to prevent aggression, which is probably the most common reason given for singly housing social animals. Birds must, of course, be protected from injury and suffering, but it is not acceptable to rely in the long term upon single housing of social animals or upon mutilations such as beak trimming, rather than reviewing and improving animal husbandry (see Section 3.6) (Hawkins et al., 2001). It is important to encourage bird keepers to review husbandry practices so that they can attempt group housing and to provide them with any support that they may need within their facility. There may also be a perception that inspectors responsible for monitoring the health and welfare of the birds (e.g. Home Office Inspectors in the United Kingdom) would penalise the keeper if any animals were injured in the course of an attempt to initiate group housing. Such beliefs are often unfounded and the issue can be resolved by encouraging better communication between the bird keeper and inspectors.

3.5 A Stimulating Environment

Providing a stimulating environment for birds is of paramount importance. Thoughtfully provided environmental enrichment allows birds to perform a range of natural or otherwise desirable behaviours, encourages exercise, facilitates appropriate social interactions and can also divert birds' attention from any pain that they may be experiencing as a result of pathologies or veterinary or scientific procedures (Gentle and Corr, 1995; Gentle and Tilston, 1999). It should be unthinkable to house birds without adequate and appropriate stimulation, yet this still occurs for birds housed in all contexts, even "pet" birds whose keepers believe that they love their birds and care for them well (Young, 2003).

Ideally, birds should be provided with enrichment from hatch; both for their welfare and to ensure that they are habituated to items and know how to use them. If birds reared in an impoverished environment are suddenly presented with a novel item, they may be neophobic or simply not understand its relevance immediately. In such cases, new items should be sited in less used parts of the enclosure, away from feeding, drinking, resting and sleeping sites (Young, 2003). It is also very important to ensure that care staff do not become disillusioned and remove the enrichment before the animals have had a chance to habituate to it and use it. Several days may elapse before the birds begin to approach a new resource, but they may go on to obtain significant benefit from it in the long term (they may also use it most when no human observers are present). Encouraging care staff to keep an "enrichment diary" helps to maintain their interest and persevere with the enrichment programme (Young, 2003). As many birds are capable of "social" learning, i.e. learning by watching the activities of others (Sherry and Galef, 1990; Fritz and Kotrschal, 1999; Nicol and Pope, 1999), it may also help if they can see conspecifics using the resource. Even laying hens who have been housed in commercial batteries will eventually use enrichment items and display natural behaviours if they are re-homed to a more appropriate environment (Dawkins, 1993).

Besides providing birds with an interesting environment, emphasis should also be on allowing them an element of choice and control, for example by including areas for different activities such as dust bathing, water bathing, perching and play. Locating desirable resources as far apart as possible is a good way of encouraging exercise (Young, 2003). All of this will obviously require sufficient space to accommodate enrichment items in such a way as to permit effective monitoring of the birds and to allow them to be caught when necessary with the minimum of disruption.

It is very important to make sure that enrichment is relevant and appropriate to the species and will genuinely benefit the birds. Environmental enrichment is sometimes not provided because people do not know what birds really need or are worried that it may cause welfare problems, for example by increasing aggression. Having identified these concerns, the crucial next step is to address them by researching suitable enrichment and suitably testing it in situ. Sufficient resources should be provided for all the birds to be able to use them at once, since many birds synchronise their actions and the sight of an individual performing an activity such as dustbathing will frequently induce others to join in. Guidance on suitable resources and how to test them can be obtained from responsible captive bird societies, organisations such as the *Shape of Enrichment*, animal welfare organisations and the scientific literature (see Section 3.8). Examples of suitable enrichment for birds are listed below.

3.5.1 Perches

The ability to perch is critically important for good welfare in many species, including all Passerines (or "perching" birds) who have feet that are anatomically adapted to close around tree branches. Perches can be essential for providing feelings of security, maintaining stable hierarchies and allowing subordinate birds to escape

(Keeling, 1997; Cordiner and Savory, 2001; Newberry et al., 2001). They also provide valuable exercise for the feet and legs, which helps to maintain bone strength, and facilitate short or long flights. Perches that are attached to the aviary at one end only, with a spring to enable them to bounce slightly when the bird alights, provide additional exercise and perches of a variety of different diameters will help to exercise the feet (Association of Avian Veterinarians, 1999). Natural branches (from pesticide-free and non-toxic trees such as northern hardwoods, citrus, eucalyptus or Australian pine) are the preferred materials for perches (Coles, 1991) and can be regularly replaced when soiled or gnawed. If this is not possible for practical or hygiene reasons, wooden dowelling or (less preferably) plastic perches are suitable alternatives. Note that perches should not be covered with sandpaper tubes, as these cause foot excoriation and infection and do not trim the claws effectively (Coles, 1991; Association of Avian Veterinarians, 1999).

If birds are to obtain maximum benefit from perches, it is essential to research the optimum shape and positioning for each species. It is not possible to generalise within avian orders; for example within the Galliformes domestic fowl require perches that are flattened on the top surface to prevent keel deformation (Duncan et al., 1992) but quail do not appear to require perches at all (Schmid and Wechsler, 1997). It is also important to consider *why* each species perches, at what time of day and for what purpose, to ensure that this very important need is properly met.

Jungle and feral domestic fowl roost at night to avoid predation and also arrange themselves on perches according to the group's dominance hierarchy, so domestic fowl need perches sited at different heights, long enough to prevent conflict and available to them all the time, but especially at dusk. Many raptors rest on structures such as tree stumps and fence posts while manipulating and eating prey, so require a post with a flattened top (Hawkins et al., 2001). Some small passerines use tree branches to approach the ground gradually when preparing to feed, so will benefit from perches of varying diameters at a range of heights (Coles, 1991).

Ensuring that perches are placed at either end of the cage or aviary will maximise the possible distance that birds can fly (Association of Avian Veterinarians, 1999). Psittacines spend much of their time climbing in the wild so the perch layout should facilitate this (mesh walls with a suitable grid size and tension are also good for climbing). Swings may benefit some species by encouraging additional exercise and play, although some birds apparently prefer fixed perches. Swings are commercially available or can be constructed from dowelling, branches, plastic or metal.

Although perches should be placed primarily to address the birds' needs, it is also important to remember that droppings will accumulate beneath perches so they should never be placed above food or water dishes (or other perches where possible). Care should also be taken that the birds' tails cannot contaminate food or water or become abraded on the floor of the cage. In species that are liable to feather peck, perches should not be sited so that birds on the floor or on lower perches can reach the feathers of birds perched above them.

3.5.2 Foraging Substrate and Devices

Birds spend a significant proportion, sometimes the majority, of their time foraging in the wild (Paulus, 1988; Fölsch et al., 2002). Captive birds have been shown to choose to forage and work for food even when additional food is freely available (Duncan and Hughes, 1972), and this phenomenon of "contrafreeloading" is believed to reflect a motivation to gather information about the environment in case the food supply should become restricted (Inglis et al., 1997). The importance of increasing foraging time in captivity to improve welfare and reduce stereotypic behaviour is increasingly recognised for all animals, including birds (Coulton et al., 1997; Field, 1998). It is therefore good practice to enable birds to forage for at least part of the day, rather than feeding from one bowl or hopper all of the time.

Foraging can be encouraged in ground-feeding species by simply scattering part of the regular diet or additional items such as seeds, grains or mealworms into a foraging substrate, such as wood shavings, sand or turf (Gill, 1994; Gill et al., 1995; Nicol, 1995). This is easy to do and regular cleaning and removal of soiled food will avoid disease. The foraging substrate can be placed in large, shallow trays that can be taken out for cleaning and removing soiled food. Some species, e.g. Corvids, enjoy foraging for invertebrates such as mealworms in deep boxes filled with bark chippings. For others, food items such as sprays of *Panicum* millet or rings of dried apple on a string can be attached to the enclosure walls. Shelled nuts, pine cones or other foods that require manipulation should also be supplied wherever appropriate for the species. For grazing species such as geese, whole vegetables including lettuce, celery and cabbage can be fixed to the ground or suspended at bird head height to increase foraging time.

Diving and dabbling birds should be encouraged to feed underwater at appropriate depths, to encourage natural behaviour and for exercise (Kear, 1976). At least part of the birds' diet can be thrown on the water to encourage diving (birds can be weighed regularly to ensure that they are getting enough to eat and food residues can be siphoned out of the pond) (Hawkins, 1998). Plants such as duck weed (*Lemna* spp.) and grains can be supplied on or in water for herbivores and omnivores. For omnivores and carnivores, suitable foods include diving duck food from specialist suppliers, small fish such as sprats or sand-eels and dried food for carnivorous mammals (this is usually available in floating or sinking form and can be fed to divers and dabblers respectively) (Hawkins et al., 2001).

Slow-release PVC feeders, floating rafts filled with fish (Sandos, 1998), or traffic cones suspended upside down and filled with fish that can be removed one at a time (Universities Federation for Animal Welfare, 1999) can also be used to prolong foraging time for aquatic carnivores (Fig. 3.4). Note that live vertebrate prey should never be given to any carnivore, as this will inevitably cause suffering to the prey animal and may result in injury to the predator if the prey defends him/herself. There are a number of suppliers of humanely killed animals such as chicks and rodents and so feeding live prey is not necessary; the practice may also contravene animal welfare legislation under some circumstances.

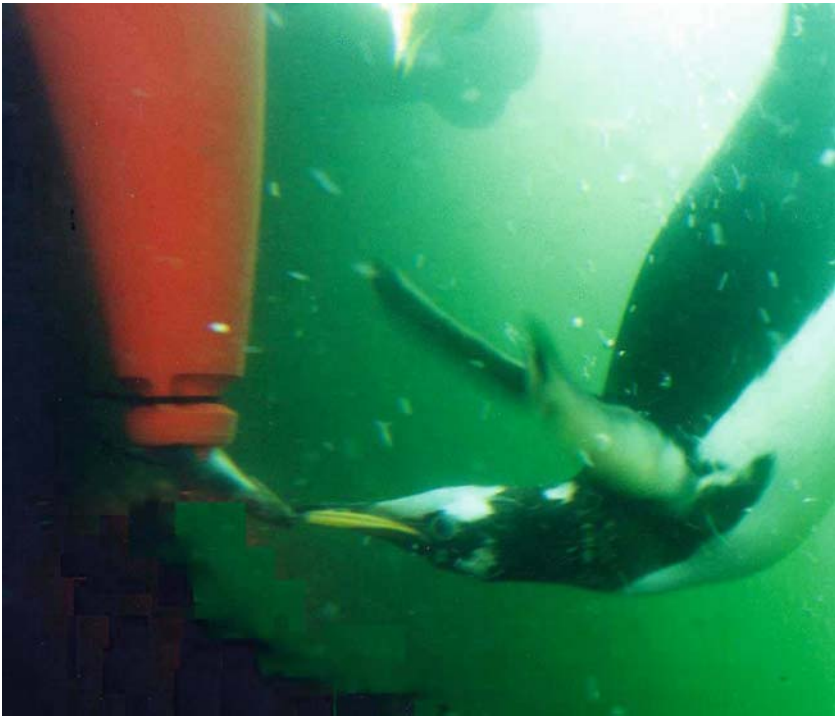

Fig. 3.4 A penguin pulling a fish from an underwater feeding device (an inverted traffic cone) (picture: Universities Federation For Animal Welfare)

Puzzle feeders are an excellent way of providing interest and extending foraging time (Coulton et al., 1997; Bauck, 1998). In their simplest form, these consist of fruit, wood blocks, logs or plastic pipe with holes drilled in them so that pieces of food can be pushed into the holes (Fig. 3.5) (Mendoza, 1996). These are suitable for most species, for example plastic pipe with mealworms for sea birds (Neistadt and Alia, 1994), wood with fruit and vegetables for Psittacines and finches, fruit with seeds for Psittacines (Hawkins et al., 2001). More complex feeders that require birds to perform a task to gain access to food should be provided for those species that are capable of using them, such as Psittacines, Corvids and tits. Examples are feeder balls, which must be turned around to release the food, or devices that require birds (e.g. tits) to pull levers, open doors or pull strings (Fig. 3.6). Pots with lids are also suitable, e.g. film canisters filled with mealworms or tubs filled with fat and covered with tin foil (N. Clayton, personal communication). Another option is to suspend items such as a piece of fruit or corn on the cob from a string tied to a perch, so that the bird must learn to pull up and secure the string.

Another important aspect of foraging behaviour in some species, especially in crows, nuthatches and tits, is the practice of caching, or storing, food to provide a reserve when it is less abundant. Any species that caches food should be fed a diet containing elements that are suitable for caching and provided with appropriate

Fig. 3.5 A puzzle feeder consisting of a wooden stump with holes into which food can be hidden (picture: Jane Cooper)

places to cache them in the ground or in crevices. These could be natural, e.g. rotten tree stumps or soil, or artificial, e.g. sections of log with holes drilled into them, or cat litter trays filled with sand or wood chippings. Caching perches can be constructed for birds such as tits and nuthatches using blocks of wood with "pockets" made from sections of inner tube (N. Clayton, personal communication).

Note that introducing new feeding techniques to birds who have not had experience of them from an early age should be done patiently; the birds should also

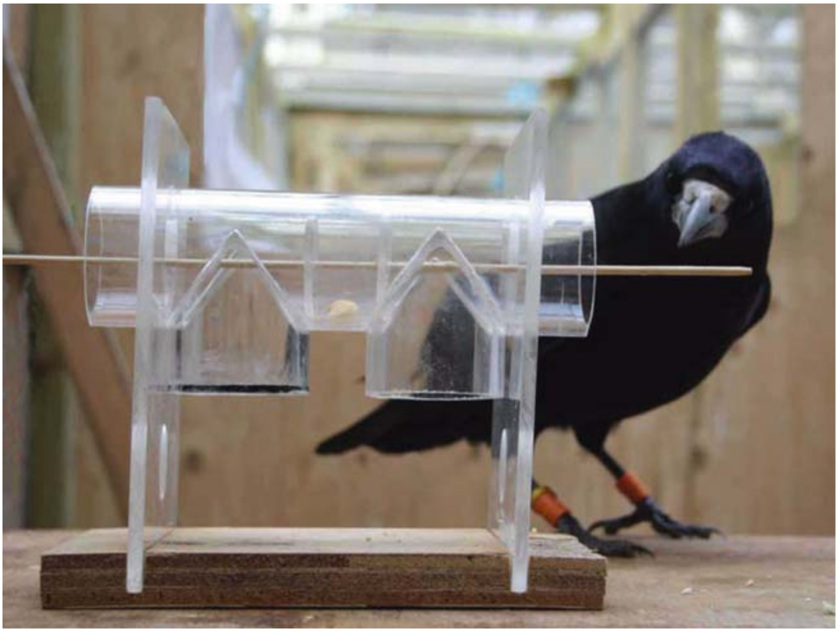

Fig. 3.6 A puzzle feeder which the bird has to manipulate in order to get a small food reward (picture: Amanda Seed)

receive their full, usual rations at the same time. As with other types of enrichment, observing conspecifics foraging in new ways should help naïve birds to learn (Nicol and Pope, 1999). See Chapter 8 of Young (2003) for useful guidance on choosing appropriate foraging enrichment and the Association of British Wild Animal Keepers (ABWAK) guidelines on enrichment for practical ideas (Field, 1998).

3.5.3 Dust Baths and Water Baths

Many species are strongly motivated to perform both dust- and water bathing and so should have access to dust and water baths for at least part of every day. Dust bathing removes excess and stale lipids from the feathers and, in the case of domestic fowl at least, is pleasurable to birds (Widowski and Duncan, 2000). Birds who do not have access to a dust bath often exhibit "sham" or "vacuum" dustbathing, where they go through the behavioural sequence of dustbathing in the absence of litter (Appleby et al., 1993; Petherick et al., 1995). In some strains of domestic fowl, this behaviour does not satisfy the birds in the same way as actual dustbathing and persists into adulthood, even in the presence of litter, if the birds were reared without a dustbath (Olsson et al., 2002). Trays containing a suitable substrate with a small particle size, such as sand, should therefore be available for at least part of the time every day, beginning as soon as possible post-hatch. It is also important to make sure that there is sufficient space for dust bathing, as some species, such as Galliformes, can travel a considerable distance while bathing.

For water baths, a large, flat dish with a few centimetres of water is suitable for many species. Some birds, e.g. pigeons, splash considerably when they bathe. If this is a problem, water baths can be placed on larger, waterproof trays, or routine cleaning out can be performed after birds have had a bath.

It is important to remember that both dust- and water bathing are often undertaken communally by groups of birds, as the sight of one bird bathing will stimulate others to copy them. To avoid conflict and frustration, there should always be sufficient space available in dust- and water baths for all of the birds to bathe at once.

3.5.4 Pecking Substrate

Providing a suitable pecking substrate, in addition to foraging and dustbathing substrate, is of vital importance for species that are susceptible to injurious pecking, such as gallinaceous birds. Injurious pecking has been found to be strongly associated with factors that reduce the opportunity to forage, including high stocking densities and compacted litter (Green et al., 2000); other contributory factors are believed to be large group sizes, grid flooring and bright lighting (Duncan, 1999; Bilcik and Keeling, 2000).

Early exposure to sufficient, suitable pecking substrates such as wood shavings or straw has been demonstrated to reduce the incidence of feather pecking in adult domestic fowl (Huber-Eicher and Sebö, 2001; Nicol et al., 2001). Current research suggests that bunches of white string (e.g. polypropylene baling twine) are preferred to many other pecking items and that the interest is sustained in the long term (Jones et al., 1997; Jones et al., 2000; Jones, 2001). Furthermore, bunches of string have been shown to be more attractive to birds than damaged feathers (McAdie and Keeling, 2002). It is important to refer to the current literature to ensure that the most effective and safe materials, string length and method of fixing the bunch to the birds' accommodation are used. Other alternatives that may be worth trying are rope and turf, or there are also some commercially available pecking objects such as Pecka-Blocks (Breckland International Ltd, UK).

3.5.5 Nest Boxes

Female birds should be provided with adequate resources for nesting, using natural nesting behaviour as a basis, unless it is necessary to suppress breeding. If birds need to be supplied with a nest box, pan or basket, they should have at least one each, with sufficient and species-appropriate nesting materials such as straw, hay, cloth or hemp fibres. Nest boxes should also be supplied at the correct time, which may need to be before birds attain breeding status so that they can investigate the boxes and become familiar with them (Sherwin and Nicol, 1993). Species that construct their own nests in captivity will need to be supplied with adequate materials and locations to build nests; again, it may be necessary to supply these before the breeding season begins or before birds attain maturity.

Some species, such as domestic fowl, will lay eggs in the absence of a nest box, nest site or nesting materials. It is sometimes believed that this means there is not a welfare issue and the birds are not stressed, but very strong motivation to obtain suitable nest sites has been demonstrated in domestic fowl at the point of lay (Cooper and Appleby, 1994; Freire et al., 1997). Laying hens will also become frustrated and display stereotypic pacing if they are deprived of a nest box or other suitable laying area (Duncan and Wood-Gush, 1972). It is reasonable to give other species the benefit of the doubt and assume that a nesting site and/or nesting materials will be a high priority for all female birds at the point of lay unless there is properly evaluated evidence to the contrary.

3.5.6 Cover and Barriers

The provision of cover is crucial for some species, particularly those that are predominantly ground living such as Galliformes (Buchwalder and Wechsler, 1997; Newberry and Shackleton, 1997; Cornetto et al., 2002). Either natural or artificial cover may be appropriate, depending on the way in which birds interact with it and on the type of housing. It seems that species adapted to living and foraging on forest floors, such as many Galliformes, are less stressed if they are housed in “dappled” light rather than uniform illumination (Newberry and Shackleton, 1997). This could be achieved in a number of ways, e.g. camouflage netting or scattering straw on the enclosure roof (Young, 2003). Plants and shrubs, provided that they are not poisonous to the species, can provide a refuge for birds housed outdoors or indoors if vegetation is provided in tubs. However, some species such as geese will quickly destroy shrubs so will need to be rotated between different enclosures, regularly supplied with new vegetation or given artificial cover. Straw bales are a good option that can provide both a refuge and additional interest because birds can also stand on top of them and peck at them. Bales can help to reduce or prevent aggression by allowing subordinates to move out of the sight of dominant birds; placing bales in an “L” shape may be helpful. Vertical barriers, either solid or in strips, can also prevent aggressive interactions and injurious pecking (Young, 2003; Hawkins et al., 2001).

3.5.7 Toys

Many birds are likely to benefit from access to toys, which may be natural objects such as pine cones or stones (Ottinger and Rattner, 1999), or commercially available toys designed for companion birds or for other species such as cats. There is a large market in animal toys and these items should be selected and used with care, as some appear to be designed to appeal to humans rather than to fulfil birds’ behavioural needs. However, human-designed toys should not be dismissed on the grounds that they are "unnatural", as many can provide interest and stimulate a broader range of behaviours (Young, 2003). Careful monitoring of the birds' use of toys, and intervention if they appear to be causing undue stress or undesirable behaviours, such as aggression, should prevent welfare problems. Videos and DVDs produced for parrots are also available (e.g. World Parrot Trust, 2007), but these should not be used as an alternative to appropriate social interactions with other birds and humans.

In addition to providing interest for the birds, toys may have other, indirect benefits. Studies in quail have demonstrated that early exposure to both brightly coloured and natural objects helps to reduce fear of humans and novel stimuli later in life and may also reduce aggression in adult birds (Jones et al., 1991; Ottinger and Rattner, 1999). Rotating the enrichment items provided for many species, including birds such as parrots, is generally believed to reduce boredom and fearfulness. However, a study in the orange-winged Amazon (*Amazonica amazonica*) has shown that this practice reduces fearful behaviour in most birds, but can increase fearfulness in highly fearful individuals (Fox and Millam, 2007). It is therefore important to take individual temperaments into account and monitor behaviour carefully when choosing and rotating toys.

Examples of suitable toys for birds include: cardboard tubes, chewing wood, Brazil nuts, short lengths of PVC pipe, knotted ropes, paper bags, bottle tops, Kong™ toys, ladders, ping pong or tennis balls, cotton reels, corks, toys, bells, mirrors and dog chews (Association of Avian Veterinarians, 2001; Hawkins et al., 2001). More specialised examples are plastic or rubber toys buried in piles of ice for Alcids (Sandos, 1998), chains to pull for waterfowl (Hawkins, 1998), and coloured shapes, stones and pine cones for quail (Ottinger and Rattner, 1999). Some objects or materials are unsuitable as bird toys, such as breakable plastics, toxic plants, some synthetic materials e.g. looped nylon carpet or nylon yarn, or toys with small openings that could trap part of the bird (Association of Avian Veterinarians, 2001).

3.5.8 Ponds

All species that are adapted for a wetland or marine environment should be provided with ponds, whether they are housed indoors or outdoors (Hawkins et al., 2001). Waterfowl and other freshwater and seabirds use bodies of water for feeding, as a refuge and for comfort behaviour such as bathing and preening. Of the waterfowl, geese are adapted predominantly for feeding and grazing on land, whereas the various tribes of duck are adapted for feeding on land and/or water to varying degrees. The Anatini or dabbling ducks such as the mallard *Anas platyrhynchos* walk well on land and feed mainly in shallow water, but the Mergini or sea ducks such as the eider *Somateria mollissima* spend much of their time on the water and are rarely seen far inland (Owen and Black, 1990).

Natural habitat and behaviour may have a bearing on the area and depth of ponds provided for different species (Forbes and Richardson, 1996), but all will need water for dabbling, swimming and diving as appropriate. The very minimum that waterfowl should be able to do is immerse their heads under water and shake water over the body. Regular access to water is also important for the integrity of the feet and helps to prevent "vent gleet", infections of the cloaca usually caused by *Pseudomonas* spp. due to the birds being unable to defaecate naturally into the water while swimming (Redig, 1996). Note that even species that appear to make little use of a pond during the day may use it more at night (P. Hawkins, pers obs.).

Indoor ponds can be sunk into the floor and lined with concrete, or solid plastic paddling pools or sandpits designed for children can be used as a (less preferable) alternative. There is a good deal of guidance available on constructing outdoor ponds using flexible or cast pond liners or waterproof cement. Features to consider for indoor and outdoor ponds are:

- a range of depths;
- stones and gravel on the bottom to encourage dabbling and diving and prolong foraging time (Guidry, 1996; Hawkins, 1998);
- large boulders that break the surface, for use as roosts;
- clear and accessible entry and exit points, especially for juveniles who may not be fully waterproof and for sick birds;
- a range of substrates, such as gravel and sand with silt and mud in deeper hollows (Street, 1989);
- additional water enrichment such as floating plastic toys, sprinklers, showers, waterfalls, air bubbles, dripping water and ice in trays (Hawkins et al., 2001);
- for very large outdoor ponds and lakes, artificial islands that are either fixed or floating (Street, 1989).

Water quality is critically important to maintain good health and feather quality; for example, water that is too hard can disrupt the integrity of the feathers and reduce waterproofing (Swennen, 1977; Robinson, 2000). An appropriate level of cleanliness is also necessary, to which end most ponds will need to be regularly drained and cleaned out using a high pressure hose. The water in small ponds can also be continually replaced with clean water from a slowly running hose located at the bottom provided that there is an adequate overflow system.

Many species of seabird regularly drink and bathe in fresh water and some can live equally well on fresh or salt water (Finney, 2000; Robinson, 2000), but others should be housed on salt water or should not be kept at all. This is particularly important where seabirds are undergoing rehabilitation for eventual release, as regular access to salt water will help to maintain salt gland function. It is essential to set up a system of water filters and skimmers to prevent a film of organic molecules forming on the surface. Otherwise, the presence of the biofilm will reduce the surface tension and the birds' feathers will lose their water repelling properties, leading to chilling and, possibly, drowning (Finney, 2000; Robinson, 2000). Water quality should be monitored continuously when housing sea birds and no birds should be brought in until the system, and its back-ups, have been demonstrated to work.

3.5.9 Humans and Other Animals

"Pet" birds housed within living rooms or gardens receive stimulation and companionship, but may also be exposed to children, who may not always behave appropriately around birds, and other companion animals including predators such as cats and dogs. Bird keepers should be aware of the importance of allowing birds appropriate social and environmental stimulation but, at the same time, enabling them to feel safe and in control. This can be assisted by siting indoor cages in a corner and just below adult eye level; providing a high level, secure refuge in outdoor aviaries; and training children and other animals to be quiet and calm when near birds (if this is not possible, their access to the birds should be restricted).

Some birds, such as Corvids and Psittacines, form close relationships with favourite humans and may also seek and enjoy interaction with unfamiliar humans provided that they do not feel threatened. It is important to make regular provision for human interaction if birds will benefit from this, although close supervision will be necessary in bird collections that are open to the public (Young, 2003). Human–bird interactions are covered in more depth in Chapter 2.

3.6 Balancing Requirements and Addressing Conflicts

When performing an animal advocacy role, it is easy to contend as a matter of principle that all of the needs of captive birds should be given a high priority. However, birds have a range of different needs, some of which can conflict with one another. Birds should be group-housed in a stimulating environment that enables them to perform a broad range of behaviours, and they need to be healthy and not subjected to avoidable pain or distress. However, birds can spread disease, fight or feather peck; they may also breed and produce unwanted chicks; they will have to be caught and they may have to be marked in some way to identify them.

It is therefore necessary to strike a balance between these different benefits and risks in practice, which involves deciding on the standards of health and hygiene that are really necessary, the levels of agonistic behaviour that are acceptable, and so on. The goal should not be to completely eliminate all undesirable behaviours such as aggression or to attempt to prevent all disease (apart from specialised cases such as some experimental studies). This can lead to inappropriate husbandry that is weighted disproportionately towards maintaining high health standards at all costs, which is not always conducive to good welfare.

Some of the key concerns regarding group housing and environmental stimulation are set out below, with suggested measures that will reduce or prevent problems with health and welfare. The aim should always be to encourage a balanced approach to husbandry from the birds' point of view.

3.6.1 Disease Control

Disease can undoubtedly cause severe suffering to animals, but living in a barren, sterile environment also causes suffering and distress. It is possible to house birds in high-welfare, animal-centred systems that will also permit adequate health monitoring, maintenance and care. Careful husbandry, regular cleaning out and removal of soiled litter, and adequate veterinary care will all contribute to a proper health-care strategy that will minimise disease risk. Using materials that are easy to clean and can withstand high temperatures and powerful cleaning agents also help to prevent the spread of disease (Duncan, 1999). Even where very high standards of hygiene are required, perches can be made of plastic instead of wood, straw can be autoclaved to provide pecking substrate and grass can be grown hydroponically.

3.6.2 Aggression

There are two factors that are especially important in preventing and reducing aggression; (i) providing sufficient space and refuges for birds to be able to escape from one another, and (ii) forming stable, compatible groups very early in the birds' lives. Both of these have been addressed earlier in this chapter. In the case of domestic birds, such as fowl, turkeys and quail, it may be possible to obtain strains that have been selected to be less aggressive (Craig and Muir, 1993). The potential for this should be researched and regularly reviewed. However, other injurious behaviours or pathologies may be inadvertently selected when breeding for reduced aggression, so it is essential to ensure that there are no significant ethical or welfare issues associated with a particular phenotype.

3.6.3 Injurious Pecking

This can occur in any context of bird keeping and is usually divided into (i) aggressive pecking; (ii) feather pecking (where individuals either peck at other birds' feathers or pluck and pull at their own); and (iii) pecking at the skin of other birds, which can cause serious suffering and mortality if unchecked (Anonymous, 2001; Blokhuis et al., 2001). The causes are not always clear, but in farmed birds it is often possible to avoid outbreaks by rearing chicks with access to substrate that enables them to forage and peck (Huber-Eicher and Sebö, 2001; Nicol et al., 2001). It is thus highly advisable to ensure that chicks of all species are able to peck and forage in a species-appropriate manner, and essential to maintain good practice with respect to space allowances, stocking density and environmental enrichment throughout birds' lives. As with aggression above, some strains of farmed bird have been selectively bred so that inappropriate pecking is reduced and such strains should be used wherever possible (Kjaer and Sørensen, 1997; van Hierden et al., 2002). It has also been proposed that feather picking in "pet" birds is a psychopathology that is analogous to trichotillomania (compulsive hair pulling) in humans (Bordnick et al., 1994).

3.6.4 Catching Birds

Birds are liable to become stressed when caught, and individuals housed in small, barren cages will obviously be easier to catch than those housed in large, enriched aviaries. However, housing in small, barren cages will cause chronic stress, which may well outweigh the acute stress caused by capture. Requirements to prevent distress and exhaustion when catching birds will inevitably set limits on the complexity of their living environment, but it should be possible to catch birds from a large, enriched aviary quickly and with the minimum of distress. Fundamental requirements are effective training and expert advice to ensure that bird handlers are competent, confident and empathetic, together with adequate equipment including well-maintained nets in appropriate sizes (Fowler, 1995; Hawkins et al., 2001). In some circumstances, especially for companion and laboratory birds, it is possible to train birds to come to handlers and even to cooperate with veterinary or scientific procedures (see Chapter 4; Heidenreich, 2004). Encouraging animals to voluntarily co-operate with scientific procedures can reduce any potential stress and improve animal welfare, for example by reducing the need for physical restraint. However, some people are troubled by the idea of training animals to co-operate with procedures that may cause them harm. This is a legitimate viewpoint, although the welfare of the animals should be the deciding factor.

3.6.5 Flight

Many species can fly safely in captivity and should be encouraged to do so wherever possible, but others may be too large or not sufficiently manoeuvrable to fly without injuring themselves. Where birds are kept in collections outdoors, there may be a requirement to prevent flight so that birds cannot escape. In such cases, it is essential to ensure that all alternatives that do not involve de-flighting birds have been fully explored, for example flight netting (Bourne, 2004c). It has been suggested that de-flighting may be preferable to caging if it would allow birds to perform behaviours that could not be fulfilled in a conventional cage (Hestermann et al., 2001). However, preventing volant birds from flying should be taken extremely seriously and a proposal to prevent flight for any reason should be cause for critical review of the justification for housing the birds at all. This is especially important if it is suggested that birds are permanently mutilated so that they cannot fly.

If flight must be prevented, usual techniques are clipping flight feathers or more invasive procedures such as pinioning or tenotomy. All of these can cause pain and distress in the short or long term. Clipping flight feathers from one wing with sharp scissors following each moult is the least invasive method and is a temporary mutilation, rather than a permanent one (Forbes and Glendell, 1989; Hestermann et al., 2001). However, although wing clipping should not cause pain it is not a "minor" procedure and should be done with great care; if blood feathers are clipped, severe haemorrhaging and blood loss can result (Bourne, 2004b). Both wings are sometimes clipped in "pet" birds, so that they can flutter safely from a perch but not fly away. Only the minimum number of feathers should be cut to limit lift and forward propulsion; it is generally possible to leave the outermost four flight feathers on each wing. Birds will experience distress each time their wings are clipped, which may be twice a year or more depending on the moulting pattern of the species.

In contrast, permanent mutilations need only be performed once but have the potential to cause distress in the long term, as birds will be unable ever to fly, and also raise very serious ethical and welfare issues that should be critically considered. Pinioning is generally performed when chicks are 2–5 days old and involves cutting off, commonly without anaesthesia or pain relief, the part of one wing that would have borne the primary feathers (Bourne, 2004e).[2] This procedure is often described as causing no pain or distress, but this represents a now discounted belief that neonatal animals experience less pain than mature animals and is highly unlikely to be the case. The development of descending inhibitory neural pathways occurs postnatally in mammals, and this lack of inhibition means that responses to all sensory inputs including pain are exaggerated (Narsinghani and Anand, 2000). If the same is true for birds, then anaesthesia and analgesia are required for all surgical procedures for hatchlings as for adult birds. Pinioning may also cause chronic, "phantom limb" type pain which will have a serious impact on the bird's quality of life (Hawkins et al., 2001).

To conclude, pinioning is a significant mutilation with long-term consequences and any routine use of this procedure on hatchlings should be challenged. Adult birds should never be pinioned unless the wing has been irreparably injured or is constantly dragging on the ground in severe cases of "angel wing" (Bourne, 2004a, d; Humphreys, 1996). Some species should never be pinioned at any life stage, such as Alcids who dive by "flying" with the wings under water.

Tenotomy is cutting the extensor tendons on the anterior edge of the metacarpal bone so that the wing is rendered immobile. This leads to atrophy of the flight muscle mass and probable chronic pain and distress (Feduccia, 1991), so this procedure cannot be justified under any circumstances.

Two other means of preventing flight, largely in game birds, are brailing and feather pulling. Brailing is strapping a wing in its flexed position to temporarily prevent flight. This is likely to cause chronic pain and may also prevent normal wing growth in juvenile birds, so should not be carried out. Feather pulling is sometimes employed where older game birds (e.g. pheasant poults of 8 weeks or more) are

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[2] There are legal restrictions on pinioning in some countries, e.g. in the United Kingdom birds over 10 days old may only be pinioned by a veterinarian and it is illegal for waterfowl to be pinioned if they are to be kept on agricultural land (Welfare of Livestock (Prohibited Operations) Regulations, 1982).

released. This involves pulling out all of the remaining juvenile primaries plus 5 or 6 of the bird's newly grown flight feathers. As the flight feathers attach directly into the limb bones, this is likely to be extremely painful and distressing, so this practice should never be undertaken.[3] Note also that attaching birds to standing perches using leg chains as an alternative to feather clipping is totally unacceptable.

In some countries there may be a legal requirement to ensure that non-native birds are prevented from escaping, but this should not necessarily be interpreted as requiring a permanent mutilation. For example, Section 14 of the United Kingdom Wildlife and Countryside Act 1981 includes this requirement but does not specify the means by which escape is to be prevented. It is thus legal to allow a non-native bird of prey to fly free, using the bird's training alone as a means of preventing the bird from escaping. Codes of practice restricting the mutilation of animals have also been set out by professional bodies, e.g. the Association of Avian Veterinarians (2004) and the United Kingdom Royal College of Veterinary Surgeons (2000).

3.6.6 Identifying Individuals

Identifying individual birds may be necessary to enable effective health monitoring, to manage breeding programmes or for the purposes of scientific research. There may also be a legal requirement to mark birds, sometimes in specific ways; for example, many native British birds must be close ringed when held in captivity in the United Kingdom under the Wildlife and Countryside Act 1981. Birds may be identified using several methods, including (from least to most invasive):

- noting physical differences, e.g. different plumage patterns or differently shaped wattles;
- ringing;
- staining the feathers with non-toxic dye;
- electronic tagging or microchipping;
- wing tagging.

The least invasive method of identification should be chosen in each situation, critically depending on why the identification is required, how skilled the marker is in applying the chosen technique and the quality of any equipment required. Highly invasive methods of marking such as toe clipping or web punching cause unacceptable levels of suffering and should never be used.

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[3] In the United Kingdom, removing a living feather for scientific purposes would require licensing under the Animals (Scientific procedures) Act 1986, as a procedure likely to cause pain, suffering or distress.

Captive birds are usually identified by ringing with either closed or split rings (Redfern and Clark, 2001). There are several important welfare issues associated with ringing birds. Competent and empathetic handling is essential to avoid injuring birds, especially small passerines and chicks of any species. Rings that are too tight can cause serious health and welfare problems, including the loss of the foot, so rings must be checked frequently in juvenile animals especially in fast-growing species such as domestic turkeys. In some species such as the zebra finch, ring colour may have a profound impact on social behaviour. The colour and symmetry of leg rings can affect their attractiveness to mates, longevity and even brood sex ratio (Swaddle and Cuthill, 1994; Cuthill et al., 1997), so research is essential to find out whether this will be a problem for a given species and, if so, which colours and arrangements should be avoided. The colours used for staining feathers should also be selected carefully in case they alter social or breeding behaviour; for example, red stains may be mistaken for blood and lead to an outbreak of feather pecking or cannibalism.

Electronic tagging is commonly used for identifying birds such as raptors and Psittacines, either on its own or with external rings. Transponders are usually inserted into the pectoral muscle, but this may not be appropriate for small birds likely to spend significant amounts of time flying as it may cause pain or impair muscular movement. Transponders may be implanted subcutaneously at the base of the neck in such cases. Techniques for intraosseous implantation have been described, presumably as tags are more difficult to remove from within bones if birds are stolen, but this will cause unnecessary pain and suffering and is not justified.

Wing or patagial tags are fitted to the leading edge of the wing by piercing through the skin. These are more invasive than leg rings because of the potential to impede flight and interfere with other behaviour and there is also a risk that a bird could catch a claw in the tag when preening. Markers should therefore not be fixed to the wings if another, less invasive, technique could be used (Hawkins et al., 2001).

3.6.7 Preventing Unwanted Chicks

Many books aimed at bird keepers contain advice about breeding birds and encourage people to do so, with little or no consideration for the fate of the hatchlings (Alderton, 1992; About Pets, 2003; Lindner, 2003). While it may be desirable to house some species in mixed-sex groups to encourage natural social behaviour, any resulting chicks can present practical, welfare and ethical problems as they will have to be accommodated, responsibly re-homed or euthanased.

The most obvious way to prevent birds from breeding yet still give them the companionship of conspecifics is to house them in single sex groups. As with mixed groups, single sex groups should be established early in life and should be stable. Expert advice should be sought before forming single sex groups, as there may be problems with agonistic behaviour; for example, male quail may become aggressive and attempt to mount one another if groups are too large (Gerken and Mills, 1993).

It may also be necessary to house groups of one sex out of the sight and sound of birds of the other sex. Some species are sexually monomorphic so would need to be sexed either surgically (which will cause pain and distress) or by karyotyping, generally using blood obtained by plucking a feather (Hawkins et al., 2001).

Birds are sometimes surgically neutered to prevent breeding or, in the case of males, to reduce aggression. Surgery is necessarily invasive for both sexes and can be difficult; the testes are internal and the ovaries are diffuse and have an extensive blood supply. In addition, neutering surgery will cause postoperative pain, yet pain relief for birds has not been evaluated to any great extent. Surgical neutering is therefore not to be recommended unless there are pressing veterinary reasons.

Breeding can be suppressed in some species by withholding nesting sites or other environmental triggers for breeding, such as certain foods. For example, wild zebra finches breed when the rains arrive so that their chicks hatch when grass seeds ripen some 1–2 months later (Zann, 1996). Withholding nest sites and ensuring that birds are never given soaked or sprouted seeds will suppress breeding in the zebra finch. Breeding can also be suppressed in the pigeon by withholding nest sites, in which case females will lay eggs but will not incubate them (Hawkins et al., 2001). It is not known whether withholding resources in this way causes distress; as discussed earlier, laying hens are known to have a strong motivation to gain access to nest boxes (Cooper and Appleby, 1994) but this has not been evaluated in other species. The benefits to social birds of group housing are significant and may be judged to outweigh going without nesting sites (and the ethical and welfare problems associated with producing unwanted chicks).

Another option is to prevent hatching by pricking eggs once they have been laid or removing eggs; with or without replacing them with dummy eggs. This is more labour-intensive and prone to error where large numbers of birds are involved, but this may not matter if the aim is to reduce but not necessarily eliminate new chicks. Birds will generally give up and stop incubating eggs if they do not hatch, and this may be less stressful than being denied a nest at the point of lay. If eggs are removed but not replaced with dummies, this should not be carried out until a clutch is believed to be completed, as indeterminate layers (such as ducks and Galliformes) will continue to replace eggs until the clutch has attained the desired size. Repeatedly replacing eggs can significantly drain the body's resources and deplete skeletal calcium.

3.6.8 Collecting Eggs or Faeces from Individuals

There may be a genuine requirement to collect faeces or eggs from a particular individual, for example if birds are under veterinary care or if they are the subject of scientific procedures such as antibody production or the evaluation of a parasiticide. In such cases single housing will be necessary, but it is essential to minimise the negative impact of this by providing an interesting and comfortable environment. Even birds housed in specialised environments such as isolators can be provided with enrichment of some kind such as perches made from autoclavable plastic. Social species may also benefit if the cages are located so that birds can at least see one another, even if they cannot interact physically.

3.6.9 Safety Checking Enrichment Items

It is important to ensure, as far as possible, that any novel item supplied to the birds is reasonably safe and unlikely to cause harm. Although many animals benefit from enrichment without any adverse incidents, failure to carry out a proper safety assessment can result in injuries to animals or damage to enclosures. There are a number of components to safety checking, including careful reading of manufacturers' information, literature searches, consultation with others who have used the same or similar items, practical tests and discussion with relevant committees. Chapter 5 in Young (2003, pp. 61–67) sets out key safety considerations.

3.7 How to Assess Bird Husbandry

When assessing bird husbandry,[4] the fundamental principle to bear in mind is that the needs of a species or strain are constant, regardless of the purpose for which particular individuals are housed. There are three aspects to assessing bird husbandry. First, it is obviously essential to view the housing, and to be clear about the minimum standards that are required and what constitutes good practice. Second, the assessment will not be complete without considering the type and quality of care that the birds receive. While these first two aspects relate to the provision of resources and care that will facilitate good welfare, the third is concerned with assessing the welfare of the birds directly. This is the most difficult of the three, since gross indicators of serious welfare problems can be easy to recognise, but signs of boredom and incipient pain or poor health are much harder to detect. The birds' welfare is naturally heavily dependent on their housing and care, which is why it is important to assess all three together.

3.7.1 Looking at Housing

The questions below are intended to form a basis for either assessing the quality of bird housing or for providing input when asked to advise prospectively on bird housing design. They should be used in conjunction with the rest of this chapter.

[4] The term "husbandry" is used here to encompass both (i) housing, i.e. the physical accommodation provided for an animal, and (ii) care, or the protocols for cleaning, feeding, watering, handling, catching, identification, assessing welfare and socialisation with humans if appropriate.

Note that not all of the questions will apply to every species and that some species have highly specialised requirements.

3.7.1.1 Siting and Design

- Is housing sited appropriately – are cages at an appropriate height above ground, are pens screened from disturbance as far as possible?
- Can birds see or hear competitors or predators?
- For outside accommodation, do birds have adequate shelter from sun, wind and rain?

3.7.1.2 Construction

- Are the pens or cages secure, structurally sound and in good repair?
- Is there a double-door system to prevent escape?
- Are all wooden structures properly treated with a non-toxic preservative?
- Are there any sharp edges that could injure birds?
- Is one or more of the walls solid?
- Are mesh walls of an appropriate grid size, material and tension?
- Is the flooring solid and made of a suitable material, covered with appropriate litter (if applicable)?
- If part or all of the flooring is grid, why is this? Are there sufficient solid resting areas and perches?

3.7.1.3 Space

- Do all birds have enough room to exercise by walking, running, flying, swimming or diving as appropriate?
- Is there sufficient space for enrichment?
- How much space is available per bird? Does this comply with or exceed any minimum legal standards or higher welfare guidelines?
- Is there an additional flight or exercise room, or are birds permitted free flight in the home? How frequently do birds have free flight periods, and for how long?

3.7.1.4 Group Housing

- Are birds housed in groups, or pairs at least? If not, why?
- Does the keeper expect any problems with territoriality or aggression during the breeding season? What provisions has s/he made for this?
- Are different species mixed together? If so, why?
- How are the birds monitored for behavioural problems, stress and bullying?
- How is breeding prevented or suppressed? If it is not, what happens to the chicks?

3.7.1.5 Environmental Stimulation

- Are there perches, for species that require them? How are they laid out – is there a range of heights and diameters? Are they made of natural branches, wood or plastic? Are they sited so as to avoid contamination and feather pecking?
- Are birds fed solely from a small number of food hoppers? Is there sufficient hopper/trough space to enable all to feed at once? Are they able to forage on the floor, using puzzle feeders, on or under water etc. as appropriate? Are species that cache food able to do so?
- Can birds dust- and water bathe? Are dust and water baths available all the time, or for limited periods (how frequently and for how long)? Can all birds bathe simultaneously?
- Are pecking substrates provided for species where injurious pecking may be a problem? Are these provided from hatch?
- If breeding is required, do all laying females have a nest box/pan/basket and/or sufficient nesting materials each? When are these made available to the birds – at what age and how long before the breeding season begins?
- Is there adequate cover if required, e.g. planted or potted shrubs, straw bales?
- Do the birds have natural and/or manufactured toys? If they do not (especially if they are Psittacines or Corvids), what are the reasons?
- Do water birds have an adequate pond?
- Do birds have appropriate human contact, and are they properly protected from humans other than their carers, e.g. at zoos and bird shows?

3.7.2 Appropriate Husbandry

To ensure good bird welfare, species-appropriate and animal-centred housing needs to be combined with empathetic, competent husbandry. The ideal animal carer would be someone who likes and empathises with animals, understands their behaviours from the animals' point of view, is open to new ideas and willing to review husbandry, and knows exactly which actions to take in the event of health or welfare problems. This section primarily concerns birds housed in non-domestic settings, but the same considerations also apply, to varying degrees, where birds are kept as companions.

Anyone responsible for assessing a facility housing captive birds should ascertain whether everyone who works with, or is responsible for, the birds has an appropriate level of knowledge of the behaviour of the species and its environmental requirements and veterinary requirements. At least one person who has received specialist training in catching and handling birds, recognising pain, distress or disease and avian nutrition should be available whenever necessary (in a home environment, this could be a well-informed keeper of a companion bird). Everyone should know who to contact if they are not competent in a particular area.

Asking about husbandry is important for two reasons. First, there is a need to know some basic facts about housing and care to make a judgement as to whether standards are acceptable. This includes asking about any training programmes bird carers have attended, how frequently birds are cleaned out, how stress to birds is minimised when their accommodation is cleaned, how long is allowed for monitoring health and welfare every day and what kinds of veterinary, environmental and breeding records are kept (these should be viewed if possible). See Young (2003, pp. 16–19) for a list of specific issues to address when assessing husbandry on-site.

Second, discussing these questions – either in the home or in a captive bird facility – will help to gain an impression of peoples' attitudes towards the birds in their care. It should be an immediate cause for concern if people are: reluctant to consider housing and care from the birds' point of view; unwilling to think about potential welfare problems; interpreting behaviour inappropriately (such as believing that birds are deliberately being difficult when they are in fact afraid); or insisting that birds' welfare must be good because they are growing or laying eggs. Such attitudes can have a direct negative impact on bird welfare because people who hold them are less likely to handle birds empathetically, monitor them effectively or provide a good quality environment. The best way to deal with poor attitudes depends on the individuals concerned, the culture within their organisation, the legal requirements for training associated with each context of bird use and powers of enforcement that the inspector has. Whatever the background to concerns about the attitudes of those responsible for birds' lives and welfare, it is vital to take immediate action before welfare problems are created or worsened.

3.7.3 Inspecting the Birds

There are a number of different, complementary parameters that can be used to assess welfare, such as physiology, behaviour, condition, health and breeding performance (Knierim et al., 2003; Whay et al., 2003). Obviously, the quality and quantity of information available with respect to each of these can vary widely in practical situations. In a farm environment, there may be little or no information about animals at an individual level, whereas in a laboratory, where birds are used in physiology research, there may be telemetered data on heart rate variability that can be used to infer welfare. "Pet" bird keepers may be able to provide more information on subtle behavioural changes, such as reduced comfort or exploratory behaviours. Table 3.1 lists some examples of clinical and behavioural signs that are causes for concern and should initiate further investigations. The explanatory notes below correspond to the categories given in the left-hand column.

Note that Table 3.1 is not intended to be exhaustive, nor is it intended to be a checklist to be used in full every time birds are inspected. A checklist can be very useful when assessing bird welfare, however, provided that it is tailored to the particular species and welfare issues that may arise, e.g. post-operative care, recovery from disease, monitoring adverse effects of scientific procedures. Working examples of checklists are available in the literature (Blogg et al., 1998; Hawkins et al., 2001; Hawkins, 2002). See also Chapter 8 of this volume for indicators of disease in domestic fowl.

Table 3.1 Examples of observations that indicate bird welfare or health have been compromised

Type of variable	Relevant observations
Physiology	Body weight decrease (non-seasonal)
	Body temperature change
	Increased heart rate or heart rate variability
	Increased respiratory rate
	Disruption of diurnal rhythms, e.g. in heart rate
	Diminished righting reflex
Behaviour	Reduced eating or drinking
	Reduced or absent comfort behaviours, such as preening, dust/water bathing
	Apathy, e.g. not interacting socially with conspecifics, not playing or exploring, not interested in treats/opportunities to forage, not investigating environment with beak (indicates pain following beak tipping)
	Reduced or stiff locomotion, staggering, limping (e.g. due to leg damage, arthritis, foot lesions, tight leg ring); lying down with leg extended (e.g. lame broilers)
	Vocalising, distress calls, escape reactions, panic/hysteria
	Guarding part of body, paying attention to surgical wound site
	Abnormal aggression
	Abnormal or stereotypic behaviour, e.g. circling, pacing, pecking at one spot; "feeding" feet (Psittacines), self-mutilation e.g. feather plucking, regurgitation, excessive biting or "attention" screeching
	Panting
	Increased, more frequent head movements
	Huddled or feathers fluffed up; neck retracted, head drawn in
	Wings drooping or held flat against the body; tail held down
	Tonic immobility
	Hiding
Health/condition*	Partially closed eyes
	Discharge from (or crustiness at) eyes, nares or mouth
	Coughing, wheezing, laboured breathing
	Feather loss; bald patches; sores
	Feather damage due to pecking
	Overgrown beak or claws
	Lameness, apparent discomfort
	Wounds or bleeding; due to injury, attack by conspecifics or self-mutilation
	Abnormal droppings; increased/decreased amount, colour change, increase in water/urine portion, decrease in faeces volume, presence of blood
Performance	Reduced egg laying
	Reduced egg size or shell strength
	Reduced hatch rate
	Reduced chick survival

* This is a very brief list to indicate some types of relevant clinical sign; see the veterinary literature for more comprehensive guidance on clinical signs and their interpretation (Cooper, 2003).

3.7.3.1 Physiology

Decreased body weight is the easiest parameter to quantify, but it is important to remember that body weight varies seasonally in many birds, particularly migratory species that build up the pectoral muscles and lay down fat reserves in preparation for long flights (Owen and Black, 1990; Saunders and Fedde, 1994). This can occur in captivity (Styrsky et al., 2004), so body weight changes should always be interpreted with reference to the time of year if this is relevant to the species.

3.7.3.2 Behaviour

Behaviour that indicates poor welfare can be easy to detect, such as huddling, or much more subtle, such as reduced exploratory or play behaviour. The list set out in Table 3.1 is included to provide examples of the types of behaviour that may be observed if husbandry is inadequate, which should give rise to immediate concern.

When considering this list, remember that many species, particularly prey animals, have evolved to suppress behaviours that could indicate that they are stressed, anxious, sick or afraid (Gentle, 1992; FELASA, 1994; Roughan and Flecknell, 2001; Hawkins, 2002). This means that subtle indicators of incipient suffering may go unrecognised unless the observer is very aware of what constitutes normal and abnormal behaviour in the species (or individuals) and can also spend a relatively long time observing the animals. The job of assessing welfare is complicated by the fact that the birds' behaviour is likely to change when humans are present – they may be afraid of, unsettled by, or interested in the observer. It is also important to remember that animals' activity patterns follow diurnal rhythms and so assessing animals at times when they are inactive (e.g. observing nocturnal animals in the light phase) could well result in missing important clinical signs (Hawkins, 2002).

Despite these difficulties, it is always possible (and essential) to detect and act on gross indicators of poor welfare, even if subtler signs of psychological distress are not immediately recognised. For example, chronic distress in birds is often indicated by stereotypic behaviour (Mason, 1991; Manser, 1992; Keeling and Jensen, 2002; Meehan et al., 2004). The ultimate causes of stereotypies may differ in each case (Keiper, 1969), but most can usually be greatly reduced or eliminated by improving animals' environments, for example by providing better quality and quantity of space and companions where appropriate (Meehan et al., 2004; Mason et al., 2007). Note that stereotypies signify that animals have been unable to cope with inappropriate husbandry at some time, i.e. they can persist even when the husbandry problems are resolved (Keeling and Jensen, 2002; Mason and Latham, 2004; Mason et al., 2007). However, since performing a stereotypy may cause distress *in itself* (Garner et al., 2003), it is essential to take any abnormal behaviours very seriously indeed, instigate a full review of housing and care in all cases and seek advice from a veterinarian or behaviourist if the behaviours persist. Of course, it is highly undesirable that birds should experience such distress at all and the goal should always be to prevent stereotypies from occurring in the first place wherever possible. For comprehensive information on stereotypic behaviour, its implications for welfare and how to address these, see Mason and Rushen (2006).

3.7.3.3 Body and Feather Condition

Partially closed eyes, possibly due to overall loss of muscle tone, are a general indicator of malaise in most birds (ILAR, 1992; Blogg et al. 1998). Birds are also especially prone to respiratory infections such as aspergillosis, due to the large surface area of the lung and air sac system. Stress caused by inappropriate housing can increase the animals' susceptibility to respiratory infections; the first apparent clinical sign is generally laboured breathing, or a wheezing or rattling on breathing.[5] Evidence of injurious pecking, e.g. self-pecking, feather pecking or vent or head pecking, ranges from slight feather damage to very serious or fatal damage to the skin and tissues including evisceration through the vent. Any level of injurious pecking requires immediate action to prevent what can lead to substantial suffering.

3.7.3.4 Performance

As discussed above, high quality performance with respect to production of eggs, chicks or meat does not mean that welfare is good, since farmed animals have been selected for extremely high production even when their condition is very poor. It is often the unsustainable production levels that have led to their poor condition in themselves, for example in lame broiler chickens and "heavy" turkeys, or laying hens with fractured bones due to skeletal calcium depletion. Despite this, the converse – that reduced performance within the life of an individual could indicate poor health or welfare – is true (Keeling and Jensen, 2002).

3.8 Information Exchange

Knowledge about animals' needs and wants with respect to housing is constantly increasing, as is the number of publications describing successfully evaluated and implemented enrichment. It is very important for all those directly or indirectly involved with bird care and use both to keep up to date with developments and to help disseminate good practice with respect to bird housing and care. Some useful resources in this regard are listed below.

- *Animal Behaviour*; journal of the Association for the Study of Animal Behaviour (http://asab.nottingham.ac.uk/) and the Animal Behavior Society (http://www.animalbehavior.org/); all aspects of animal behaviour.

[5] Note that respiratory diseases such as aspergillosis and ornithosis are transmissible to humans and are hard to treat, so great care is necessary when examining birds who appear to be experiencing difficulty with breathing.

- *Animal Welfare*; journal of the Universities Federation for Animal Welfare (http://www.ufaw.org.uk/); animal welfare science relating to all species and areas of animal use.
- *Applied Animal Behaviour Science*; official journal of the International Society for Animal Ethology (http://www.applied-ethology.org/); mostly farmed animals but also covers companion, wild and laboratory animals.
- *Electronic Zoo*, http://netvet.wustl.edu/ssi.htm; extensive collection of veterinary and animal-related links. Includes species-specific mailing lists, newsgroups, publications and organisations.
- *International Zoo Yearbook*; published annually by The Zoological Society of London, Regent's Park, London, NW1 4RY, UK (http://www.zsl.org/).
- *Journal of Applied Animal Welfare Science*; a joint project of Psychologists for the Ethical Treatment of Animals (PsyETA) and the American Society for the Prevention of Cruelty to Animals (http://www.psyeta.org/jaaws/). Covers refinements in procedures and husbandry in all contexts of animal use.
- *RATEL*; bi-monthly journal of the Association of British Wild Animal Keepers, written by and for zoo keepers (http://www.abwak.co.uk/).
- Reinhardt, V. and Reinhardt, A., 2004, *Refinement and Environmental Enrichment for All Laboratory Animals*; http://www.awionline.org/SearchResultsSite/laball.aspx.
- *The Shape of Enrichment*; quarterly journal published by the Shape of Enrichment, Inc (http://www.enrichment.org). Successfully evaluated enrichment ideas for all captive animals, including birds.

Some of the above resources focus on birds kept for a specific purpose, such as farming or in zoos. However, it is useful to research husbandry refinements for birds used in a range of contexts regardless of the area in which you are working. For example, laboratory birds are often housed in better conditions than farmed birds of the same species, so guidelines for laboratory bird use can be helpful when improving farmed bird husbandry; enrichment ideas for birds in zoos (or the principles informing them) can be used to enrich the lives of birds housed for any other purpose.

In addition to consulting relevant resources, it is also important to contribute to them and to encourage other people to do so. This includes submitting articles to appropriate publications, passing on husbandry protocols at meetings, participating in web-based fora, visiting different establishments and so on. All of these measures will help to ensure that published information and good practice in all contexts of bird husbandry are disseminated for the benefit of other birds and their keepers.

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Chapter 4
Training Companion Birds

Greg Glendell

4.1 Introduction

The purpose of training companion birds is to ensure good, effective communication between the bird and his/her keeper. Trained birds have a much better relationship with their human carers, since mutual understanding is greatly improved. Trained birds can also spend far more time out of their cages than untrained birds since they pose fewer problems for the keeper. The more time a bird can spend out of the cage, the more opportunities there are for better quality environmental stimulation. Another advantage of basic training is that any behavioural problems that develop can be corrected far more easily in trained pet birds than in untrained ones. This chapter aims to provide some basic guidance and an overview of good practice relating to the approach to training companion birds, although the same principles can be applied to training birds in other contexts. It is partly written in the form of direct instructions for purposes of clarity. For further information and guidance, see Glendell (2007) and Friedman (2006, 2009).

Training methods should be based on the accepted scientific principles of applied behaviour analysis (ABA) and in particular, *positive reinforcement* and *shaping* techniques. Positive reinforcement means providing the bird with an incentive (a reward) for performing the behaviour in question. Shaping is where any approximation of the behaviour in question is rewarded during training, but the bird is asked to perform progressively better approximations to the desired behaviour as the training develops. The reward offered is determined by knowing what the particular bird already likes. Rewards can be food treats, a favourite toy to play with, verbal praise or, with parrots, having their head scratched for a few seconds. It is vital that the keeper/trainer first finds out which reward(s) the bird is *already motivated to work for*, before starting any training programme.

The success and ability to train birds depends on a range of factors. Although birds can be trained at any age, the bird's past experiences with people, degree of

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tameness and whether s/he was hand-reared, parent-reared or part parent-reared are all factors that can affect the ease with which individuals can be trained. The bird keeper or trainer's knowledge of training techniques and bird behaviour is also of considerable importance. Trainers need to understand the importance of avoiding all forms of punishment and indeed admonishing of birds; such methods are counter-productive and tend to cause further behavioural problems. *Negative reinforcement* should also be avoided. Negative reinforcement is where a bird is subjected to unpleasant or harmful actions, until it obeys the request. For example, chasing a nervous or fearful bird around a room until it "obeys" a request to step up onto the hand.

On no account should a bird be punished for any bad behaviour. Punishment has no place in companion bird care. Even unintentional punishment and verbal reprimands can have seriously adverse effects on birds and must be avoided. "Bad" (unwanted) behaviour should always be corrected using non-threatening behaviour modification techniques based on applied behaviour analysis, as mentioned earlier. For example, although some birds may bite sometimes, such a problem is not usually difficult to overcome through training. Once, through training, a bird has agreed to accept the basic requests detailed below, biting can be addressed by the trainer simply leaving the room if s/he or anyone else is bitten hard. On no account should biting result in the bird being placed back into the cage, as this can induce further serious problems. Once a bird who has bonded to a person realises that that person will deny the bird their company for a few minutes because of the biting, the bird then has the incentive to cease biting.

Most birds kept as "pets" are highly social species adapted to living in the company of their own kind. Such birds have an elaborate "language" of behavioural signals to ensure social cohesion and minimise aggressive encounters. While the "language" is different for each species, closely related species have a similar repertoire and similar behavioural signals. Birds kept in a domestic situation can be divided into two types. First, those kept as "aviary" birds who are generally housed outdoors in the company of their own kind within an aviary. Second, those kept as companion animals, usually indoors with the bird using a cage. Since aviary birds will have the company of their own kind, provided they are given suitable space and an aviary that encourages them to perform most of their normal daily behaviours, it is not suggested that they be required to perform any particular behaviours. It is only birds being kept as companion animals who should be asked to accept some basic requests or "commands" from their keepers. This is quite easy to achieve with all Psittacines and some other species including canaries and mynah birds.

4.2 Training Psittacines

If a companion parrot is to socialise well and be comfortable with people, it is imperative that the owner and anyone else in the household who wants to interact with the bird can communication effectively with him/her. This is essential for the parrot's mental well-being and relationship with the human "family". The purpose of training is in effect to establish basic, two-way communication between the trainer and the bird; much the same as when training a companion dog. This training ensures good "control" of the bird who can be asked to do (or not do) several things on request. Trained birds can, of course, be out of their cages for long periods since they pose fewer "problems" than untrained birds with respect to control, acceptable behaviour and returning to the cage. Training also ensures that the bird remains tame and allows the owner to introduce new items and resources such as toys, foods and new people far more easily. Good training therefore enriches birds' lives, since it facilitates new experiences.

4.2.1 Pros and Cons of Imprinting

Parrots and passerines are not usually susceptible to full (irreversible) reproductive imprinting (in the true sense of the word). However, many other birds including all pigeons become imprinted on to the first moving object they see and touch when they are nestlings; this, of course, is usually their parents. When nestling pigeons are hand-reared, they usually develop as true human-imprinted birds and have an irreversible "bond" to humans for the rest of their lives. Parrots raised solely by humans, (i.e. having no contact with their natural parents) tend to develop behavioural problems, but these are not seen until the birds mature at 2–5 years old (depending on the species). Passerines initially display a "bond" that is similar to that in truly imprinted species, but which can change throughout their lives depending on the experiences that they have with humans and other species. Birds who have been hand-reared will certainly be tame, even fearless of humans. This has implications for training, in that bold or even aggressive birds, though easier to train than nervous ones, can cause problems with aggression once they mature. Parrots and passerines who have been wholly or partly parent-raised tend to be more wary of humans. Though still quite tame by default, they tend to have far fewer behavioural problems than hand-reared birds and show a better degree of independence. Given a suitable environment in which to live, they invariably socialise appropriately with birds of their own species.

4.2.2 Gaining the Confidence of Nervous Birds

Nervous, fearful birds may have a deep-seated mistrust of people. They are liable to be stressed by anyone making a close approach, showing their hands, standing in front of them or staring at them. Many birds have a real fear of people wearing hats, or black or dark clothing, so anyone who needs to approach them including the birds' trainers should be dressed in bland, neutral coloured clothes. Nervous birds cannot be trained until they are tame and reasonably comfortable in the company of people.

Flightlessness (usually due to) can cause many birds to be very fearful, since they are denied their most basic “escape” reflex action of defensive flying. These birds should have flight restored without any delay wherever possible. This can be effected by a specialist bird vet repairing the clipped wings by “imping” on feathers moulted from another bird of the same species. Alternatively, most of the clipped remains of the flight feathers can be removed from the wing completely, which induces immediate regrowth of feathers. Parrots’ feathers grow at three to four mm per day, so most species will have complete new feathers within four to six weeks of the damaged or clipped feathers being pulled out. Both these procedures are done under general anaesthetic.

The taming process uses the same principles of rewarding “desired” behaviours as in more formal training sessions. However, progress with nervous birds will usually be very slow. Initially, it helps to ensure that nervous birds have a perch in their cage that is higher than human eye-level. This will reduce their fear of people when they come close. It will also help to avoid looking directly at the bird. Another tactic to help nervous birds habituate to humans is for the trainer to simply sit down below the cage and eat some food in front of the bird. Most birds are highly social and perform many activities as a group, so birds can be reassured by seeing other people (or birds) eating. However it is important that this process be carried out at a pace with which the bird is comfortable.

Over a few days, most birds get accustomed to these sessions and either eat their own food (which should always be available at these times) or show some interest in the trainer’s food. When this begins to happen, the bird should be offered a favourite titbit through the bars of the cage. Later on, the bird can be offered food treats through the open cage door, placing a hand-held titbit just below the beak. Later still, the cage door can be left open with the food treat being offered once the bird has walked out of the cage. After 20 min or so, the bird can be tempted back in by a treat being placed conspicuously in the food pot within the cage.

4.2.3 The Role of Perches in Training

As fundamentally flying animals, the relative height of people, other birds and objects to a bird will have a significant effect on his/her behaviour. Unless a bird is nervous of people (see above), it is best to ensure that there are no perches in the cage above shoulder height. Aggressive companion birds who spend much time in high places often reject training and can become difficult to work with. Parrots should not be allowed to use anyone’s shoulder as a perch. “Shoulder birds” tend to reject training, may inflict painful bites to the face and often escape as the owner forgets about the bird on their shoulder and walks outdoors. If a flying bird lands on someone’s shoulder, s/he should be asked to “step up” onto the hand immediately (see basic requests, below). While the bird is on the hand, the hand should be turned so that the bird faces the trainer. This allows good eye contact and the opportunity to read the bird’s body language. Birds should not be permitted to walk up the arm onto the shoulder; this should be prevented at all times using the “stay” command or asking the bird to "step up" onto the other hand. The bird's inclination to walk up the arm can be reduced by keeping the elbow slightly lower than the wrist while the bird is perched on the hand.

Where owners have high ceilings, or places where birds can get out of reach, it is a good idea for them to train the bird to step onto a stick held in the hand. The stick should be long enough to reach the bird wherever she might land, resemble a perch from the bird's cage and be sufficiently thin for the bird to wrap her toes right around it. It should be presented to the bird as a perch, just above the level of her feet, never pointed at the bird. The "step up" command should be given as the stick is presented and the bird's compliance should be rewarded immediately. It may be best to stick train in the training room at first.

4.2.4 Using a Training Room

Bold or genuinely aggressive birds often show "territorial" or aggressive behaviours while in or near their cage, so they can be very difficult to train in these locations. In these cases it is best to start the training with the bird well away from the sight of the home cage, in another room that is unfamiliar to them. Conversely, nervous birds should *always* be trained near their cage, as this will help them to become more confident in the company of people. Where a training room is used this should be fairly small; a spare bedroom is usually ideal. It should be carpeted and sparsely furnished with a couple of chairs whose backs can be used as perches for the bird. Any large-pane windows should have net curtains hung at them to prevent the bird flying into the glass and there should be no mirrors or any ceiling fans in the room. Also, there should be no objects such as pictures, shelves or ornaments that the bird can perch on that are higher than the trainer's chest. The door should be kept closed throughout the training session. Once the bird is stepping on and off the hand wherever she happens to be, the use of a separate training room can usually be dispensed with and training can be done in the same room as her cage. For the flight requests, the bird should be able to fly quite well and be reasonably able to control her landings.

4.2.5 The Basic Requests

All birds should be asked to accept three basic requests. These are:

1. "step up" (step onto my hand now);
2. "go down" (step off my hand now);
3. "stay" (do not approach me for now).

Assuming that the bird can fly, s/he should also be asked to accept these further commands:

1. “go, go” (leave me by flying from me);
2. “off there” (leave a “banned perch” by flying off it);
3. “on here” (fly to me);
4. “cage” (go to cage/travelling cage).

4.2.6 Teaching the Commands

It is important that the trainer is calm and confident at all times during training, regardless of what happens during these sessions. The bird will sense the trainer’s confidence and will thus be more likely to remain calm; this is an advantage because calm birds learn very fast! Good behaviour should be rewarded with something that the bird is already known to really like. With some birds, verbal praise can be used, or the bird’s head can be scratched; others will work eagerly for a favourite food treat or a favourite toy to play with. *The trainer must know what reward is to be used before any training is started.* The rewards provide the bird with the incentive to accept the trainer’s requests or “commands”. Without such incentives, training can be unnecessarily hard for both trainer and the bird. When the bird understands the connection between the behaviour being asked for and the reward it results in, progress is usually rapid.

Before training the bird, trainers should understand the basic, established rules about working with birds.

- Use methods based on applied behaviour analysis, as explained here.
- Remain *calm and confident* at all times (even if the bird bites!). Speak clearly and calmly, *never* in a loud voice.
- Discourage or prevent the bird from having access to any high perches (including your shoulder).
- Use positive reinforcement. Reward all good behaviour, promptly, with something you already know the bird really likes.
- *Never* punish or even admonish a bird for any “bad” behaviour.

Bold or aggressive birds will usually need to be taken to another room for training. This is best done by taking the bird, still in the cage, into the training room. Here, the cage door is opened and the bird encouraged to leave by offering a suitable food treat outside the cage. Once the bird is out, the cage is removed from the room and training can begin. The requests should be taught in the order suggested below. Birds are hereafter referred to as “him”, but the concepts and guidance apply equally to both genders.

4.2.6.1 First Requests: Stepping up onto the Hand and Stepping off

With the bird in position, on the back of a chair and the room door closed, wait a few moments to ensure that the bird is calm. Then, approach the bird and make eye contact with him, say his name and make sure he is attentive. If you are to ask the bird to "step up" on your left hand make sure to show the bird a reward (perhaps a food treat) now, in your right hand. Next, raise your left (step-up) hand to the same level as the bird's feet and approach him calmly. Try to maintain eye contact with the bird, to keep his attention. The hand should be held with the thumb down out of the way and with the four fingers in line offered as a perch. Place the hand very close to the bird's feet near his belly and say "step up". You can also touch the bird's belly with the edge of the forefinger. The bird should step onto the finger after a few attempts at this. If the bird bites, it is best to try to show no reaction to this, in particular, the trainer should not make any sound at being bitten. The "step up" phrase should be simply be repeated in a calm voice while the reward is offered in the other hand. If the bird flies down to the floor, the trainer should not chase around after him. Instead, the bird should be allowed a few moments to calm down.

Then the trainer should crouch down beside him and again place their hand just above his feet and ask the bird to "step up". Many birds will actually step up very easily from the floor. Then, without any delay, return the bird to the perch you started from by saying "go down" as you ask him to leave your hand, immediately giving him the reward he has earned. When praising the bird the tone of voice should be calm and full of encouragement. Give the bird plenty of time to enjoy the food reward or toy you have been offering him.

The chair back should be slightly higher than the hand the bird is on, since birds tend to step *up* on to a perch much more easily than they step down on to one. If this is all that is achieved during the first lesson, a good start will have been made. With this in mind, it is best to finish each lesson on a positive point, and return the bird to his room or cage.

The training lessons should not last more than four or 5 min. Birds should be allowed to calm down if they become flustered, but lessons should cease immediately if the bird ever appears to be upset. A bold bird may bite once or twice, but birds are unlikely to bite several times in succession in the training room. Some birds are slow or reluctant to accept some requests at first, but as soon as the bird knows that he is getting a reward for complying with requests, he will learn very quickly. Training sessions should be conducted every day; in most cases significant progress will be seen within a few days.

It is essential to praise all good behaviour in an enthusiastic tone of voice. Everyone who works with a particular bird should use exactly the same words and hand positions for the same requests otherwise the bird may become confused. Once a bird accepts requests while in the training room (at least the "step up" and "go down" requests) the process can be repeated with the bird in the same room as the home cage. If the bird refuses to agree to your requests while in or near the cage, moving the cage to a new location, within the same room, can help. Another technique that can help is to return the bird to the cage, using the "go down" request, but allow him to remain in the cage for only a few seconds (leaving the cage door open) and then ask him to "step up" back onto the hand again. This can be repeated a few times, praising and rewarding the bird each time he does as he is asked. Bold or aggressive birds are generally better behaved when they are accustomed to coming out of the cage by stepping onto the hand when requested. If the bird does begin to reject training in the cage room, the training room can be used for some "remedial" lessons for a few days.

4.2.6.2 Next Requests

When birds are fully trained to step up and down from the hand wherever they happen to be, they can be taught the other requests below. During the training process, most (but not all) birds begin to bond with their trainers as they learn to take requests and be rewarded for their efforts.

4.2.6.3 Stay, i.e. Do Not Land on Me

This "stay" request does not mean that the bird should stay where he is, but only that he should not come to you for the moment. All birds should be encouraged to be active, *not* forced to stay in one place for long periods ("stand trained") since this can cause them to develop serious behavioural problems.

Trained birds will often want to fly to the person they have bonded to, which is fine on most occasions. However, there will be times when the bird's approach needs to be stopped. To do this effectively, the bird can be taught the "stay" request so that he knows he cannot always land on his human carers. To teach "stay" the trainer should look at the bird, raise one hand with the palm towards the bird and say "stay"; perhaps as they are about to leave the room. If the bird disobeys and flies towards the trainer, the hand should be left held up and the "stay" request repeated. The raised hand is then used as a barrier to prevent the bird from landing on the trainer. The bird will soon learn to turn around and land elsewhere. When he does, the trainer should praise or reward him and then leave the room, closing the door behind them. This request and the same hand gesture can be used to ask a bird to refrain from walking onto someone as well.

4.2.6.4 Go, Go (Fly off Me)

This request tells the bird to leave the trainer by flying off him or her. This is initially taught by standing with the bird perched on the hand, about one metre from the cage or other regular perch. A reward for the bird should be placed conspicuously on the place you are going to ask him to fly to and you should ensure that the bird has seen the reward. Next, the hand with the bird on is turned at the wrist so that the bird is facing away from the trainer and towards the intended perch, then on the command "go, go" the hand is gently but decisively swung in the direction of the perch or cage. The bird should leave the trainer and land on the perch and take up his reward while you give verbal praise. When the bird is happy to fly from one metre, the distance to the perch can be gradually increased. The trainer should then practise this request in other locations, until the bird is happy to leave on command wherever the trainer happens to be. If a bird flies and lands on the shoulder once the "go" request has been taught, he can be removed by using the "step up" command or by repeating "go, go" and jerking the shoulder upwards to tell the bird to fly off.

If he tries to return again, the “stay” request can be used to ask the bird to refrain from doing this for the moment.

4.2.6.5 Off There

This is a safety request to be used if the bird ever lands on a dangerous perch such as the television, a light fitting or a high perch such as the top of a door. It can be difficult to teach some birds this command. When the bird does land on such a “banned perch”, the trainer should approach him and wave one or both hands (or an unfamiliar but harmless object such as a handkerchief) in a gesture that is unfamiliar to the bird, saying “off there”. The bird should not be allowed to fly and land on the trainer as he leaves a banned perch; he should land on some other, normal perch. When he does land on a familiar perch, he should be praised verbally without offering too strong a reward, as this may encourage the bird to go to a banned perch so as to get a “reward” after he leaves. The trainer cannot teach this request “predictably” but should only do so if and when the bird lands on a banned or dangerous perch. Once certain places have been determined to be off limits to the bird, they must always be so.

4.2.6.6 On Here

This is a recall request, which asks the bird to fly to the trainer on command. By the time the other requests have been taught, the bird will probably have bonded quite well to the trainer. Indeed, most trained birds want to be with their trainers, if not on their hand most of the time. However, trainers can reinforce the bird’s desire to come to them on a verbal command by rewarding him “automatically” each time that he does already come. Working with the bird when he is about to fly to the trainer anyway is a good way to get him used to associating the verbal request “on here” with flying to the trainer. So, each time the trainer sees the bird about to fly to him/her, the arm should be held out, the request “on here” given and a reward visibly offered (e.g. a favourite toy or food treat). The reward should be given as soon as the bird lands, and combined with enthusiastic verbal praise, perhaps scratching his head as well if he likes this.

4.2.6.7 Go to Cage

This request is used to ask the bird to return to his cage or to enter a small travelling cage, which might be needed when taking him to the veterinarian. Travelling cages should be all-wire with a large door that hinges flat down and allows the bird to walk in easily. Birds are far more prepared to enter this type of cage, which affords good visibility, rather than a dark, box-like type. The travelling cage should be positioned at least at table-top height near the home cage and should be left in this place for several days to allow the bird to habituate to it. Next, a small but favourite food treat should be left near the travelling cage. When the bird approaches and takes the food treat, the command “go to cage” should be given.

Over the next few days, the bird should become used to moving towards, and finally into the cage using the food treat and the cue phrase of "go to cage". The trainer should remain close to the bird. Finally, when the bird already feels comfortable with eating a food treat in the cage, the door can be closed with the bird inside, offering another food treat as a reward. The door should only be closed for a few seconds on the first few occasions, gradually increasing this period to a minute or two, then picking the cage up and moving it very gently a couple of metres. By now, the bird should be used to going in and out of the cage on command and travelling stress should be minimised. During transit, to reduce stress, the travelling cage should be covered to restrict the bird's view. The bird should never have sight of other animals, particularly dogs and cats, while inside the carrier as this may cause an extreme fear response.

4.2.7 Other Training Hints

In general, birds should not be forced to stay on anyone by being physically restrained, especially by their feet, e.g. by gripping the bird's toes while he is sitting on the hand. If a parrot attempts to fly while being held by the feet, his toes or other joints may be dislocated and this is very painful. Occasionally a trained bird will want to leave the hand without being told to go and this is quite acceptable. After a few moments the trainer can simply ask the bird to come back, using the "step up" request.

Whenever the bird is offered a familiar object or treat to take in his beak, it should always be presented at or just below beak-level, using the same phrase each time, e.g. "take this", "take toy", or "take nut", depending on the circumstances. A bird should not be offered a new object until he has seen the trainer handling it and (this is especially important) putting it up to their mouth a few times before offering it to him. Putting an object up to the mouth reassures a bird that the object is safe to touch. Also, the use of a spoken phrase while offering an object tells the bird clearly that the trainer would like him to take it.

4.2.7.1 Towelling

If a bird ever needs to be held or restrained (perhaps for a visit to the veterinarian or administering medication) stress can be reduced by accustoming the bird to being held gently in a towel. Once the bird accepts the other training requests, as above, the trainer can practice getting him used to the towel. This should begin by sitting the bird on the trainer's lap and offering him a corner of the towel to hold. Gradually, after several sessions like this, more of the bird's body can come into contact with the towel. Eventually the trainer should be able to play with him, ending by wrapping him gently in the towel and holding him there for a few brief moments. The bird should be rewarded and encouraged at all times and all stages by giving food treats, favourite toys, praise or head scratches, i.e. whatever the bird is already motivated to appreciate as a reward.

4.2.8 Problems of "Free-Range" Birds

Free range birds are those whose keepers allow the bird to have free access to most or all of the house, with little or no training, behavioural restriction or supervision while the bird is out and flying around. Keeping a bird in this way often results in the bird becoming aggressive and refusing instructions from its owner or anyone else. He may also start to bite. This is not the fault of the bird; he does this because he is not receiving any guidance or training from his owner/carer. While the bird should certainly spend as many hours out of the cage as possible in order to prevent cage frustration behaviour, it is vital that he is supervised while out of the cage. For their own safety, pet birds should be returned to their cage to spend the night.

4.3 Conclusion

In summary, training can improve the relationship between companion birds and their human carers. This training is not necessary and may not even be appropriate for aviary birds. Training methods should be based on positive rather than negative reinforcement or punishment. This paper has described the basic techniques for training companion birds in this way, which is likely to lead to more frequent interactions of better quality, and less risk of problem behaviour developing.

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Chapter 5
The Welfare of Captive Birds in the Future

Simon J. Girling

5.1 Introduction

This chapter addresses three key uses of captive birds by humans: (i) selective breeding for productivity and appearance and the potential for genetic disorders, (ii) biomedical research and testing and (iii) wild bird trapping and trading. These very different uses have been selected because, although birds have been used in these ways for hundreds or thousands of years, rapid legal, scientific and economic developments are now placing unprecedented pressure on the birds involved.

5.2 Selective Breeding for Phenotypic Traits

The keeping of birds in captivity has been traced as far back as ten thousand years ago in Asia (Delany, 2004). Few avian species have become truly domesticated to the extent of the domestic fowl (*Gallus gallus domesticus*). This may be one of the reasons why the domestic fowl is over-represented in the scientific research literature in relation to other avian species, in addition to the fact that it provides nearly 25% of the animal protein consumed by humans worldwide (Cooper and Cooper, 2003). The welfare of domestic fowl in the future is covered in Chapter 12 by S. Millman et al., this volume. The paucity of literature on non-domesticated avian species causes problems when one tries to consider the health and welfare impact of captive breeding programs.

The history of captive bird keeping is pervaded with the human desire to select certain traits and breed selectively for these features. Sometimes these "desirable" traits are associated with rapid growth and meat production, as in domesticated poultry. At other times they are associated with physical appearance, feather colouration or feather shape, as in "show" cage birds. These traits and features are referred to as the phenotype of the bird, which is the physical manifestation of the combination of

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the bird's genetic makeup and the influence of nutrition and environmental factors on the bird's development. It is thus impossible accurately to discern the true genotype, or genetic makeup, of any animal purely from its physical appearance in the majority of cases.

It is obvious that, in the absence of artificial breeding programmes, natural selection will act upon animals. The process of natural selection maintains a balance between the positive attributes of a trait being selected for and the negative attributes, for example reduced fecundity, decreased energy conversion rates or reduced lifespan. An example would be the natural selection of exaggerated secondary sexual characteristics. Darwin (1874) describes two main benefits from exaggerated secondary sexual characteristics: as a form of weapon which may be used to compete with other individuals of the same sex and as ornaments to attract members of the opposite sex for successful mating to occur. However, the "handicap theory" (Hamilton and Zuk, 1982) suggests that many of these secondary sexual characteristics, such as the sizes of cockerels' combs, come with a limiting factor; in this case the energetic cost of producing the combs. This homeostatic mechanism ensures that the phenotypic development of any species increases the ability of that species successfully to colonise its niche in the ecosystem without risking its chances of survival.

With the advent of human interference in the process of natural selection, another form of phenotypic bias has been created. The main aim of the domestication of poultry, as with other species, is to "adapt" a wild animal to a captive way of life, and to increase its ability to produce, in the case of poultry, eggs and meat. In this respect, the selected phenotypic traits have allowed many strains of domesticated poultry to cope with captivity better. An example would be the Hy-line breed, a White Leghorn laying hybrid which has been selected mainly for food conversion efficiency. Studies by Schütz and Jensen (2001) showed that birds of the Hy-line breed were less active and less involved in social interactions than the wild type ancestor of the domestic chicken, the Red Junglefowl (*Gallus gallus*). The selection of a strain for high production results in the modification of behavioural strategies that are of high energetic cost, but coincidentally also makes the breed quieter, less inclined to fight and so more suited for captivity.

Concerns are inevitably raised where certain desirable phenotypic traits are linked with harmful genes that may lead to the expression of deleterious phenotypic traits, or indeed may be lethal to the individual. This produces an ethical dilemma that has raged down the centuries and is still a topic of contention today. Should we breed for certain phenotypic traits that we know are linked with genes that may also produce deformities, increased the susceptibility to disease and lead to the death of individuals, purely for show?

5.2.1 Effects of Genetic Mutations

It is first pertinent to describe some of the scientific background to genetic mutations and their effects on the phenotype before reviewing specific examples of inherited, or genetic, disorders. When selecting for desirable phenotypic traits in captive birds, the resulting genetic alteration is frequently not confined to one gene allele. In addition, point mutations can occur, either spontaneously or by line breeding. The phenotypic consequences of such a mutation in any species are difficult to predict. In captive birds, the paucity of information on this subject in species other than the domestic fowl makes it even more difficult to predetermine the outcome of a specific mating. The use of homology between species has been suggested as a useful strategy in further determining the effect of specific avian genes (Tixier-Boichard, 2002). For example, the "C" locus in birds is homologous with the albino gene in mammals, and both have been shown to be the same candidate gene – the tyrosinase gene – which has been localised on chromosome 1 (Oetting et al., 1985; Suzuki et al., 1999). The "Extension" locus, which affects coat colour, has been shown to code for the receptor of alpha-melanocyte stimulating hormone in the mouse (Robbins et al., 1993), in cattle (Joerg et al., 1996), in pigs (Kijas et al., 1998) and in the chicken (Takeuchi et al., 1996). Therefore, in this instance the same gene would control the same phenotype across the species.

Of course, it is not always as simple as that. In many cases the mutation of a specific gene does not produce the same phenotypic variations across different species. An example is the mutation of the ryanodine receptor gene "RYR1" which leads to malignant hyperthermia in the pig (Fuji et al., 1991), whereas in the chicken the lack of expression of the alpha isoform of the ryanodine receptor *RYR1* causes severe skeletal muscle dysgenesis as is seen in the "crooked neck dwarf" mutant (Airey et al., 1993).

From a functional point of view, mutations of the genotype of a bird with relation to a single gene can be classified into one of three groups: loss of function; interference with dominant negative action; and gain of function (Tixier-Boichard, 2002).

The *loss of function* mutation generally behaves in a recessive manner, because the normal allele of the heterozygous carrier retains its function (the normal allele is 100% dominant). However, where the product of the normal allele function and the recessive mutated gene is insufficient to achieve the gene threshold value[1] then the mutation can behave in a dominant manner. This is often described as haploinsufficiency, where the presence of only one normal allele is insufficient to maintain the gene function.

The *interference with dominant negative action* mutation is seen when the gene product of the mutated allele is only partially active and may interfere with the normal gene product. This is seen predominantly when the mutated gene product acts as a cofactor, i.e. a substance (such as a metallic ion or coenzyme) which must be associated with an enzyme for the enzyme to perform its function. It may also occur when the mutated gene product is involved in the formation of a dimer, which

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[1]Gene threshold value: The level of gene expression that a gene needs to exhibit for it to be expressed phenotypically. Classically, a dominant gene will always over-ride a recessive one and so the phenotype will mirror the dominant gene. However, if the dominant gene is not "fully dominant" then it may not be strong enough to over-ride the recessive gene and so the phenotype does not mirror the incomplete dominant gene.

is a molecule or chemical compound consisting of two identical similar molecules. In these cases, the defect of one component may be sufficient to impair the overall function of the dimer.

The *gain of function* mutation generally behaves in a dominant manner and may have significant phenotypic effects. An example would be the "henny" feathering mutation in the chicken (Tixier-Boichard, 2002), which is due to the expression of an aromatase in the peripheral tissues of the bird which converts testosterone into oestrogen. Even though the heterozygous individual has about half the peripheral aromatase action of the homozygous mutant, this level of aromatase is sufficient for the female plumage pattern to appear in a male heterozygous bird, so affecting the phenotype in a dominant manner.

With regard to development and growth, it has been shown in domestic chickens that intermediate phenotypic birds, i.e. those that exhibit average growth rates and food conversion rates, have a higher level of fitness than those at the extremes do. This phenomenon is described as genetic homeostasis (Lerner, 1954). This suggests that when selecting for growth rates, there should be an optimum rate that will result in optimal levels of reproductive success, fitness and health. If the phenotype selected for is "pushed" towards rapid growth rates, then it could be expected that fitness and reproductive success will suffer as a consequence (Siegel and Dunnington, 1985). This was shown in a study by Marks (1979) on breeding Japanese quail (*Coturnix coturnix japonica*), where successive breeding of individuals for the phenotype of high body weight led to a reduction in egg production, fertility and hatchability; the latter two to a significant extent. However, the size of the eggs and the yolks produced were significantly larger in a similar study performed by Anthony et al. (1990). These factors again highlight the difficulties in predicting the changes in the overall phenotype of an animal when selecting for one specific trait.

5.2.2 Species-Specific Genetic Disorders

Many traits and mutations are specifically bred for to increase the commercial value of individual birds. Many of these, mainly colour variants, seem to have no obvious deleterious effects on the health and welfare of the individual bird. Several do, however, have very obvious effects, some of which are listed below. The reader should be aware of the lack of information available in the scientific literature for many of the variants that are currently being selectively bred. Regrettably, this is partly because of the lower commercial profile of these species, in relation to domestic fowl for example. It is also partly because the development of new colour and feather shape variants is occurring at such a rapid rate amongst private commercial breeders that it is almost impossible to ascertain their true impact. In addition, we have little ability to determine how colour and feather shape variations affect these individuals on a psychological basis – particularly when dealing with highly intelligent and cognitive species such as the Psittaciformes (parrot family). Many avian species can see ultra-violet light, which completely changes the way that an individual bird looks with respect to another bird (Burkhardt, 1989; Cuthill et al., 2000; Cuthill, 2006). The breeding of cage birds is geared towards variations in human visual radiation spectra and we have no real idea how this impacts on their appearance in avian visual radiation spectra and, by extension, on their behaviour and social interactions.

5.2.2.1 Feather Colouration Abnormalities

These are some of the most commonly selected for genetic variations in cage and aviary birds. Colour mutants and other variants on the normal or "wild-type" colouration of the species can vastly increase the value of a bird to enthusiasts. In many cases the colour variation brings no obvious deleterious effects, but some colour variations have severe phenotypic effects. Examples include the incomplete dominant gene, which selects for white feather colouration in canaries (*Serinus canaria*). This produces a white canary in the heterozygous state, but is a lethal gene in the homozygous state.

5.2.2.2 Feather Structure Abnormalities

These are common amongst cage birds. Some disorders, such as the inherited "feather duster" conditions (as opposed to those feather duster conditions caused by viruses such as the Avian Polyomavirus) seen in budgerigars are actually specifically bred for showing purposes. This condition is associated with contour and flight feathers that do not possess the barbs and barbules necessary to interlock the feather vein. The shaft (or calumus) is also curved, and so the feathers appear deformed and fluffed out, making the bird resemble a traditional feather duster.

Other inherited feather deformities include the "straw feather" syndrome in the canary, where the primary feathers retain their sheaths and grow to look like straw (Rosskopf, 2003). This condition is sometimes lethal and appears to be genetically based.

Feather cysts may be seen in any species of bird. These occur when a newly emerging feather fails to break cleanly through the skin, but becomes entrapped beneath it. This produces a large swelling, which may then rupture later, exuding a form of caseous (i.e. thick, "cheese-like") material. Certain breeds are known to be predisposed to this condition, including certain lines of budgerigars (*Melopsittacus undulata*) and Norwich and Gloucester canaries where it is thought to be genetically associated. The cysts form predominantly in the feather tracts covering the pectoral and interscapular areas (Bauck, 1997).

Kelly and Ash (1976) describe feather abnormalities in a lethal recessive mutation of White Peking ducklings (*Anas platyrhynchos*), including reduced rachis size with a much reduced medulla, thickening of the feather sheath and increased abundance of pulp cells. Other lethal recessive mutations affecting feather structure include the hard feather and crested abnormalities seen in canaries. These are demonstrated phenotypically in the heterozygous state but are lethal in the homozygous state.

5.2.2.3 Skeletal Deformities

Overgrown beaks can result from genetic causes, although more commonly in cage and aviary birds they are associated with nutritional and infectious disorders. An example of a hereditary cause is the so-called "Donald Duck" beak seen in the White Leghorn breed of domestic fowl. The condition is characterised by the upturning of the upper beak and buckling of the lower beak which causes an apparent shortening (McGibbon, 1973).

As another example, an autosomal, recessive lethal mutation in White Peking ducklings causes shortening of the upper beak, shortened limbs, abnormal development of cartilage, osteoporosis, subcutaneous oedema of the neck and feather abnormalities with reduction in overall size of the bird (Kelly and Ash, 1976).

Chondrodystrophy or hereditary dwarfism is well-known in many chickens, turkeys and quail and has also been recorded in a number of birds kept in captivity, including Lovebirds (*Agapornis* spp.) and birds that have been bred for release into the wild. For example, the Californian Condor (*Gymnogyps californianus*) has shown a 9% incidence of this autosomal recessive allele in one study (Ralls et al., 2000). This presents welfare and ethical problems, where the benefit of reintroducing an endangered species must be considered against the potential harm of chondrodystrophic chicks hatching in the wild.

5.2.2.4 Stereotypical Behaviour

Jenkins (2001) lists the following species as having a predilection and probable inherited tendency towards feather picking and self-mutilation: African Grey parrots (*Psittacus erithacus*); Lovebirds; Eclectus parrots (*Eclectus* spp.); Moluccan cockatoo (*Cacatua moluccensis*); Goffin's cockatoo (*Cacatua goffini*); Bare-eyed cockatoo (*Cacatua ophthalmica*); Monk (Quaker) parakeets (*Myiopsitta monachus*) and the macaws. The pattern of picking often occurs in specific anatomical sites depending on the species involved. The larger macaws often start feather plucking over the legs before moving onto the chest, back and wing coverts. Eclectus parrots often pluck the chest and back and leave the wings. Self-mutilation seems to be more commonly seen in certain species, such as the Goffin cockatoo, where predilection sites have been quoted as the chest and neck in addition to the feet and toes, which may be heavily chewed or even self-amputated. The predilection is often the neck and chest in Monk parakeets and Blue and Gold macaws (*Ara ararauna*) often head and neck scratch. Of course, as mentioned elsewhere in this chapter and this book, feather plucking and self-mutilation in cage birds, particularly parrots, is multifactorial. Although certain species are especially prone, it is difficult to untangle the often complex web of factors that lead to an individual starting these stereotypies.

5.2.2.5 Other Hereditary Abnormalities

Many other hereditary abnormalities can occur in captive bred companion, show and zoo birds, often due to deliberate inbreeding or inappropriate breeding programmes. For example, cataract formation is common in adult Canaries and has been reported in some lutino colour variants of Cockatiels. In addition, associations between dilute feather colouration and a lethal neuropathy have occurred due to close in-breeding of wild Northern Goshawks (*Accipiter gentilis*) (Rutz et al., 2004). Hereditary deafness has been breed-associated in Belgian Waterslager Canaries.

5.2.3 Breeding for Reduced Fearfulness – Adaptation for Captivity?

Many breeds of domestic poultry have been selected to be docile, in order to reduce the incidence of feather picking and territorial fighting in intensive farming situations (cf. the Hy-line breed mentioned above). An additional economic benefit for the farmer is that such birds also expend less energy on these deleterious pursuits and so convert more energy into production.

In many non-domesticated cage and aviary birds, the desire is to provide early human socialisation in order to produce the ideal house pet that is human-bonded and tame. Much of this adaptation is related to management procedures such as hand rearing, although the gradual selection by aviculturists for hand-tame birds has provided some evidence of a genetic drift as well.

However, there are problems associated with this method of socialisation that are commonly seen in avian veterinary practices. These fall into two main categories: (i) individual birds that become over-bonded to their owners and so suffer separation anxiety when their owner leaves the house, and (ii) birds that no longer perceive themselves to be a bird and so attack other birds.

Over-bonding to an owner can produce a number of anxiety related problems in a highly intelligent cage bird, such as a cockatoo for example. Such birds frequently become distressed when their owner is out of sight and may then resort to stereotypic behaviours such as feather plucking or chewing, sometimes even going as far as self-mutilation. Other undesirable behaviours associated with separation anxiety can include increased destruction of their surroundings (although most parrots will chew and destroy cage furniture and household items, even when apparently settled, as part of their normal behaviour), prolonged screaming and stereotypies such as head bobbing or weaving. More aspects of the human-bird bond are discussed in Chapters 2, 4 and 9.

The apparent failure of a bird to perceive itself as a bird is a commonly seen trait, particularly in cockatoos that have been over-socialised to humans. During the non-breeding season they may tolerate the presence of other birds or cockatoos. However, with the onset of the breeding season, the human-bonded bird will often attempt to mate with their owner rather than a bird of the opposite sex. When the owner then places the bird into a cage or flight with a potential mate, fighting inevitably ensues. This can be severe and result in the death of one or other of the birds, particularly when considering the larger parrots such as the cockatoos that possess large, crushing beaks.

This, then, is one of the many dilemmas facing avicultural breeders of birds for the pet industry. The production of human-tame birds is obviously one of the many aims of the industry, and yet as far as the welfare of the bird is concerned there potentially can be serious and direct conflicts involved.

These problems are minimised in zoological collections, as in these facilities captive breeding is geared towards the successful breeding of wild-type individuals. Most parrots will therefore be kept in flock or paired situations and so allowed to perform nearly the full range of social interactions. Parents will generally rear their own young and imprinting on humans is minimised. Indeed, unless birds are properly socialised with their own kind, the likelihood of successful reproduction (one of the main aims of any conservation orientated institution) is greatly diminished (Styles, 2002). There is thus a clear distinction to be made between the future "uses" of captive cage and aviary birds, i.e. whether they are intended for the pet and show market where human socialisation is a desirable trait or for the conservation field where maintaining as much of the wild-type behaviour and gene pool as is possible is the main aim.

With this in mind, from an ecological and potentially a welfare point of view, the captive breeding of psittacine birds in a flock situation has benefits. It has been shown in Philippine cockatoos (*Cacatua haematuropygia*) that flocking and allowing mate self-selection reduces the incidence of aggression in that species (Bousseky, 2000). There is also an increase in fecundity in many of these situations as has been shown in an aviary of F4-generation macaws (Styles, 2002). There are, however, potentially serious downsides to flocking. It is not possible to take poorly socialised birds and place them into a flock situation and expect them to revert to their wild type. The correct aviary size is important to consider (see Chapter 3) and all birds should be tested for relevant pathogens and quarantined prior to entry, otherwise there is a high potential for rapid disease spread. It is also important to only flock conspecifics together to prevent interspecies aggression.

5.2.3.1 Assessment of Stress in Breeding Programs

The assessment of the success or failure of any captive bird breeding program is complex. One of the main aims should be to ensure that the levels of stress that an individual bird is placed under are minimised to ensure good levels of welfare and also fertility (Styles, 2002). It follows therefore that one should be aware of how to measure the degree of stress a bird is under in a qualitative, and preferably quantitative, manner.

First, it is important to define stress and describe its physiological background. Manser (1992) has defined stress as follows: "a state of stress occurs when an animal encounters adverse physiological or emotional conditions which cause a disturbance of its normal physiological and mental equilibrium".

Whether or not an individual can cope with the stressors acting upon it will depend on how successfully it can employ the General Adaptation Syndrome (GAS) mechanism coined by Selye (1946). The main crux of this generalist response to a stressor is the activation of the hypothalamus/pituitary/adrenal axis (HPA). This will occur during the "alarm" phase of exposure to a stressor and will cause increased mobilisation of body fat to provide the energy for the "flight or fight" response.

There will also be an increase in cardiovascular output for the same reason. If the stressor persists, then the animal moves into an adaptation phase in which there are more specific physiological changes in response to the stressor. This will allow the animal to counter the stressor, but the physiological changes may also cause it to become open to new stressors. An example would be where an animal chronically exposed to cold may mobilise energy reserves to increase heat production and blood flow to the skin, which reduces heat loss so making the animal feel less cold. However, this may cause a decrease in immune system function, leading to increased susceptibility to disease. If the intensity and duration of the stress exceed the ability of the animal to adapt, then the third phase of GAS ensues – that of exhaustion (Webster, 2005).

Theoreticians and scientists since Selye have argued that animals do not produce one general response; rather there is a marked degree of interspecies variation particularly with reference to behavioural, autonomic and endocrine responses (Moberg, 1987). Breazile (1987) described three states associated with stress, namely eustress, neutral stress and distress. Eustress is "good stress", where the animal can benefit from exposure to the stressor; for example, where a social animal is housed with conspecifics and experiences low level social stress but benefits from the ability to express normal behaviour. Neutral stress is, logically, where no changes occur in the animal's well being associated with the stressor. Distress is where a stressor is harmful to the animal and may have a negative impact on wellbeing, reproductive performance, health or longevity.

5.2.3.2 Clinical Assessment of Stress

A qualitative assessment of stress can be made based on behavioural traits expressed by the captive bird. Repetitive or stereotypic behaviours such as those outlined in Section 5.2.2.4 above often indicate that an animal is, or has been, unable to cope with the housing and care provided (see also Chapter 3). However, these behaviours cannot be used in isolation to infer welfare. It is essential to take the bird's history into account (if known) and to recognise that repetitive behaviour can also be associated with different types of challenge such as infectious diseases, inhaled or ingested toxins and nutritional deficiencies.

Prolonged exposure to harmful stressors in animals has been associated with cardiovascular disease, hypertension, weight loss, anorexia, gastric and intestinal ulceration, reproductive failure and urticaria (Breazile, 1987). It is well known that many members of the parrot family are prone to atherosclerosis, although this is chiefly associated with poor nutrition and obesity; however, the level that stressors may play on the development of cardiac insufficiency is not known in birds.

There are certain parameters that can be measured in animals to give an indication of whether they are undergoing physiological stress. One of the main parameters to be altered during periods of physiological stress is the white blood cell or leukocyte count. In stressed birds the leukocyte count is often elevated, the so-called "stress leukocytosis" (Fudge, 1997). This is particularly common in macaws, cockatoos, African Grey parrots and ratites (Rosskopf and Woerpel, 1991). In addition the percentage differential of the white cell count also alters, often with a heterophilia and sometimes a lymphopaenia. Measurement of these parameters is of course invasive and the procedure itself may cause intolerable additional stress to the bird concerned and so be counterproductive. For this reason, non-invasive methods of assessment of the degree of stress experienced by a bird have become increasingly favoured amongst researchers.

One such non-invasive procedure is the measuring of the excretion of endogenous corticosteroid metabolites in the faeces of stressed birds (Thiel et al., 2005; Scheiber et al., 2005). This has shown that the amount of corticosterone metabolites excreted correlates with the degree of stress a bird is experiencing, thus allowing a non-invasive method of assessing welfare status. Indeed, studies in the goshawk (*Accipiter gentilis*) showed that faecal corticosterone metabolite measurement provided a direct assessment of adrenal function (Dehnhard et al., 2003).

Little research has been performed on birds, particularly cage and aviary birds, with regard to other non-invasive techniques for stress assessment. Work has been performed in mammals on the use of infrared thermography to assess response to stressors and disease (Stewart et al., 2005). The technology employs the use of a highly sensitive infrared camera that measures the body surface temperature of the animal in question. Areas of inflammation are readily detected as “hot-spots”. In addition, when the HPA has been activated, surface temperatures often increase in response to some vasodilation as well as increased cardiovascular output. Macaws, for example, will often exhibit flushing of the face when angry or stressed. However, this vasodilation may also occur during the breeding season, as is seen in the necks of stag turkeys and male ostriches, and so cannot be used as a reliable indicator of poor welfare. It is possible that this technology may be of use in assessing the welfare of captive birds in the future, although more work needs to be performed.

Other non-invasive procedures which can aid assessment of stress and welfare over longer periods of time include the reproductive output and longevity of captive birds. These are much less sensitive parameters however, as levels of stress that are undesirable from a welfare point of view may be tolerated and not impact significantly on breeding patterns. Indeed, the lifespan of over fecund females may be reduced through sheer exhaustion, both nutritional and physical (especially in domesticated strains that have been selected for high fecundity even when body condition is poor), and so the correlation between reproductive success and welfare is not a straightforward one.

5.3 The Use of Birds in Research and Testing

The use of vertebrate animals in research and testing is regulated by legislation such as the European Convention and Directive[2] on animals used for experimental and other scientific purposes (Council of Europe, 2006; European Community, 1986)

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[2] The Directive is under revision at the time of writing.

and the United States Animal Welfare Act and Health Research Extension Act (see National Research Council, 1996). Most national laws require that suffering is minimised and some, such as the United Kingdom Animals (Scientific Procedures) Act 1986 (Home Office, 2000), also require that humane alternatives are used wherever possible and that the justification for each project is assessed by considering the scientific benefits to be gained alongside the potential harms caused to the animals involved.

Animals are used for a very broad range of purposes in research and testing and each experiment raises different scientific, welfare and ethical issues. It is beyond the scope of this book to address this use of animals in depth; for further information on animal experimentation, the associated ethical issues and the potential to replace animals, reduce suffering and improve welfare see Nuffield Council on Bioethics (2005).

Relatively large numbers of birds are used in research and testing; for example, they are the third most commonly used type of animal after rodents and fish in the United Kingdom (Home Office, 2007). Most birds used in research are domestic fowl, mainly to evaluate the pharmacokinetics and test the safety of drugs designed to treat other birds, for example vaccines for farmed stock. In practice, all veterinary pharmaceuticals are developed and tested using laboratory animals. Smaller numbers of birds are used to "model" aspects of human diseases and disorders in biomedical research. Many are used to study birds in their own right, either in fundamental research or to evaluate the effects of substances on wild and domestic birds, for example in the safety testing of agricultural substances, industrial substances, pollutants and additives for animal feeds.

Fundamental research may be carried out to gain knowledge relating to avian anatomy or physiology, for example to study the mechanics of flight or the neurological control of song. This type of research involves a very broad range of species including passerines. Other bird studies are aimed at preventing or treating disease epidemics, such as the current outbreaks of avian influenza and West Nile virus that are often spread or passaged through migrating wild birds. Concerns about these diseases will inevitably lead to more bird experiments, for vaccine development and diagnostic tests.

The use of genetically altered (GA) animals, including birds, is increasing rapidly in many fields of biomedical research. Fowl can be genetically altered to express pharmacologically important substances in their eggs, such as protein-based drugs and monoclonal antibodies. GA fowl are often used in genetics studies and research is also ongoing to develop genetically altered fowl that will be resistant to diseases such as avian influenza.

Whatever the primary purpose of the research, the scientific benefits need to be very carefully considered against the welfare of the individuals within the project. During studies, regular assessment of the bird's welfare and health status are vital (see Chapter 3). It is also essential to be able to define a humane endpoint, at which the research procedure must be halted in favour of the bird's welfare; this is a legal requirement in the United Kingdom.

There are other aspects to avian research that do not involve invasive procedures. These include the assessment of behaviour and measurements of reproductive success as well as the non-invasive methods of assessing the levels of stress a bird is exposed to as outlined above. These, as well as in situ ecological research, are a vital aspect to the very survival of many endangered species.

5.4 The Trapping of Wild Birds

The legitimate trade in wild-caught birds has become very lucrative. This has inevitably led to a huge increase in recent years in the illegal trade of wild-caught birds which has in itself led to huge welfare, ethical and ecological problems.

5.4.1 Legal Aspects of the Wild Bird Trade

The following describes the international legal controls imposed on the sale and import of wild birds, and some of the guidelines regarding their protection. Specific welfare considerations for individual birds are also covered by relevant national legislation.

5.4.1.1 CITES

The so-called "Washington" Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES; www.cites.org/) is designed to protect selected plants and animals from illicit trade to prevent their potential extinction from the wild (see also Chapter 1). The CITES legislation was adopted by the UK in 1976 and it groups plants and animals into three appendices (Scott, 2005).

Appendix I covers species that are close to extinction. This includes many cage and aviary birds including Amazon parrots such as the Cuban Amazon (*Amazona leucocephala*), macaws such as the Spix's macaw (*Cyanopsitta spixii*), cockatoos such as the Moluccan cockatoo (*Cacatua moluccensis*) and some other members of the parrot family such as the Red and Blue lory (*Eos histrio*) and the Orange-bellied parrot (*Neophema chrysogaster*). Non-psittacine species include most of the Falconiformes (falcons, eagles etc.) particularly those native to the United Kingdom and Europe, and many perching birds such as the Red Siskin *Carduelis cucullata* and the Rothschild's mynah bird, *Leucopsar rothschildi.* Trade in these species is allowed only in exceptional situations.

Appendix II covers species that are endangered but do not face imminent extinction. These include the bulk of cage and aviary birds such as the African Grey parrot, the Blue-fronted Amazon (*Amazona aestiva*), most of the Toucan family (e.g. *Rhamphastos toco*), the majority of the Strigiformes (owl family) and some perching birds such as the Yellow-faced Siskin *Carduelis yarrellii.*

Appendix III covers species that are protected in individual countries that have approached the CITES listed countries. Many such birds are therefore listed with the country concerned after the species, for example the Gray Singing finch *Serinus leucopygius* (Ghana).

5.4.1.2 COTES

Following the creation of the CITES agreement in 1975, the European Union (EU) enforced its own version of the Regulations in 1984. This is encapsulated in two main European Regulations; Council Regulation 338/97 and Commission Regulation 1808/2001. The former regulates the trade in endangered species and the latter prescribes the required rules and certificates permitting trade. In general these EU regulations are referred to as the COTES (Control Of Trade in Endangered Species) Regulations 1997 and they have re-classified species from the CITES lists into four Annexes.

Annex A covers all species from Appendix I of the CITES legislation, as well as additional species (usually from Appendix II) that are thought to need greater protection or that look similar to an endangered species. Birds from Annex A are not allowed to be imported into the United Kingdom or other European countries within the EU for commercial breeding purposes.

Annex B covers all the remaining species from Appendix II of the CITES legislation, as well as species which closely resemble Appendix II species or where individual countries within the EU have voiced concerns over an indigenous endangered species.

Annex C covers all the remaining species from Appendix III of the CITES legislation; Annex D covers all species not listed in the above Annexes but which are imported into the EU in sufficient quantities as to merit close monitoring.

COTES regulations also mean that anyone possessing a captive bird from Annex A (such as any falcon, eagle or hawk species native to the United Kingdom), who intends to breed that bird or display it for commercial gain, requires a licence under Article 10. This is referred to as a “specimen specific” licence and the sale of a bird also requires an Article 10 certificate. Zoos with many Annex A species may gain exemption from the above by applying for Article 30 licences which apply to a whole collection rather than a specific individual. All Annex A birds in captivity are required to be permanently marked, either with a closed ring or a microchip.

5.4.1.3 Transport Regulations

There are controls applied to the transport of birds covered by CITES and COTES. Regulations for transport by air are reviewed annually and published by the International Air Transport Association (IATA, 2007). For example, all legally imported birds in the United Kingdom arrive through London Heathrow airport where they are initially quarantined in approved premises for a minimum of 30 days. This adds to the potential welfare problems for such commercially imported birds, but is a necessary step in the control of Newcastle disease and avian influenza in particular. Exceptions exist for private owners where, providing there are no more than three birds, they may be quarantined in the owner's own premises subject to veterinary inspection.

Various Acts of Parliament in the United Kingdom cover the safe and humane transportation of birds. They include the Welfare of Animals (Transport) Order 1997 (Defra, 2006) which broadly lays down that birds and other vertebrates should not be transported in any way that causes or is likely to cause injury or unnecessary suffering. In addition, for commercial transportation of birds, there are requirements covering the watering and feeding of the birds, as well as prescribed container designs. If a journey by road should exceed 50 km, then a competent person should be in attendance to ensure that any feeding, watering or other requirements are adequately performed.

5.4.2 Ethical Aspects of the Wild Bird Trade

Besides the legal constraints on trapping wild birds for commercial markets, there are some serious ethical considerations. Most birds trapped for the home markets or pet trades are still in every sense of the word truly "wild" animals. They therefore do not adapt easily, if at all, to the pressures of captivity. Worse still are the problems associated with inappropriate husbandry and nutritional aspects of captive bird keeping that are so commonly seen in private ownership (see Chapters 2 and 3).

An example would be the commonly kept African Grey parrot which in its natural state lives in flocks varying from extended family units of twenty to thirty up to communal roosts of ten thousand birds (Juniper and Parr, 1998). In private households in many import countries this species is often kept as a solitary bird. This inevitably leads to psychological problems associated with fear and aggression, as the parrot is now in close contact with an "alien" species, namely human beings, and has no ability to escape or to blend in with the rest of its flock. This will inevitably cause psychological problems, as the bird's identity is based on an appreciation of itself not only as an individual but also as an integrated part of a larger flock unit. Parrots in particular are highly intelligent species, so affording them some of the intellectual facilities of human beings is not unreasonable. Even on a very basic level the deprivation of one's social unit for a gregarious animal will lead to unending stress.

If one then adds to this the insult of a poor diet such as the sunflower and peanut seed mixes so commonly retailed for parrots, the consequences for the individual bird are ethically unacceptable. The natural diet of the African Grey parrot is based on the fruit and seeds of various tropical plants of western and central Africa including *Ficus, Bombax, Prunus* and the flesh of the oil-palm *Elaeis guineenis*, which are very difficult to reproduce in captivity. This is just the tip of the iceberg, of course, as these considerations, although very important, do not take into account the degree of stress and suffering induced by the capture and transportation of these birds.

Allowances do need to be made for the capture and captive breeding of endangered species for the purposes of saving a species from extinction. In these instances, the above legislation will only allow the import of wild caught species for this purpose if they are destined for homes within zoological collections that conform to (in the case or Europe) the EU so-called "Balai" Directive 92/65 EEC and have an agreed action plan in place for the breeding program and captive care of the species. In these cases, many resources are allocated to ensure that the welfare of the imported individuals is maximised to encourage successful breeding. There are still cases where this situation may not work satisfactorily, mainly with regard to species about which little is known of their natural feeding, breeding and foraging habits. In these cases, an ethical assessment is necessary in which the risk of extinction in the wild is considered against the harm of maintaining a captive population of the species in sub-optimum conditions.

There has been some progress since the avian influenza outbreaks in the restriction of trade in wild caught species. This is currently banned throughout the EU and many welfare and national veterinary organisations have also put forward compelling evidence to provide a permanent ban on the import of wild-caught birds to the EU on ethical grounds. This will not interfere with the capture of species for conservation purposes and so should hopefully strike a balance between the protection of birds in situ with the aid necessary to help prevent the decline in numbers of endangered species.

5.5 Conclusion

When birds are selectively bred for high production or for physical appearance, the genetic mutations that are selected for can have a significant, yet not always predictable, effect upon the phenotype. Genetic disorders can cause serious animal welfare problems, yet the desire for new variants of cage and show birds, and the economic benefits of selecting farmed birds for higher meat and egg yields, frequently override the ethical and welfare concerns. It can be difficult to assess the full implications of selective breeding, as the behavioural and social consequences of selecting for traits such as feather colour are poorly understood. In addition, birds are adapted to conceal signs of discomfort, pain and distress, which means that behavioural signs of suffering may be misinterpreted or not recognised.

Important measures with respect to improving the welfare of domestic poultry and cage or show birds in the future are listed below.

- Better guidance for cage and show breeders with respect to the potential consequences of selective breeding, including assessing the harms and benefits of selecting for particular traits.
- For domestic poultry, encouraging the selection of "positive" traits to facilitate good welfare in captivity, such as docility and reduced activity. This, however, raises ethical questions in relation to making animals fit into a suboptimal environment, rather than improving the environment to suit the animal.

- Developments in welfare assessment for birds, including the use of new technologies as well as better observation and interpretation of behaviour.
- Questioning the necessity and justification for ever-higher meat and egg yields.

Unlike selective breeding, animal research and testing is subject to legal controls, which ideally include a requirement to justify research projects before permission is granted to conduct them. However, animal experiments are carried out for a broad range of purposes and it is difficult to predict future trends, as research directions can change rapidly and create new demands on animals. In the case of birds, the demand for biological products and drugs, diseases such as avian influenza and other unpredictable diseases of livestock are likely to contribute to future requirements for their use. The potential to replace or avoid bird use depends heavily upon the purpose of the research. Bird use could be refined and replaced in the future by the measures set out below.

- Avoiding and replacing bird use wherever possible, e.g. as new *in vitro* techniques arise or as the validity of individual toxicity test protocols using birds is revised. For example, the use of birds in acute tests for agricultural substances has been criticised because of species differences, as many different wild species are affected. Other test protocols use fewer birds and cause less suffering.
- Ensuring that the regulation of animal use includes an effective assessment of the necessity of and justification for each research project.
- Improving housing and care for laboratory birds, which benefits both animal welfare and the quality of the science.

Trapping wild birds is also subject to legal controls in many countries, but there is still a significant amount of illegal and uncontrolled trapping. Even where trapping, transporting and trading wild birds is carried out legally, animal care and welfare standards within national laws can be minimal and birds can suffer avoidable physiological and psychological stress before they reach the country where they are to be sold. The key measures in the following list are important for protecting wild birds in the future.

- More funding and resources to improve the level of policing of the illegal trade in wild birds.
- The introduction of minimum welfare standards for all stages of wild bird capture and transport in all countries, not just CITES signatories.
- Better education of those involved in the trade as well as would be bird owners, to ensure that they are aware of the ethical and welfare implications of the wild bird trade. Owners need to be encouraged to take responsibility for bird welfare, e.g. by ensuring that the provenance of wild caught birds is traceable and legal, or preferably by purchasing captive bred animals from sustainable sources.

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Part II
Domestic Fowl

Chapter 6
The Physical Environment and Its Effect on Welfare

Tina Widowski

6.1 Introduction

Modern domestic fowl are kept in a wide array of housing systems, depending on their use (meat or egg production), stage of life of the birds (brooding, rearing, breeding or egg laying) and geographical location. The nature of the physical environment in different systems varies considerably. In farmyard and free-range systems, for example, birds may be kept outdoors at lower animal densities for a large portion of the day. The birds generally have greater control over their microenvironment and can seek shelter. They are exposed to natural daylight, a variety of substrates and may experience a wide range in environmental temperature and weather conditions, depending on climate. At the other end of the spectrum are complete confinement houses where birds are generally kept at higher densities and nearly all aspects of the physical environment are controlled through automated systems. These types of houses are illuminated solely by artificial lighting, and temperature and air quality are controlled via mechanical ventilation systems. In these types of systems, birds have less control over their microenvironments and are exposed to a much narrower range of physical conditions.

Regardless of the type of housing system in which birds are kept, one of the primary considerations for their welfare is whether the physical environment meets their basic biological requirements. Meeting basic requirements includes supporting homeostatic mechanisms such as control of body temperature, water balance and energy metabolism. Meeting basic requirements also involves the prevention of disease and promotion of a sound and healthy body. In order to meet their basic needs, an understanding of the birds' abilities to adapt to different aspects of the physical environment is required. Knowledge of the birds' sensory capacities is important since their senses determine the birds' ability to detect and respond to environmental challenges. Knowledge of the bird's thermoregulatory abilities and

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their responses to various aspects of the physical environment such as light, sound and air quality are also critical for providing environments that meet the birds' basic needs.

6.2 Sensory Capacities

All adaptive responses that an animal makes depend on reception and interpretation of information from both internal and external environments. The common senses - vision, hearing, taste, smell and touch - allow the receipt and processing of various kinds of information so that an animal can monitor the status of its external environment and communicate with conspecifics. Certain aspects of the physical environment can influence the development of the sensory systems resulting in permanent structural or functional changes in these systems.

6.2.1 Vision

As is true for most species of birds, vision is the predominant sensory modality and domestic fowl rely heavily on visual cues for finding food and water, negotiating their environment and interacting with conspecifics. Visual cues are very important for directing and motivating many aspects of the bird's behaviour. There are several different aspects of the visual system that determine how images are perceived. These include the *field of vision*, which is the spatial area around the body that can be viewed by the eyes at a given moment, *visual acuity* which is the ability to focus on objects, *spectral sensitivity* which is the ability of the visual system to respond to different wavelengths (colours) of light and *motion detection* which is the ability of the visual system to resolve rapidly changing visual stimuli (Güntürkün, 2000). In domestic fowl, each of these aspects of the visual system are considerably different from that of humans.

6.2.1.1 Field of Vision and Visual Acuity

The field of vision is determined by the placement of the eyes in the skull. In domestic fowl the eyes are set widely apart on the sides of the head which results in a large area of monocular vision that allows them to see a large area to the side and behind themselves. This panoramic view of the world is very common in prey species. When the visual fields of both eyes overlap, the corresponding input from the two eyes results in binocular vision, which imparts a greater ability for depth perception. In domestic fowl, the area of overlap is relatively small.

Visual acuity refers to the ability to resolve detail (the sharpness of an image). Acuity is determined by two factors; the density of photoreceptive cells in the retina, and the shape of the eye, cornea and lens. Ground-feeding species of birds, including the domestic fowl, have a gradient of myopia (near-sightedness) in the lower frontal field of binocular vision called the *pecking field* that provides a sharp image of very close objects. This field allows the birds to keep parts of the ground in focus while at the same time keeping the lateral field of vision focused on the more distant objects around them. Birds also have very limited ability to move their eyes, so when viewing objects or scanning the environment, birds are often observed to use head movements which shifts the view between the different regions of acuity and even between the eyes (Dawkins, 2002).

In a series of experiments aimed at elucidating if and how individual hens recognize one another, Dawkins (1995; 1996) demonstrated that hens use the frontal and lateral fields of vision differently when viewing other hens or objects from different distances. Analyses of head movements indicated that hens turned their heads to use their lateral field of vision when viewing another hen or an object that was farther than 30 cm away and switched to using the frontal binocular field (pecking field) when that object was moved closer. When hens were given the choice to feed next to a familiar hen or next to an unfamiliar hen but had to make the choice from either 66 or 124 cm away, their choices did not differ from random. When able to make the choice from only 8 cm away, the hens exhibited a clear preference for feeding with a familiar hen. Further experiments indicated that a minimum viewing distance of 20–30 cm is required for social recognition between hens (Dawkins, 1996).

6.2.1.2 Spectral Sensitivity and Colour Vision

Birds have several adaptations for colour perception not found in mammals. In addition to simple rods and cones they have a third type of photoreceptor – a double cone. Their retinas contain four photopigments (compared to three in primates) and many of their cones are associated with oil droplets that have light-filtering capabilities. Unlike some species of mammals, the corneas of birds allow the transmission of ultra violet light.

Using electrophysiological recordings (Wortel, et al., 1987) and behavioural discrimination tasks (Prescott and Wathes, 1999a) the spectral sensitivity of domestic fowl has been determined (see Fig. 6.1).

Birds respond to short wavelengths (near UV) and are more sensitive than humans to longer wavelengths in the red-orange range. Overall, they can perceive a broader range of wavelengths. In addition to differences in perception of light intensity, certain colour-mediated visual cues for social or sexual communication may be altered by light source since the spectral outputs (the ranges of wavelengths emitted) of different types of lamps can change the colour appearance of objects. For example, the redness of a flock-mate's comb may look quite different when illuminated by cool white fluorescent light than when lit by incandescent light. Finally, most sources of artificial light are devoid of UV wavelengths. It has been demonstrated that certain feather patterns are only visible in UV-rich light (Prescott and Wathes, 1999b) and that these may influence mate choice and mating behaviour in broiler breeders (Jones et al., 2001).

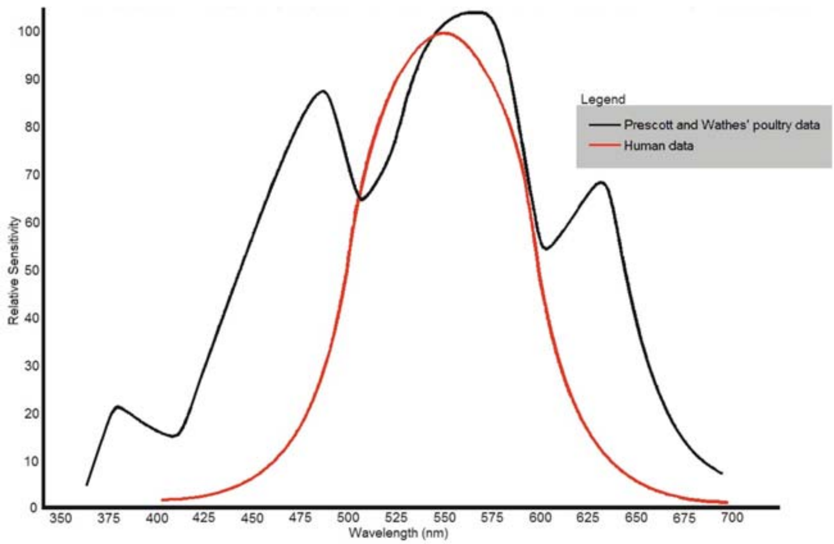

Fig. 6.1 Relative spectral sensitivity of the photopic domestic broiler fowl and the human, normalized to a sensitivity of 100% at 550 nm. (Adapted from Prescott and Wathes, 1999a)

6.2.1.3 Motion Detection and Critical Fusion Frequency

Another aspect of the visual system that varies across species has to do with the ability to detect motion. Motion detection depends on the temporal resolution of neurons in the visual system. The flicker-fusion or critical fusion frequency (CFF) is the frequency at which motion can no longer be detected, or in other words, the frequency at which a discontinuous light source (flicker) appears to be continuous. In human beings, the CFF is 60 Hz. This means that at frequencies higher than 60 Hz, images blend together and appear to be continuous - the phenomenon on which the motion picture depends. Birds generally have much better motion detection than do human beings. The domestic fowl's CFF was initially estimated at around 105 for blue light with lower sensitivities for other colours (Nuboer et al, 1992). This high CFF of fowl led to an interesting question when it comes to lighting of the bird's environment. Common fluorescent light sources powered by magnetic ballasts flicker at twice the frequency of the electricity supply. In North America the supply frequency is 60 Hz, whereas in Europe it is only 50 Hz. This means that fluorescent lights flicker at 120 and 100 Hz, respectively, in those places. Human beings cannot detect this flicker because it is well above our CFF. Because birds' CFF is near the flicker frequency of fluorescent light sources it has been speculated that they may be able to see the flicker of fluorescent lighting.

In order to determine whether domestic hens find fluorescent lighting aversive, Widowski et al. (1992) allowed hens to choose between two rooms illuminated respectively by either standard incandescent lighting or a compact fluorescent source during a preference test. The rooms were identical except for type of illumination. Light intensities were similar to those used in laying-hen houses. The hens spent around 73% of the time in fluorescent light and only 27% in incandescent. This meant that either the birds did not perceive the flicker of fluorescent lights, or if they did, they did not avoid it. In fact, they found some aspect of the fluorescent light more attractive than incandescent and spent most of the time in it. Similar results have been obtained from preference tests conducted on turkeys (Sherwin, 1999). It is not clear why birds prefer fluorescent lighting over incandescent, but it probably is due to differences in the wavelengths of light emitted. When hens were given a choice between compact fluorescent lights emitting the same wavelengths but differing only in the rates of flicker (Widowski and Duncan, 1996) the birds spent similar amounts of time in the two lighting conditions. More recently, Jarvis et al, (2002) determined that hens could not detect a flicker of 100 Hz at 100 lx level of illumination. Therefore it is unlikely that any flicker of fluorescent lighting will pose a welfare problem in poultry houses.

6.2.1.4 Lighting Systems and Poultry Welfare

In many poultry production systems, lighting is a critical aspect of the overall management of the birds, and artificial lighting is carefully controlled to maximize production and reproduction. There are three basic aspects to any lighting system that can alter the biology of the birds. These are photoperiod, intensity and type of light source (e.g., incandescent, fluorescent). These different aspects of the light environment can influence the bird either directly through stimulation of photosensitive physiological processes or indirectly by altering behaviour through the visual system. Some photosensitive processes, such as the setting of biological clocks and reproductive function do not require the presence of the eye, as domestic fowl have extra-retinal photoreceptors in the pineal gland and hypothalamus that receive light directly through the skull (Lewis and Morris, 2006). The effect of lighting on the welfare of poultry has been extensively reviewed (Manser, 1996; Prescott et al., 2003a) and only some aspects will be considered here.

6.2.1.5 Photoperiod

The day-length for birds in closed houses can range from just a few hours of light (8L) to continuous or nearly continuous light (23L), depending on the production setting. For birds that are producing eggs (layers, broiler breeders or breeding stock) lighting schedules are dictated by the photoperiods necessary to stimulate and maintain reproduction. In nature, domestic fowl are seasonal breeders and long days (14L) or increasing day-length stimulate gonadotropin release which controls egg laying in hens and spermatogenesis in roosters. A period of darkness is necessary to prevent photorefractoriness which inhibits reproduction.

In growing birds, lighting schedules are much more flexible and a variety of daylengths are used in practice. Traditionally, broiler chickens have been kept in either continuous lighting or a 23L with the notion that these lighting schedules promote feeding, faster growth rates and improved productivity. For the same reason, replacement pullet chicks are often kept on 23L for the first few days or weeks and then their lighting schedules are reduced to approximately 8 h per day until they near sexual maturation. Continuous light may be detrimental to birds in that they are less active overall while at the same time may not obtain sufficient rest. Natural brooding by the hen involves alternating periods of rest and activity, and this cycle of activity may be important for the health of the developing chick (Malleau et al., 2007).

The domestic chick is commonly used as an animal model for vision research and there is an abundance of published work in the biomedical literature that indicates continuous light, continuous darkness and disruption of normal visual stimulation induces abnormal ocular growth. The visual system of chicks begins forming during the first few days of embryonic development and by day E3, embryonic chicks respond to light by increasing movement (Rogers, 1995). Exposure to light during both the pre- and post-hatching stages of development can affect both structural and functional development of the visual system. Light during incubation, for example, results in an increase in the size and weight of the right eye compared to the left, since the left eye is usually obstructed from light by the position of the chick within the egg. This differential exposure to light apparently results in brain lateralization as the right eye plays a dominant role in the ability of chicks to recognize food (Rogers, 1995). Differential exposure to light and other visual stimuli in the early days post-hatch can also influence ocular growth resulting in changes in the size and shape of the eye that affect visual acuity.

Continuous lighting has been shown to lead to eye abnormalities such as corneal flattening and hyperopia (farsightedness) during the first few weeks of post-hatch development (Oishi and Murakami, 1985) and to thinned lens, and retinal and choroid damage over longer periods of time (Li et al., 1995). Interestingly, at least some of the detrimental effects of continuous light are not due to direct exposure of the eye itself to light but rather to a disruption of the circadian rhythm of eye growth patterns. Diurnal growth rhythms have been observed in the chick eye with periods of growth occurring during the day (Weiss and Schaeffel, 1993). This diurnal rhythm disappears when birds are kept under continuous light. Li and Howland (2003) found that covering chicks heads with a hood for 12 h per day while exposing the chicks eyes to continuous light was nearly as effective for reducing corneal flattening and preventing hyperopia as was covering the birds eyes or rearing chicks in 12L:12D. Covering the birds' heads prevented light from reaching the extra-retinal photoreceptors in the pineal gland, and this appeared to be sufficient for maintaining a circadian rhythm. By exposing chicks to various light:dark cycles Li et al. (2000) found that a minimum of 4 h of continuous darkness was necessary for normal ocular development.

Although the body of evidence from biomedical research indicates that constant light permanently alters the visual system of birds, any long-term effects of lighting schedule during rearing on the visual capabilities of adult birds used for poultry production is generally not known. It may be that the ability to use visual cues for recognizing group-mates, identifying resources or negotiating their environments are affected by the lighting schedules used during the first few days or weeks of rearing.

Broiler chickens can be grown under alternative lighting schedules which have the potential to improve their welfare. Intermittent lighting schedules which involve a repeating schedule of a few hours of light followed by 1 or 2 h of darkness have been shown to be beneficial in reducing leg abnormalities in broilers (Renden et al., 1991). Lighting programs in which birds are initially kept on short days with gradually increasing daylengths have also been shown to be beneficial in reducing leg abnormalities and fast growth problems in broilers (Classen and Riddell, 1989; Classen et al., 1991; Renden et al., 1993). The effects of these programs on reducing welfare problems may be twofold; the birds eat less during the short days so that growth rate is slowed leading to more normal development of the skeletal and cardiovascular systems in relation to muscle tissue; and the birds are more active during the shorter light periods which promotes exercise. While the use of specialized lighting programs for reducing fast growth problems seems promising for improving broiler welfare, these types of programs can only be applied when birds are kept in closed houses under artificial lighting. In many areas of the world, broiler chickens are reared in open sheds or naturally ventilated houses where birds are exposed to natural daylight and seasonal photoperiods.

6.2.1.6 Intensity

Lighting levels in poultry houses are often kept extremely low in order to reduce energy costs, to improve the feed conversion ratios and to control behaviour problems such as feather pecking and cannibalism. At low light intensities birds are less active and use fewer calories for maintenance. The average light intensities used in broiler and layer houses generally range from 3 to 30 lux (Prescott et al., 2003). However values within a house can be quite variable. For example, Prescott and Wathes (1999b) measured illumination levels ranging from less than 2 to over 200 lux for individual hens within a layer house, depending on their location. Thus, illumination levels that birds experience in closed houses are considerably lower than those which occur in bright sunlight (100,000 lux), on overcast days (1,000 lux) or even at twilight (10 lux). Because domestic fowl rely so heavily on vision, keeping them at low light intensities raises welfare concerns because it essentially deprives them of sensory input (Manser, 1996).

A variety of operant and preference tests have been used to demonstrate that domestic fowl will work for light and have preferences for different levels of illumination. Both broiler and layer strain hens were willing to work in an operant system for light (15 lux) (about 4 h per day) Savory and Duncan (1982/83) and this usually was associated with feeding. Those same birds however were not willing to work for darkness. When hens were offered the choice to eat in light levels of <1, 6, 20 or 200 lux, they spent the most time eating in the bright light (39%) although they still spent 14% of total feeding time in the dimmest light (Prescott and Wathes, 2002). Hens were also more willing to press a switch to access feed in the bright compared to the dim light, but when the task was made more difficult by increasing the number of pecks required to feed in the bright light, the hens were not prepared to work for it. Their feeding efficiency (pecks/min and food consumed) was lower at <1 lux compared to any of the other higher light levels. Thus it appears that while hens have a preference for feeding in brighter light, their preference is not that strong.

Preferences for different intensities have been shown to change with the age of the bird (Davis et al., 1999). Given free choice of lighting levels of 6, 20, 60 and 200 lux, both broiler and layer chicks spent most time in 200 lux at 2 weeks of age but by 6 weeks they spent most time in the dimmest light. Low light levels may be especially problematic in aviary systems in which hens must be able to negotiate perches and change levels safely, since bone breakage due to trauma is prevalent in these systems. Hens trained to jump between perches, took longer to perform the task, were less likely to complete a jump and vocalized more during tests, when light intensities were low (< 1 lux compared to 35–40 lux) (Taylor et al., 2003). While it might be argued that birds should be kept in light intensities that are high enough to allow them to perform their full behavioural repertoire, behaviour problems such as feather pecking and cannibalism occur more frequently at higher light intensities (Kjaer and Vestergaard, 1999) and low lighting levels are an effective way of reducing these problems.

6.2.1.7 Light Source

The differences in spectral sensitivity have several implications for lighting of poultry houses. Standard measures of light intensity (lux) are based on the human spectral sensitivity; the intensity of different light sources that birds perceive are likely to be very different from the intensity indicated by the standard light meter. Therefore, the use of alternative units for estimating perceived light intensity by domestic fowl that account for differences in spectral sensitivity ("clux") have been proposed (Nuboer et al., 1992; Prescott and Wathes, 1999a).

6.2.2 Chemical Senses

The chemical senses, which allow animals to detect various chemical stimuli in the external environment, fall into three types: olfaction or smell, gustation or taste and chemesthesis, also referred to as the common chemical sense. Olfaction generally refers to the ability to detect airborne chemical stimuli. Gustatory receptors responsible for the sense of taste are usually stimulated when in direct contact with a relatively large number of chemical molecules. Trigeminal receptors, which are a major component of the chemesthetic system, are free nerve endings located in various mucous membranes in the cranium that respond to chemical irritants as well as to mechanical and thermal stimuli. This system activates reflex and avoidance responses to potentially damaging chemical stimuli. There is often close proximity among receptors of the three systems and some chemicals may stimulate more than one of these chemical detection systems (Mason and Clark, 2000).

Until recently, chemoreception in domestic fowl has not been considered to be important because of the notion that birds in general have limited capabilities in responding to chemical stimuli (Jones and Roper, 1997). However, there is now a large body of evidence from neuroanatomical, neurophysiological and behavioural studies that the chemical senses do play a functional role in birds and specifically in domestic fowl (Jones and Roper, 1997; McKeegan, 2004a). Because poultry are exposed to a variety of odours and gasses during production in poultry houses and during gaseous stunning at depopulation and slaughter, their perception of chemical stimuli has important implications for their welfare.

6.2.2.1 Olfaction and Chemesthesis

Birds have a fully developed olfactory bulb and share some of the same anatomical and physiological features of the main olfactory system of mammals. Their olfactory system consists of receptor cells arranged along the epithelium that lines the nasal cavity. This system allows detection of molecules in the stream of air that flows over the nasal passages and the detection of chemical stimuli within the nasal cavity. The anatomy of the trigeminal systems of birds is also similar to that of mammals, although birds and mammals may respond to very different chemical stimuli. In domestic fowl, branches of the trigeminal (5th cranial) nerve receive input from eyes, nasal cavity and mouth. Free nerve endings of the trigeminal system are closely associated with gustatory receptors in the mouth and palate and with olfactory receptors in the nasal mucosa (Mason and Clark, 2000).

Although the anatomy of avian olfactory and trigeminal systems has been known for some time, neurophysiological studies of the responses of domestic fowl to different chemical stimuli have only recently been done. McKeegan (2002a) measured electrical activity in single neurons of the olfactory bulbs of laying hens in response to the odours of geraniol, limonene and clove oil (standard stimuli in tests of olfaction) and ammonia. All of the odours were capable of causing either inhibition or excitation of spontaneous firing in some neurons, but ammonia most commonly evoked a response compared to the other odours. The firing response patterns observed in the hens were intermediate to those previously reported for mammals and reptiles. In a similar study McKeegan et al (2002) measured electrical activity of olfactory bulb neurons in laying hens exposed to different concentrations of ammonia and hydrogen sulfide, two air pollutants commonly found in poultry houses. The stimulus-response curves observed indicated that the olfactory system of hens is able to distiguish differences in concentrations of both of these gasses. McKeegan et al. (2004b) also demonstrated concentration-response curves for trigeminal nerves in the nasal mucosa and palate of laying hens to ammonia, carbon dioxide and acetic acid vapour which indicated that the trigeminal system is able to detect all three of these compounds. In follow up to the neurophysiological studies, McKeegan et al (2005) measured the behavioural responses of hens to brief (7s) pulses of varying concentrations of ammonia (5–100 ppm), hydrogen sulfide (1–20 ppm) and carbon dioxide (10–80 ppm). The hens interrupted their previous activity during exposure to all three of the gasses but showed distinct responses to each gas. They oriented to source of the odour at all concentrations of ammonia and hydrogen sulfide (olfactory detection) but not to CO_2 (trigeminal detection) and responded to CO_2 with mandibulation (rapid opening and closing the beak) and gasping. Hens only showed avoidance and eye shutting in response to hydrogen sulfide and blinking only in response to ammonia. Thus, the neurophysiological studies indicate that hens have the ability to detect these gasses, and the behavioural studies indicate that they also perceive them and respond to them in different ways.

6.2.2.2 The Effect of Atmospheric Ammonia on the Welfare of Birds

Ammonia is the most common air pollutant in poultry houses, and it can cause reduced growth, increased susceptibility to respiratory disease and inflammation (or permanent damage) of the cornea and conjunctiva when it occurs at relatively high concentrations (see review by Kristensen and Wathes, 2000). The most commonly recommended maximum concentration for poultry houses is 25 ppm, which is based on human safety guidelines rather than any measures of poultry welfare.

There have been a few studies aimed at determining whether domestic fowl will actively avoid environments with high levels of atmospheric ammonia. Laying hens given the choice among compartments with ammonia concentrations of 0, 25 or 45 ppm spent significantly more time foraging, preening and resting in the fresh air compared to the other two compartments (Kristensen et al, 2000). However, even though the hens were observed most often in the compartment at 0 ppm (approximately 42% of observations), the majority of time they were observed in the higher ammonia concentrations (29 and 29% for 25 and 45 ppm, respectively). In two separate experiments, female broiler chickens given free choice of compartments with atmospheric ammonia concentrations of 4, 11, 20 and 37 ppm spent 80–90% of the time at the two lower concentrations. These studies indicate that the threshold for avoidance of ammonia by domestic fowl may be lower than the 25 ppm commonly recommended, but the aversiveness of varying concentrations still needs to be determined. Ammonia levels much less than 25 ppm may be difficult to achieve in practice, especially in deep litter houses in cold climates. For example, mean ammonia concentrations in poultry layer and broiler houses measured over different seasons in Northern Europe ranged from 5 to 30 ppm with a number of houses exceeding the recommended 25 ppm (Groot Keerkamp et al., 1998).

6.2.3 Hearing

The auditory receptor cells in the inner ear encode both the frequency (pitch) expressed in Hertz (Hz), and the intensity (loudness) of sound expressed in decibels (dB). There are two different aspects of sound perception by animals that have received a great deal of study: range of hearing and ability to localize the source of a sound. Most sounds or auditory signals relevant to animals are not composed of pure tones, of course, but rather are a complex mixture of different pitches and intensities.

The range of hearing refers to an animal's ability to detect sounds of different frequencies. The ears of birds differ from those of mammals in several respects. Birds generally lack an external auricle (pinna) and their middle ear is anatomically different and generally less specialized than that of mammals (Necker, 2000a). In general the range of hearing in birds is narrower than that of mammals. Although their hearing is not as sensitive as mammals', most birds nevertheless use a complex repertoire of calls and songs for vocal communication. Approximate perceivable sound-frequency limits for domestic fowl based on discrimination trials are roughly 500–6,000 Hz (Temple et al., 1984), which corresponds to the frequencies of most vocalization given by the birds. Their most sensitive range is between 3,000 and 5,000 Hz.

6.2.3.1 Effects of Noise on Welfare

Noise can be defined as sound that is noxious or unpleasant. There are several sources of noise in animal environments that can be either aversive or cause physical damage to the auditory system. They include sounds associated with feeding and cleaning operations, which may be especially problematic with automated systems. Noise may be generated by the animals themselves, either from vocalizations or from banging and rattling feeding and caging equipment. Heating and ventilation equipment (especially fans) are a common source of sonic and ultrasonic noise in animal accommodations. During transportation, vehicular noises also can be a problem.

Durham et al. (2002) recorded average sound pressure levels of 90 dB in both egg layer and broiler breeder barns with the majority of the sound either below 100 Hz or between 700 and 7,000 Hz. This is approximately the same noise level experienced when running a lawn mower, driving a tractor or operating a chainsaw. The maximum allowable exposure limits for workers in Canada is between 85 and 90 dB for an 8-h workday. Durham et al. (2002) also identified evidence of severe cochlear damage in broiler breeders and subsequently found a breed difference in cochlear damage between broiler breeder and layer strains from commercial barns. Rearing broilers in quieter laboratory conditions resulted in less damage (Smittkamp et al., 2002). Therefore it appears that broiler strains may have a genetic predisposition to auditory damage and that the noise levels common under commercial conditions can cause the damage. Outside of the biomedical literature, hearing loss due to noise in commercial poultry houses has not been studied, and any consequences for behaviour and welfare needs to be determined.

Another situation that may involve high levels of noise is during transport. However, when birds were trained to peck a key to alter either noise, or a combination of noise and motion (simulating transport), the birds only changed their pecking rate to alter motion and noise and therefore did not find the noise aversive in this case (Nicol et al. 1991). However the noise exposure was simply that of a motor and neither the frequency, intensity, or similarity with what a bird would experience during actual transport, were described.

6.2.4 The Beak as a Sensory Organ

Birds use their beaks in a wide variety of ways including foraging, feeding, drinking, preening, nestbuilding, arranging eggs in the nest and as a weapon during aggressive encounters and predator evasion. Therefore the beak serves not only as a tool for pecking, grasping and moving objects but also as a highly specialized sensory organ for discriminating food from non-food items, detecting appropriate sources of water and generally exploring the physical and chemical properties of the environment. In order to serve these functions, the beak is highly innervated with gustatory receptors, mechanoreceptors, which detect pressure and touch, thermoreceptors, which detect changes in temperature, and nociceptors, which detect intense or noxious mechanical and thermal as well as painful stimuli (Necker, 2000b).

The anatomy, physiology and function of the beak of domestic fowl have been studied in great detail (Gentle, 1985; Gentle and Breward, 1986; Lunam, 2005). The structures of the upper and lower beak are supported by the premaxillary and mandibular bones, respectively. The external surface of the beak is covered by a tough layer of keratin tissue. Below this keratin layer lies a layer of epithelial cells, forming the epidermis. Between the epidermis and the bone is the dermis, which is supplied by numerous veins, arteries, nerve fibres and sensory receptors. The bill tip organ, an area characterised by 15–20 small projections (dermal papillae) that are densely packed with mechanoreceptors, is considered to provide fine tactile discrimination for feeding. In many avian species such as geese and ducks, bill tip organs are located at the ends of both the upper and lower beaks, but in domestic fowl the bill tip organ is only present on the lower beak. However, specialised encapsulated mechanoreceptors, the Herbst and Grandry corpuscles, are also located near the tip of the upper beak, decreasing in number from the tip to the nares. In addition to the mechanoreceptors, numerous free nerve endings that respond to thermal, chemical and painful stimuli are located in the tip of the upper beak and the bill tip organ. Removing the highly innervated tip of the beak therefore, results in significant deprivation of sensory input and is one of the major welfare concerns regarding beak trimming. The taste buds of domestic fowl are found primarily in the palate and floor of the oral cavity in close proximity to salivary ducts, with fewer taste buds located on the tongue.

6.2.5 Effects of Experience on Locomotory Development

Experience with aspects of the physical environment during rearing can have permanent effects on the locomotory abilities of animals. For example, laying hens that do not have opportunities to perch as chicks often have difficulty adapting to commercial aviary systems where nest boxes, feeders and drinkers are arranged on different levels off the ground and must be accessed by perches (Appleby et al., 1988). Some of the difficulty may arise because of physical deficiencies – the birds simply have not developed the muscle mass or bone strength to perform the necessary motor patterns. However there is also evidence that the lack of experience during early stages of development results in a deficiency in the cognitive spatial skills necessary for negotiating three-dimensional space (Appleby and Duncan, 1989). If an animal is to be kept in a relatively complex environment as an adult it must have the opportunity to develop the required locomotory skills early in life.

6.3 Thermal Biology of Domestic Fowl

6.3.1 Heat Balance and Modes of Heat Exchange

Domestic fowl are homeotherms in that they maintain a constant body temperature within a range of environmental conditions. Their deep body temperature in the brain and visceral organs is around 41°C, but the temperature of peripheral areas of the body can vary widely, as the birds use warming or cooling of the extremities as one means to control heat flow to and from the environment. Regulation of body temperature involves numerous physiological and behavioural mechanisms that serve to maintain the balance of heat produced from metabolism with gains and losses to the environment. The relationship of heat exchange between the body of the bird and the environment is described by the classic heat balance equation:

$$\Delta = \mathrm{H} - \mathrm{E} \pm \mathrm{R} \pm \mathrm{K} \pm \mathrm{C}$$

Where Δ= gain or loss of body heat; H = heat production; E = heat lost through evaporation; R = heat gained or lost though radiation; K= heat gained or lost through conduction; and C = heat gained or lost through convection (Dawson and Whittow, 2000). Thus if metabolic heat production is greater than the amount of heat that can be lost to the environment, body heat, and consequently body temperature will rise. Conversely, if more heat is lost to the environment than is produced by metabolism, body heat and body temperature will drop. When environmental conditions are such that no energy expenditure is necessary to maintain body temperature, the bird is considered to be in its thermo-neutral zone (Hillman et al., 1985).

The rate of heat production is a function of the basal metabolism together with excess heat that is produced when birds are feeding, active, laying down tissue during growth or producing eggs. The amount of heat produced when a bird is fasting, resting and in thermo-neutral conditions is determined by its basal metabolic rate, in which virtually all of the energy that is involved in oxidative reactions required for bodily functions are released as heat in the tissues. Basal metabolic heat production depends on metabolic body size, which can be estimated from the bird's body weight. Ingestion and the digestive processing of food produces heat and this heat increment of feeding varies with the type of foodstuff. When energy intake is greater than the amount of energy used for basal metabolism, which is usually the case for poultry in production, the bulk of that energy is converted into product. However, since the conversion of feed energy to product is never 100% efficient, the excess energy is given off as heat. The total heat production rate of a bird can therefore be estimated from its body weight, metabolisable energy intake and feed conversion efficiency. Calculations for ventilation rates of closed poultry houses are largely determined from estimates of the birds' total heat production rates. By using, the number of birds in a house, their body weights and their estimated caloric intakes we can estimate how many calories of heat they produce, and therefore how much warm air needs to be exhausted from a building in order to maintain the building within an acceptable temperature range.

Since living tissues constantly produce heat, it is essential that some of that heat be transferred to the environment. The modes of heat flow between the bird's body and the environment are divided into the sensible modes, in which heat energy is transferred directly along a thermal gradient and the latent mode, evaporation, in which heat energy is absorbed during the conversion of water from liquid to vapour. The sensible modes - radiation, conduction and convection - depend on a measurable temperature difference between the surface of the body that is involved in the exchange of heat and temperatures of the bird's surroundings. Evaporation, on the other hand, depends on a vapour pressure gradient between the evaporative surface of the body and the air and is therefore affected by humidity, which reflects the water holding capacity of air.

Radiation involves the transfer of heat energy without a medium, such that warmer surfaces will radiate heat energy to cooler surfaces. For poultry housed indoors, heat from the warm surfaces of the bird's body will radiate to any cooler surfaces that they are exposed to such as the walls or ceiling of the barn. In the case of radiant supplemental heaters or uninsulated roofs that are heated by the sun, the heat energy from lamps or hot surfaces will be directly transferred to and absorbed by the bird's body. In outdoor conditions, birds will radiate heat to the sky and any cooler objects in the environment and will absorb radiation from the sun and warmer surroundings such as the ground. These radiant heat exchanges occur independently of air temperature.

Conduction involves the transfer of heat energy through a medium. It too depends on a thermal gradient but unlike radiation, conductive heat exchange requires physical contact between the surfaces involved in the heat exchange. The rate of conductive heat flow depends not only on the temperature gradient, but also on the thermal conductivity of the contact surface. The reciprocal of thermal conductivity is the insulation value of substance, which is described by its r-value. Substances such as water, metal or concrete have high thermal conductivities and readily transfer heat. Air has an extremely low thermal conductivity, and materials that are porous and effectively trap air such as polystyrene, straw or feathers have the lowest rates of heat transfer.

Convection involves the transfer of heat through moving streams of air (or water). Natural convection occurs because of thermal buoyancy so that even in still air, some heat is transferred from the surface of the body to the surrounding air, which then warms, rises and carries away the heat. A stationary layer of air, the boundary layer, surrounds the body and provides insulation. In drafts or windy conditions (forced convection) heat loss from the body increases significantly as this boundary layer is disrupted and the air surrounding the body is warmed and carried away much more rapidly. The rate of heat transfer by convection is determined by the combination of air temperature and air velocity. The combination of the two factors on heat loss is described by what is commonly referred to as the wind chill factor.

Since the sensible modes of heat flow depend on a thermal gradient, these modes affect the heat balance of the bird most under cold or cool conditions when the differences between body surface temperature and the air or surface temperatures are greatest. Under hot conditions, the gradient between body and environmental temperatures diminishes and heat transfer occurs mainly or solely through evaporative means. For each gram of water evaporated approximately 586 calories of heat energy are absorbed and consequently transferred to the environment. When the air is fairly dry, evaporation is a very effective means of transferring heat to the environment. However, under conditions of high humidity, the water holding capacity of the air is reduced, rate of evaporation diminishes and heat loss via this mode is reduced. Therefore, hot humid conditions severely restrict heat exchange by both sensible and latent modes of heat flow and therefore are the most difficult for the bird to maintain body temperature.

6.3.2 Thermo-regulatory Mechanisms

Thermo-regulatory processes are controlled through central nervous system integration of inputs from temperature receptors in both the periphery and within the body core. Domestic fowl have thermal receptors in areas of feathered skin, tongue and beak. Brain tissue is particularly sensitive to deviations in temperature, and many of the deep body temperature receptors lie within the brain and spinal cord. Thermo-regulatory responses are graded in that different effector mechanisms will be invoked at different times depending on inputs from the various receptors that signal the degree of thermal challenge. Usually these will occur before any changes in deep body temperature can be detected.

All of the means which birds use to maintain homeothermy can be viewed in terms of the heat balance equation. Heat production within the body can be altered in several ways. One of the first lines of defence in either cool or warm environments is a change in feed intake. In warm environments birds will reduce feed intake in order to reduce metabolic heat load whereas in the cold they will increase intake in order to convert feed energy to heat. The birds can also alter activity to effectively increase or decrease heat production rates. Under cold conditions domestic fowl begin shivering, during which muscular contractions in the legs and pectoral muscles result in generation of heat in these tissues. Non-shivering thermogenesis involves an increase in metabolic rate through longer-term changes in thyroid and glucocorticoid hormones. Energy is diverted from growth or other productive processes in order to raise the metabolic rate and generate heat.

Other thermo-regulatory mechanisms serve to modify the rate of heat transfer from the bird's body to the environment. These include postural adjustments that alter the amount of surface area involved in the various modes of heat transfer, and changes in peripheral blood flow that affect the amount of heat flowing from the body core to the body surface tissues through the blood. Specialized features of the vascular anatomy function specifically in thermo-regulation. Networks of closely grouped veins and arteries such as *venae commitantes* and *retia*, serve as counter current heat exchangers to prevent heat from reaching the skin. Arteriovenous anastomoses, which are found mainly in areas of unfeathered skin of domestic fowl, shunt blood away from the skin in the cold but significantly increase blood flow to the skin in hot conditions. The position of the feathers can also be altered by either raising (ptero-erection) or lowering them, which changes the insulating layer of air that is trapped within them and consequently alters the rate of heat flow from the skin to the environment.

In cool or cold conditions, behavioural mechanisms are invoked to conserve metabolic heat within the bird's body or even to gain heat from the environment. If given the opportunity, birds will move to more favourable microclimates, into warmer areas under heat lamps or in the sun and out of draughty areas. Birds will hunch keeping their wings close to the body or tuck their heads into the feathers on their back. In addition to these behavioural responses, vasoconstriction will occur, primarily in the unfeathered areas of the body and the birds will fluff their feathers to increase the insulative value of the plumage. When the behavioural and passive thermo-regulatory mechanisms are not sufficient in maintaining body temperature, the birds actively increase heat production through shivering and non-shivering thermogenesis.

In hot conditions, mechanisms are invoked that facilitate the dissipation of heat from the body to the environment. A variety of hormonal and neuroendocrine mechanisms may also participate in adaptation to heat stress (Etches, et al., 2008) The birds increase body surface area by holding their wings out away from their bodies and may lie with their legs extended. Vasodilation occurs in the unfeathered extremities such as feet, legs, comb and wattles, and blood flow to the feet increases significantly through the arteriovenous anastomoses. If available, birds will move to cooler surfaces to increase conductive heat loss through their feet (Estevez et al., 2002). Domestic fowl also use several means to actively increase evaporative heat loss. Since birds have not evolved sweat glands, they rely primarily on respiratory evaporation. Thermal tachypnea, or panting, is used to move more air across the respiratory passages. Altering both the frequency and depth of respiration controls the rate of evaporative heat loss. Although thermal panting is critical in maintaining body temperature during heat stress, there are some negative consequences. The muscular activity required for panting increases heat production rate. Panting also disrupts the acid-base balance of the blood by increasing exhalation of CO_2, which results in respiratory alkalosis. This shift in blood pH causes a disruption in electrolyte and mineral balance, affects calcification of eggs and results in reductions in egg shell quality in laying hens. Some species of birds, including domestic fowl supplement panting with gular fluttering, a rhythmic pulsation of a highly vascularised area of the throat, which allows for evaporative cooling without the changes in gas exchange that occur during panting. To a degree, birds have an advantage over mammals in hot humid conditions, in that their body temperature and thus their respiratory surfaces are several degrees warmer than that of mammals. This results in a higher vapour pressure gradient at the respiratory surfaces and the ability to evaporate more water at a given temperature and humidity.

6.3.3 Factors Affecting Heat Balance and Temperature Requirements of Birds

Although air temperature is the most readily measurable factor that affects the bird's heat balance, it is the combination of environmental factors that ultimately affect heat flow between the bird and the environment and thus determine the bird's effective environmental temperature or how it feels. In addition to air temperature, the wall and ceiling temperatures, type of flooring, stocking density, air movement and relative humidity all affect the bird's effective environmental temperature.

Individual characteristics of the bird such as size, gender and genetic strain also affect its ability to maintain body temperature under variable conditions. Smaller birds have a larger surface area per unit of body weight and therefore are less able to conserve metabolic heat. This means that they have a higher energy requirement per unit of body weight and their temperature requirements are higher. Feed intake, growth and egg production all result in higher heat production rates such that high producing birds generally have lower temperature requirements. Males generally have higher production rates than females due to differences in muscle tissue and activity. Some genetic strains of birds are more tolerant of temperature extremes than others and therefore are better suited for production in certain climates or types of housing systems. Plumage condition can also affect a bird's temperature requirements.

The thermal experience of birds significantly affects their tolerance to temperature extremes. The terms "acclimation" and "acclimatization" are often used interchangeably to describe long term adaptations to environmental conditions. Acclimation results in changes in the body's thermal set point, resting metabolic rate and thresholds for thermo-regulatory processes so that the thermo-neutral zone is essentially shifted as the bird adjusts to long term climatic conditions. Thermal stress results more often when a change in temperature is sudden rather than gradual. In temperate climates, for example, laying hens may suffer from severe heat stress if there is a sudden heat wave early in the Spring while they may be largely unaffected by the exact same environmental temperatures occurring later in the Summer, after they have been gradually exposed to warmer conditions for some time (Arieli et al., 1980). Thermal conditioning, which is different from acclimation, has also been shown to affect thermo-tolerance of fowl. Exposing broiler chicks to high temperatures for a just a few hours within the first few days after hatching has been shown to reduce mortality when the birds are subjected to heat stress at market weight (Yahav and McMurtry, 2001; Lin et al. 2006).

6.3.4 Thermal Stress and Welfare

It is generally accepted that exposures to extreme environmental conditions cause physical discomfort, which severely impact the welfare of the birds. In addition to the immediate effects of resulting discomfort, thermal stress can also compromise immune function resulting in reduced disease resistance. Heat stress and cold stress are typically defined by effective environmental temperatures that lie outside of the birds' thermo-neutral zone - above the upper critical temperature and below the lower critical temperature, respectively - where active, energetically expensive mechanisms are used to thermo-regulate (Fig. 6.2). A narrower "zone of thermal comfort" (Curtis, 1983a) or "zone of least thermo-regulatory effort" (Hillman et al., 1985), has been defined by some authors as the range of environmental temperature in which behavioural thermo-regulation is absent (Curtis, 1983a) or where passive evaporative heat loss occurs in species that sweat (Hillman et al., 1985). Webster (1994) has argued that because poultry are less able to control heat loss from the skin and rely primarily on changes in heat production to maintain body temperature, that their "thermo-neutral" and especially their "thermal comfort" zones are less well defined. He therefore refers to this narrow range of temperature for poultry as the "zone of optimum productivity". Regardless of the terms used, any feelings of

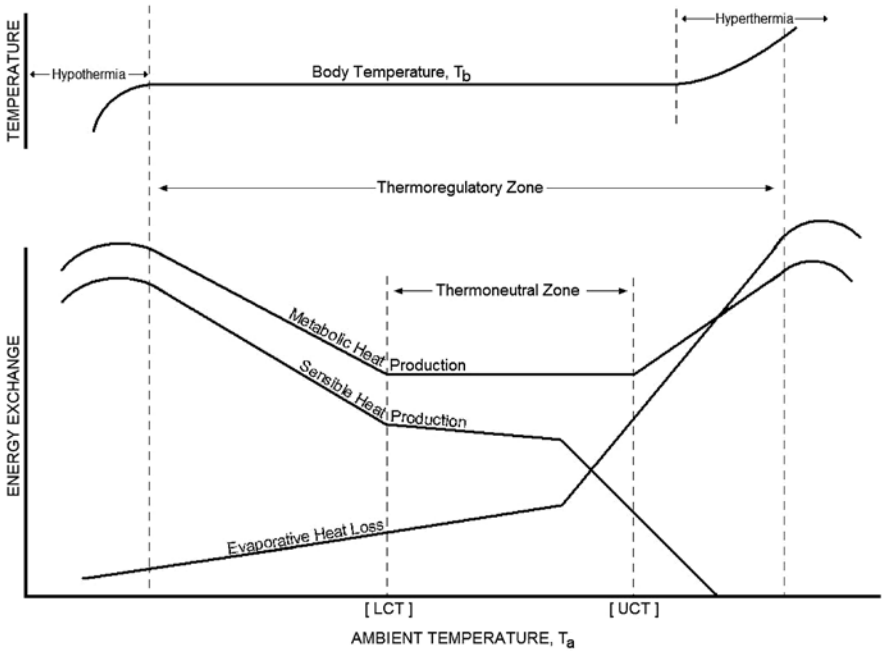

Fig. 6.2 Generalized scheme for relationships among ambient temperature (T_a) metabolic heat production, heat loss and body temperature. LCT=lower critical temperature, UCT = upper critical temperature. (Adapted from Hillman et al., 1985)

Table 6.1 Critical temperatures (upper critical temperature = UCT, lower critical temperature = LCT), recommended temperatures and optimal temperatures for production for various types and ages of domestic fowl. Acclimatization, feed intake level and feather cover will affect these values

	Critical temperature	Recommended temperatures[a]	Optimal temperatures[b]
Brooding chicks			
Neonate[a]	UCT = 36–37°C[c]		
Week 1		29–32°C	
Weeks 2–5		reduce 2–3°C each week	18–24°C
Week 6		21–23°C	
Adult broiler breeders		10–27°C	
Laying hens	UCT=33°C[d] LCT=18°C[b]	10–27°C	21–22°C

[a] CARC, 2003a, b.
[b] Charles et al., 1994.
[c] van der Hel et al., 1991.
[d] Etches et al., 2008.

discomfort that birds may have when experiencing mild or even moderate deviations from either their thermo-neutral, thermal comfort or zone of optimum productivity are largely unknown (Curtis, 1983a; Webster, 1994). Estimates for upper and lower critical temperatures and recommended temperatures for different types of domestic fowl are given in (Table 6.1).

Young chicks readily learn to peck at a switch to obtain supplementary heat when exposed to cool temperatures (Morrison and McMillan, 1986), and their demand for heat is greater when housed on wire versus litter floors (Morrison and McMillan, 1985) and when they are exposed to increases in air movement (Morrison et al. 1987). At high environmental temperatures broilers and broiler breeder hens prefer to roost on water-cooled perches rather than perches at ambient temperature (Estevez et al., 2002). While these behavioural measures indicate that the birds are sensitive to even small deviations in thermal environment and will actively try to maintain conditions in their thermal comfort zone, it is difficult to determine at what point the birds actually experience discomfort. Even under conditions in which birds adopt metabolic thermoregulatory mechanisms - and by definition, are experiencing heat or cold stress - the birds may not be suffering. For example, a well-feathered hen in an outdoor yard may increase her appetite, produce more heat and be less energetically efficient when the temperature drops a few degrees below the recommended temperature of 21°C, yet it is unlikely that she is experiencing reduced welfare. In one study, the operant responses of laying hens were compared with changes in oxygen consumption when they were exposed to increasingly cool and increasingly warm temperatures (Hooper and Richards, 1991). In the cold, oxygen consumption increased more rapidly than the rate of operant responding, while in hot conditions the hens preferred to use the operant response to maintain body temperature. Since the hens were much more willing to "work" at avoiding hot rather than cool conditions, these data suggest that the birds find hot conditions more aversive than cold.

6.3.4.1 Welfare Problems Associated with the Thermal Environment

Because thermal stress and energy balance are so tightly coupled with productivity, most poultry stockpeople are quite knowledgeable about the importance of and various ways to manage the thermal environment. Every production manual has a section devoted to temperature management, and numerous extension publications focus on prevention of thermal stress. On the other hand, the capital expenditures and energy costs required to maintain optimal temperatures in large poultry operations are substantial and there is often a trade-off made between the cost of maintaining comfortable temperatures and loss in productivity. In broilers, for example, "economic best temperature" depends on the ratio of live weight value to feed cost (Charles, 1986). In some cases, welfare may be compromised. As with most physical stressors, the impact of thermal stress, and its consequences on welfare, depend on the combined effects of its intensity and duration. There are a number of situations in which laying hens, broilers and breeders experience such severe thermal stress, that they are unable to adapt and that result in increased mortality. These include transportation, power failures in artificially ventilated houses and heat waves. Domestic fowl have numerous thermo-regulatory mechanisms that should allow birds to adapt to some deviations in environmental temperature. However, some housing systems, management practices or even genetic changes may limit the bird's ability to use those mechanisms.

6.3.4.2 Power Failures/Ventilation Shut Down

In temperate climates, birds used for egg and meat production are commonly housed in insulated, artificially ventilated buildings for most or all stages of the production cycle. One of the main goals of housing the birds indoors is to protect them from climatic extremes and to provide an appropriate thermal environment for age of the bird regardless of outdoor temperature. The design of these barns maximizes the use of heat produced by the birds themselves in order to maintain indoor temperature and reduce the energy costs of providing supplemental heat during the winter. Therefore the buildings are well insulated with the intention of conserving the heat produced by the birds within the building. Temperature control within these barns is completely dependent on the operating fan and air inlet systems.

Ventilation failure in closed poultry houses is catastrophic, both economically and in terms of bird welfare. The high stocking densities together with the birds' high levels of heat production lead to rapid increases in air temperature and humidity resulting in heat stress and heat death within minutes of ventilation failure, depending on outside conditions. A standard Leghorn layer is estimated to produce 40 BTU/h of heat, while a 2 kg broiler chicken produces around 60 BTU/h (Chepete and Xin, 2002). Considering that thousands of birds are housed within a commercial poultry house at any one time, the heat and moisture produced by a flock is substantial, and ventilation failure can lead to heat death within 20 min (Randall and Boon, 1994). Therefore it is essential that provisions be made for ventilation failure in poultry houses. These include alarm systems, back-up generators and fail-safe panels that open the sidewalls of the house when temperature exceeds a given set point. Many livestock regulations now require an alarm and back-up system for closed poultry houses.

6.3.4.3 Welfare in Hot Environments

In many parts of the world, high temperatures and humidity during the summer months result in losses in productivity and increases in mortality due to heat stress. Annual economic losses from heat stress for broilers, layers and turkeys combined have been estimated to be between $128 and $165 million dollars in the United States, (St-Pierre et al., 2003) with most of those losses occurring in the southern states. In laying hens, a portion of these losses is due to increases in heat death, which was reported to be as high as 0.96% of the hens in some areas. The adverse effects of hot weather on laying hens are generally greater in climates that are more variable since hens readily acclimatize to gradual increases and long-term elevations in environmental temperature. For broilers, the majority of economic losses from heat stress are due to decreased feed intakes and consequent reductions in growth rate rather than from mortality. Paradoxically, the slower growth rates that occur during heat stress in broilers may actually reduce mortality from the metabolic diseases that are associated with fast growth. For all birds, the adverse effects of hot weather are compounded by high humidity, and hot climates in which there is a daily temperature cycle, for example desert areas, are better tolerated than those in which temperature and humidity remain relatively high throughout the day and night. In any climate, the decision to provide cooling systems for birds is usually based on economics. The losses in production are weighed against the capital and operating costs of fans, tunnel ventilation or evaporative cooling systems. In many areas, there is a clear economic incentive for providing more comfortable environments for birds (St-Pierre et al., 2003). However, with high and variable costs of energy needed to control the environment, there is a danger in that, in some cases, it may simply be cheaper for producers to incur losses from reduced productivity and increased mortality rather than modify the environment, with significant costs to the welfare of the birds.

6.3.4.4 Nutrition in Hot Environments

Although it is generally accepted that the best defence against reductions in productivity and welfare is to provide birds with a comfortable thermal environment, a number of different nutritional strategies have been proposed to alleviate the effects of heat stress on productivity of broilers and laying hens (Lin et al., 2006; Daghir, 2008a). These include altering the amounts of fats, carbohydrates and protein and supplementing diets with certain vitamins. The goal of many of these dietary manipulations is to offset the reduction in feed intake that occurs in hot environments.

Dietary fat has a lower heat increment for digestion than either protein or carbohydrates, and increasing the amount of fat in the diets of both broilers and layers results in higher energy intake while lowering heat load of the diet. Vitamin C supplementation reduces losses in productivity in both broilers and laying hens (Leeson, 1986). Supplementing the diets of laying hens with vitamins A or E may enhance immune function of the birds in addition to ameliorating some of the effects of heat stress on egg production. Providing hens with supplemental calcium sources such as oyster shell can reduce temperature effects on egg shell quality and there is some evidence that providing hens with carbonated drinking water can improve bone strength. Apart from any effects of diet formulation, the timing of feeding can affect birds' responses to high temperatures. Since the thermogenic effects of digestion occur 3–8 h after eating (Leeson, 1986) birds should not be fed at a time when heat production from eating would coincide with the hottest times of the day. Fasting of birds before the onset of acute heat stress, for example prior to a heat wave, can increase survival. While many of these nutritional strategies may protect bird welfare by reducing heat loads or by enhancing long term health, there is always a risk to welfare when there are economic advantages of feeding diets that maintain productivity rather than providing birds with a more comfortable environment.

6.3.4.5 Welfare in Cold Environments

Under most poultry housing systems, cold stress is not a problem given that the birds are either maintained indoors, or provided sufficient feed and have good plumage. However there are a few situations in which cold environments can impact of the welfare of the birds.

Brooding Chicks

Thermoregulatory mechanisms in domestic fowl are not fully developed until about 10 days of age (Baarendse, et al., 2007). This fact, together with their large surface to volume ratio makes newly hatched chicks especially vulnerable to cold stress. This is also the time that chicks are transported from the hatchery to the grower house. They should therefore be transported in properly designed chick boxes within climate-controlled vehicles.

Ascites Syndrome in Broiler Chickens

A major welfare concern related to cool or cold temperatures occurs in fast-growing strains of broiler chickens. Ascites syndrome, one of the metabolic disorders related to fast growth, occurs under conditions of increased oxygen demand. In order to increase blood flow through the lungs, there is an increase in pulmonary blood pressure, which puts stress on the right ventricle of the heart. The increased work load on the heart results in hypertrophy and eventually failure in function of the right ventricle, which in turn results in back pressure in the venous supply to the heart and leakage of plasma from the liver. Birds suffering from ascites have fluid accumulation in the abdomen as well as pulmonary congestion and oedema. In cool or cold environments, the increase in metabolic rate needed to maintain body temperature increases oxygen demand and consequently triggers ascites. In fact, cold exposure is the most important environmental cause of ascites syndrome in temperate climates when broilers are reared in open-sided or non-insulated buildings (Julian, 2000).

There are genetic differences in susceptibility to the condition in response to low environmental temperatures, with the fastest growing strains being most vulnerable (Deeb et al., 2002). In fast-growing strains, ascites syndrome is reported to occur in temperatures as high as 15°C (Buys et al., 1999) and those strains that are most susceptible to cold-induced ascites have also been shown to be the most prone to heat stress (Deeb et al., 2002). In principle, domestic fowl, especially those consuming large amounts of feed, should be able to adapt readily to mildly cold temperatures and tolerate a considerable range in daily temperature. Based on data obtained from studies on broilers in the 1960s and 1970s, Curtis (1983b) suggested that young chickens can tolerate considerable daily variation in ambient temperature so long as the average was appropriate. More recent data obtained from modern fast-growing strains indicated that a daily fluctuation of only 6°C resulted in increased mortality compared to birds in a constant temperature (McGovern et al., 2000). The welfare issue here has more to do with the fact that selection for fast growth has reduced the bird's ability to adapt to what could be considered a normal range of environmental fluctuation than it does with provision of an inadequate environment. This reduction in thermal adaptability of fast-growing strains of broilers means that, for welfare to be protected, environmental temperature must be maintained within fairly narrow limits. This also has implications for birds produced in free-range or more extensive conditions since most of the readily available commercial strains of meat-birds are simply not suited for outdoor rearing conditions.

6.3.4.6 Other Considerations

Feather Condition of Hens

Plumage condition of laying hens typically deteriorates over the course of the laying cycle. Feather loss may be due to either wear from confinement in cages, which is exacerbated by poor cage design, or from feather pecking in aviary or free range systems. Heat loss increases significantly in poorly feathered birds and the effects can be seen, since feed efficiency also declines, indicating that when hens are less able to conserve body heat they must use more feed energy for maintaining body temperatures (Leeson and Morrison, 1978; Lee et al., 1983). The effects of feather loss on the birds' thermal comfort have not been addressed directly, but it is likely that in cool or draughty environments birds with poor feather condition are at a greater risk of discomfort whereas those in hot environments have an advantage.

Comb and Wattle Removal

Dubbing of combs and wattles is a common practice done to prevent injuries. However, these structures are highly vascularized and have relatively large surface areas and therefore are an important means of dissipating heat from the body core as an increase in blood flow to the periphery that allows transfer of heat from the extremities to the environment. In domestic fowl, exposure to high temperature results in a vasodilation in the comb, wattles and shank (Richards, 1971; Nolan et al, 1978;) and in one study, it was estimated that at 35°C, 34% of total sensible heat loss was from the combs and wattles of white leghorn hens (van Kampen, 1971). Although it has been suggested that removal of comb and wattles from laying hens (Daghir, 2008b) or from broiler breeder flocks (Leeson and Summers, 2000) is not recommended in hot environments, any effect of dubbing on severity of heat stress has not been studied empirically.

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Chapter 7
Nutrition, Feeding and Drinking Behaviour, and Welfare

John Savory

7.1 Introduction

In the wild, feral domestic fowls (*Gallus domesticus*) and their ancestor the red junglefowl (*Gallus gallus spadiceus*) typically spend at least 50% of their time foraging for a wide variety of plant (mostly leaves, seeds and fruits) and animal (mostly insects) food items (Collias and Collias, 1967; McBride et al., 1969; Savory et al., 1978). They are mainly herbivorous in adulthood, but increased consumption of animal food in the first few weeks of life coincides with a greater need for dietary protein then (Savory, 1989). Their foraging behaviour, like that of other animals, consists of a series of processes that can be classed as appetitive and consummatory (Manning, 1967). The appetitive processes involve walking, searching, pecking and scratching the ground, and selection of food items based on visual cues. Consummatory processes involve procurement and insertion of selected items in the mouth, mandibulation (preparation for swallowing), and deglutition (swallowing).

Results of a classic experiment with newly hatched domestic chicks by Hogan (1971) indicated that appetitive (pecking) and consummatory (eating) processes are controlled independently by separate motivational systems. The integration of these processes in the first few days of life appeared to depend on the chicks learning to distinguish food items (starter crumbs were used) from non-food items (sand was used), through experience of post-ingestional consequences. In other work with chicks, Sterritt and Smith (1965) concluded that feedback from pecking at a stimulus panel and feedback from separate delivery of food into the crop were both reinforcing, but only in interaction with each other. Such findings suggest that different appetitive and consummatory components of foraging may represent separate potential sources of reinforcement. This is further suggested by results of neurophysiological studies with rats that were trained to work for food. In these animals there was evidence of "reward", based on increased dopamine transmission

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in the nucleus accumbens region of the brain, in association with both the operant behaviours directed towards obtaining food and (separately) consumption of the food itself (Hernandez and Hoebel, 1988; Kiyatkin and Gratton, 1994; Salamone et al., 1994).

In natural environments, where, as stated above, foraging tends to take up at least 50% of a fowl's time, levels at which different components of foraging are expressed presumably depend mainly on the availability of different food sources necessary to make up a balanced diet, and on their respective nutrient contents. In captivity, however, some components of foraging are likely to be suppressed relative to these levels, because of physical confinement in a limited space, provision of a concentrated balanced diet, and, in some contexts, limited access to that food. It has been suggested previously (Savory and Blokhuis, 1995) that, under these conditions, components of foraging that are suppressed are likely to be expressed in apparently inappropriate ways, but in appropriate contexts, in response to specific deficits in reinforcement. This assumes a homeostatic basis to reinforcing processes (cf. Delius, 1970).

If expression of at least some abnormal behaviours by domestic fowls reflects constraints on foraging, this implies contravention of one of the UK Farm Animal Welfare Council's five freedoms (FAWC, 1992), namely the freedom to display most normal patterns of behaviour. In addition, contravention of three other freedoms, from thirst, hunger and malnutrition, from thermal and physical discomfort, and from pain, injury and disease, can also be attributed to interactions between certain feeding and drinking practices, genotype and housing system. The ways in which feed and water are supplied thus have many and varied consequences for the welfare of commercially reared fowls. These interactions and their implications for welfare are the subject of the various sections in this Chapter. In most sections, layer stock and broiler stock are considered separately because aspects of their behaviour, physiology and husbandry differ fundamentally.

7.2 Ad Libitum Feeding

7.2.1 Layer Stock

When commercial layer strains of fowl are fed ad libitum on conventional starter and layer diets, that are both concentrated and balanced in terms of nutrient content, they tend to show a variety of apparently abnormal behaviours that may well reflect constraints on appetitive components of foraging.

Firstly, when given a choice between eating freely available food and working for access to identical food, a variety of captive birds and mammals have been found to work for at least part of their daily food consumption, a phenomenon commonly referred to as "contra-freeloading" (Osborne, 1977). This has been demonstrated with layer fowls and pigeons that were trained by operant conditioning to peck at a disc in order to obtain small food rewards (Neuringer, 1969, 1970; Duncan and Hughes, 1972). It was also shown by starlings that could search for hidden food as well as eat freely available food (Inglis and Ferguson, 1986). Proportions of food earned in this way vary between individual animals and are reduced by prior food deprivation. Such behaviour, which appears to be inconsistent with optimal foraging theory, has been interpreted by some as being adaptive in terms of monitoring predictability of food supply (Inglis et al., 1997). However, an alternative explanation is that working and/or searching for food (i.e. appetitive components of foraging) represent separate sources of reinforcement, as proposed above. This proposal is further supported by the finding that when layer chicks were given continual free access to both pellet and mash forms of the same diet in a choice feeding treatment, they consistently ate much more of the mash, despite the fact that this greatly increased the time they spent feeding (Savory, 1974).

In a critical review of evidence relating to the notion of behavioural "need", Hughes and Duncan (1988) concluded that there are cases where performance of a behaviour itself has motivational significance that is not necessarily related to its functional consequences. As well as the example of contra-freeloading in layers, referred to above, they also cited research of theirs which showed that laying hens continue to perform sequences of (appetitive) nest-building behaviour, even when a nest they created previously is still available (Hughes et al., 1989).

Another apparent anomaly concerning layer foraging is the extent to which their feeding efficiency (g food eaten per minute of feeding) varies in different contexts. In a comparison of feeding behaviour of young layers and broilers, the layers ate consistently less efficiently and, unlike the broilers, were even less efficient feeders in the middle of the day than at the beginning and end of the day (Masic et al., 1974). In other words, time spent feeding by layers is not a good indicator of their food intake. This is because, unlike broilers, layers often peck at their food without eating it, appetitive behaviour that has been called "exploratory" pecking (van Rooijen, 1991).

In a study where two layer strains were kept either singly in cages or grouped in deep litter pens, both strains spent more than twice as much time feeding in the cages as in the pens, despite the fact that body weight gains were similar in both environments (Bareham, 1972). This was because the birds in cages (with no litter) directed their exploratory pecking at food, whereas those in the pens directed their exploratory pecking at the floor litter. In other words, different ways of expressing exploratory pecking appear to be substitutable.

In another study of laying hen behaviour, in a deep litter house, birds spent 18% of time feeding at food dispensers and 25% of time in ground pecking (and scratching) when they were on the litter floor area, but 33% of time feeding and 7% of time ground pecking when they were on the raised slatted floor area of the house (Appleby et al., 1989). In a strawyard system, on the other hand, hens spent 40% of time feeding (possibly stimulated by frequent delivery of food by chain feeder) and only 7% of time foraging in the barley straw litter (Gibson et al., 1988). Interestingly, the results of both these studies show that hens spent a total of 40–47% of time in pecking behaviour, which compares closely with the 48% of time foraging observed in a population of domestic fowls in the wild, where no artifical food was provided (Savory et al., 1978). In a study of semi-wild red junglefowl, hens were seen to ground peck in 60% of observations (and ground scratch in 34% of observations) during the "active part of the day", despite the fact that "the birds were fed three times a day" (Dawkins, 1989).

Undoubtedly the most serious impact that suppression of normal appetitive foraging behaviour has on laying hen welfare is the re-direction of ground and/or food pecking in the forms of feather pecking and cannibalism. Together they can cause progressive feather loss, injury and death, and clearly contravene "freedom from pain, injury and disease". It is well known that the risk of feather pecking and cannibalism is reduced by providing food in mash form rather than in pelleted form (e.g. Bearse et al., 1949; Calet, 1965), presumably because more pecking is required to consume mash, and that is why layers are commonly fed on mash diets. The risk of pecking damage may be reduced further by increasing the fibre content of a mash diet, because that causes birds to spend even more time feeding (Savory et al., 1999; Hartini et al., 2001). In a comparison of behaviour of layer pullets reared in groups on either wire or litter floors, there was more feather pecking and object pecking, and less ground pecking and scratching, on the wire floors, while the amount of food pecking did not differ significantly (Blokhuis and van der Haar, 1989). Likewise, in a comparison of layer pullets reared on sand at high or low stocking densities, those at the low density showed more ground pecking and less feather pecking than did those at the high density (Hansen and Braastad, 1994).

Providing alternative pecking substrates in the form of cut straw or polystyrene blocks reduced the incidence of feather pecking in groups of laying hens kept on wire or slatted floors (Norgaard-Nielsen, 1989; Wechsler and Huber-Eicher, 1998; Aerni et al., 2000). Also, increasing the stimulus value of floor litter by regularly adding whole grain to it during the rearing period was found to increase ground pecking and scratching then, and to reduce feather pecking damage in adulthood (Blokhuis and van der Haar, 1992). On the other hand, pecking and eating moulted feathers lying loose on litter floors has been identified as a causal factor in the development of both feather pecking and, subsequently, cannibalism (McKeegan and Savory, 1999). The positive association between damaging feather pecking and cannibalistic behaviour has been confirmed by others (e.g. Cloutier et al., 2000; Kjaer and Sorensen, 2002).

In an experiment where access to food was limited to four 15-min periods per day, separated by intervals of about 4 h, there was evidence of more non-food pecking by grouped layer pullets in the hour after a feeding period than in the hour before it. Most of this increased pecking was directed at the ground when they were tested on a litter floor. However, when they were tested on a slatted floor, where there was less ground pecking, there were increases in ground and feather pecking and preening (Blokhuis, 1986). This result suggests two things. Firstly, that feather pecking and preening can substitute for ground pecking, and, secondly, that (appetitive) non-food pecking may be activated by scheduling of (consummatory) feeding. Such apparent activation of non-food pecking was also found in another experiment with individually caged hens, which had access to food only during the middle 8 h of a 14-h photoperiod, and which pecked at various objects in a stereotyped manner after the feeding period (Blokhuis et al., 1993). Stereotyped activities, or "stereotypies", have been defined as being repetitive actions that are fixed in form and orientation with no obvious function (Odberg, 1978).

Dustbathing has also been implicated in the causation of feather pecking (Vestergaard and Lisborg, 1993; Vestergaard et al., 1993). However, its contribution may have more to do with the fact that it is the main context where pecks are directed at litter particles on plumage than with the proposal that "feathers become treated as a substrate for dustbathing" (Vestergaard and Lisborg, 1993). Foraging and dustbathing explanations need not be mutually exclusive because ground pecking is common to both.

7.2.2 Broiler Stock (Progeny)

Modern broiler chickens have been genetically selected to be highly efficient converters of food to meat, when fed ad libitum, and they do this partly by reducing their physical activity to conserve energy. Compared with layer chicks of the same age, they spend roughly twice as much time resting and half as much time feeding, and consume three times as much food per minute of feeding (Masic et al., 1974; Savory, 1975). Appetitive foraging behaviour is therefore very much reduced in broilers, and it is unlikely that their welfare is compromised much by contravention of "freedom to display most normal patterns of behaviour".

However, because growing broilers eat more food per day than do layers of the same age (Masic et al., 1974; Savory, 1975), they also produce more heat. A modern broiler that is slaughtered at about 2.5 kg bodyweight at 42 days of age will eat about 180 g food per day in its last week of life (Aviagen, 2002), and its metabolic heat production then has been estimated to be 10–15 W (Mitchell and Kettlewell, 1998). In a 30,000-bird house this is equivalent to the heat production from 300 to 450 one kilowatt heaters, and this has consequences for "freedom from thermal and physical discomfort". In a comparison of three different terminal (42 days) stocking density treatments (28, 34 and 40 kg/m^2), it was found that broilers reared at the lowest density spent significantly less time panting in the last two weeks of life (McLean et al., 2002). It was therefore suggested that thermal comfort (and hence welfare) at that age may be improved at densities of less than 34 kg/m^2, which is currently the recommended maximum in the UK (see also Section 7.5).

In recent years it has become common practice in Europe to substitute the ground wheat in broiler grower and finisher diets with whole (unmilled) wheat. This is supplied to birds already mixed with their pelleted diets, and its inclusion level typically starts at 5% at 10 days of age and increases gradually to 15% or 20% in the final week. It is always removed from the diet 2 days before slaughter, to reduce the risk of contamination at the processing plant. Such feeding of whole grain saves costs in feed manufacture, and is thought to enhance digestive efficiency, improve floor litter condition, and even increase resistance to coccidiosis (Aviagen, 2002). All birds appear to like it equally and it does not lead to more varied body weight gain.

7.3 Restricted Feeding

There are several contexts in commercial layer and broiler production where the consummatory component of foraging (eating) is constrained to varying degrees for varying lengths of time. Husbandry practices which involve severe food restriction clearly contravene "freedom from thirst, hunger and malnutrition".

7.3.1 Layer Stock

According to Council Directive 99/74/EC (1999), it is (or will be) legally binding throughout the EU to provide at least 10 cm feed trough space per laying hen in both non-cage systems and conventional battery cages, and at least 12 cm trough space per hen in "enriched cages". However, as the average width of a modern hybrid laying hen is 15 cm when standing (Savory et al., 2002), this implies that it may be difficult or impossible for all birds in either a cage or a non-cage system to feed simultaneously. Conceivably, therefore, there could be competition at the feed trough, especially as there is a tendency for grouped birds to feed together rather than as individuals (referred to as allelomimetic feeding; Hughes, 1971). Such competition was indicated in a comparison of deep and shallow battery cages, with either three or four hens per cage, and 10 cm (deep cages) or 15 cm (shallow cages) trough space per bird, and where typical feeding peaks at the beginning and end of the photoperiod were suppressed in the deep cages only (Hughes and Black, 1976). However, overall mean proportions of time spent feeding were similar in the deep (45%) and shallow (48%) cages, and total food consumption during the same experiment was actually increased in the deep cages (Lee and Bolton, 1976). Hence, in that experiment, there was no evidence that food intake was reduced by apparent competition at the trough.

A mild form of quantitative food restriction used to be practiced during commercial rearing of layer pullets (Balnave, 1973; Wells, 1980; Kwakkel et al., 1991). Its purpose was to reduce food costs and body weight at point-of-lay, and to improve subsequent egg production and efficiency of food conversion. However, as modern strains of laying hens tend to weigh less and perform better than before, it is now used less widely. One form that this food restriction could take was to "freeze" daily food intake from, say, 6 or 8 weeks of age, at the ad libitum intake level at that point, and then to return to ad libitum feeding after about 8 weeks. In a trial in which such freeze-fed birds were compared with ad libitum-fed controls, the freeze-fed ones showed stereotyped pecking at non-food objects when their feeders were empty, which appeared to substitute immediately and completely for time that they would otherwise have spent feeding (Savory and Fisher, 1992). This is another example of apparently inappropriate behaviour being expressed in response to constraints on both appetitive and consummatory components of foraging.

Similar mild quantitative food restriction, involving a reduction of about 10% in daily food intake, can also be applied to adult laying hens for up to 8 weeks after the peak in egg production, without having negative effects on their total performance

(Mennicken et al., 1999). This serves to reduce both food costs and body weight gain due to (unnecessary) fat deposition.

The most severe form of food restriction applied to domestic fowls is the total food withdrawal for periods of up to 3 weeks that may be imposed on laying hens towards the end of their first laying year. Its purpose is to induce (or “force”) a moult and a pause in laying lasting at least 4 weeks, and to increase egg production, egg size and egg quality (including shell thickness) in a second laying cycle. This practice is applied routinely to at least 75% of egg-laying flocks in the USA, where there is a high demand for very large eggs, but to very few flocks in Europe where most table eggs sold are either medium or large.

The procedure depends on giving a severe jolt to a hen’s physiology in order to put it out of lay and cause regression of the ovary and oviduct. This involves a reduction in circulating oestrogen level, which promotes growth of new feathers and moulting of old feathers. Before recommencement of laying in the second cycle there is restructuring of medullary bone, which reverses the osteopenia known as “caged-layer fatigue”, caused by progressive loss of calcium from bone due to egg-shell formation. The progressive thinning of egg-shells in the latter part of the first cycle is also reversed at the start of the second cycle. While the severe jolt is usually achieved through total food withdrawal, it can also be achieved more gradually by altering the balance of certain dietary minerals (see also Section 7.4). A reduction in the photoperiod to 8 h or less is usually involved, and there may also be up to 3 days without water.

In the USA, there are several recommended methods for inducing a moult, such as the “California method”, the “Washington method”, and the “North Carolina programme” (Ibrahim, 1998). All involve a single period of total food withdrawal of up to 21 days, and up to 35% loss of initial body weight. “This strategy is deemed by many [egg] production managers to be most likely to result in a rapid return to peak egg production and sustainment of high production by a flock during the second production cycle” (Webster, 2000).

In a detailed study of caged laying hens subjected to 21 days without food, and consequent 35% weight loss, there was more aggression within and between cages in the first few days of food withdrawal, more non-nutritive pecking (including feather pecking) throughout the withdrawal period, and more “resting” (to conserve energy) as fasting continued (Webster, 2000). Similar behaviour responses, including increased locomotion, have been observed over just 4 days food withdrawal, in different production systems (Aggrey et al., 1990; Webster, 1995). Increased aggression, locomotion and non-nutritive pecking are all characteristic of frustration of feeding motivation (Duncan and Wood-Gush, 1971, 1972).

There was no mortality during the study of 21 days food withdrawal, and it was concluded that hens “appeared to respond in an adaptive way to feed deprivation”, and that their behaviour was not “suggestive of suffering” (Webster, 2000). However, the behaviour responses observed were indicative of frustration (see above), and in other studies physiological changes indicating stress have also been reported. Thus, during fasting periods of 10–14 days, some types of white blood cell (monocytes, heterophils, eosinophils, basophils) have been found to increase in frequency, while another type (lymphocytes) decreased or remained unchanged (Brake et al., 1982; Holt, 1992; Alodan and Mashaly, 1999). Total numbers of white blood cells (leucocytes) and packed cell volume also increased (Brake et al., 1982). It has been proposed that, in birds, an increase in the ratio of heterophils to lymphocytes is typical of mild to moderate stress, whereas an increase in the frequency of basophils may indicate more extreme stress (Maxwell, 1993). There is also evidence that immune function may be depressed during induced moulting (Holt, 1992).

The practice of totally withdrawing food has been illegal in the UK since the "Welfare of Battery Hens Regulations 1987", which states that "all laying hens shall have access to adequate, nutritious and hygienic feed each day and to adequate fresh water at all times". As a result, the recommended procedure in the UK for inducing a moult now involves reducing photoperiod to 8 h per day and light intensity to 3.5 lux, and feeding limited amounts of whole grain oats for 20 or 30 days (Lynn, 1989, The effect of the degree and duration of different feeding regimes on laying hens undergoing induced moult. Agricultural Development and Advisory Service Report (File number: ECT 338), unpublished). However, hens that are unused to whole oats appear to find them unpalatable and their daily food intake is still greatly reduced with such a programme (less than 10 g per day in the first two weeks), weight loss is still about 30%, and increased mortality has been recorded (Lynn, 1989, ibid.). Feeding of whole grain barley can also be used for the same purpose (Balnave et al., 1992).

In general, judging from the behavioural and physiological evidence, the sustained total or partial fasting associated with forced moulting procedures may compromise the welfare of laying hens to a degree that is ethically unacceptable.

7.3.2 Broiler Stock (Progeny)

Although broiler progeny are normally fed ad libitum at all times in order to maximise their growth rate, there is evidence that a period of reduced food or energy intake early in the growing period can reduce the incidence of skeletal and metabolic diseases and associated mortality, reduce total body fat, and increase the efficiency with which food is converted to body weight gain (Robinson et al., 1992; Yu and Robinson, 1992). Such restriction can be achieved non-quantitatively in various ways, and, with faster growing genotypes, may become more commonly used. It is unlikely to pose a threat to broiler welfare because only mild restriction (10% maximum) is required, for one or two weeks, and the benefits to health probably outweigh any hunger involved.

7.3.3 Broiler Stock (Breeders)

As a consequence of the continuing genetic selection for faster growth and more efficient food conversion in broiler progeny, it became necessary to impose progressively more severe food restriction on parent stock (breeders) during rearing in order to limit their body weight at sexual maturity (about 24 weeks of age). Currently recommended weights for Ross 308 broilers at 24 weeks are 2.8 kg for females and 3.8 kg for males (Aviagen, 2001). If breeding birds are fed ad libitum (like the progeny), their weights at that age are much higher (females weigh more than 6 kg), fat deposition is excessive, many birds are lame, and mortality associated with skeletal and heart diseases is unacceptably high (Katanbaf et al., 1989; Savory et al., 1993; Hocking et al., 1996). High body weight is also associated with impaired immune function (Han and Smyth, 1972; O'Sullivan et al., 1991; Hocking et al., 1996), increased incidence of multiple ovulations causing reduced production of hatching eggs (Hocking et al., 1987; 1989), poor shell quality (Robinson et al., 1993), and reduced fertility in males (Hocking and Duff, 1989). Hence, the chronic food restriction that is applied routinely to broiler breeders decreases fat deposition, heart disease, skeletal disease, lameness, mortality and food costs, and it increases fertility in both females and males. It has been confirmed that food restriction reduces the incidence of multiple ovulations (which cause multiple yolked eggs) (Hocking and Robertson, 2000).

All broiler breeders are fed ad libitum to 1 week of age, and thereafter according to programmes of quantitative restriction recommended by the breeding companies. In the EU, rations are usually provided once a day and are eaten in less than 30 min. Elsewhere they may be provided every alternate day ("skip a day") because this is thought to provide greater uniformity of body weight gain. Male and female birds are reared separately because they receive different rations. During rearing of commercial flocks it is now common practice for food rations to be scattered evenly on the floor litter by machines ("feed spinners"), to reduce competition among birds and increase (slightly) the time they spend feeding.

Female broiler breeders (which form at least 90% of adult flocks) that were fed according to one such programme (Ross Breeders, 1988) to 21 weeks of age gained about a third as much weight and ate about a third as much food as did ad libitum-fed control birds (Savory et al., 1993). This level of food restriction (two thirds relative to ad libitum) is twice as severe as that recommended for pregnant sows (Lawrence et al., 1988). It is at its most severe from 7 to 15 weeks of age, when females' daily intake is only about a quarter of that of ad libitum-fed controls at the same age (Savory et al., 1993).

Using an operant conditioning procedure to measure feeding motivational state, where birds worked for access to food during short test sessions at different times of day and different ages, it was found that females fed according to the Ross 1 restricted feeding programme were highly motivated to eat at all times. Their feeding motivation was just as great 1 h after their daily meal as it was 1 h beforehand, and was nearly four times greater than that of ad libitum-fed control birds subjected to 72 h of food withdrawal (Savory et al., 1993). In another comparison of restricted-fed and ad libitum-fed broiler breeders, it was found that levels of neuropeptide Y (a potent stimulator of food intake) mRNA in the hypothalamus were significantly increased in the restricted-fed birds (Boswell et al., 1999).

Behaviour of broiler breeders differs markedly from that of (ad libitum-fed) broiler progeny. The former are much more active than the latter, and they show increased pacing before expected feeding time and increased drinking and pecking at non-food objects afterwards (Kostal et al., 1992; Savory et al., 1992). Expression of these activities is often stereotyped in form (according to the definition of Odberg, 1978), and is correlated positively with the level of food restriction imposed (Savory and Maros, 1993). It is characteristic of frustration of feeding motivation (Duncan and Wood-Gush, 1972), and presumably reflects constraints on both appetititve and consummatory components of foraging (see Section 7.1).

There are clear analogies between the behaviour of restricted-fed broiler breeders and that of layer stock. Firstly, just as feather pecking and preening appear to substitute for ground pecking in layers (Blokhuis, 1986), so do drinking, pecking at any non-food object (including litter) and preening appear to substitute with each other as dominant post-feeding activities in broiler breeders (Savory and Maros, 1993). Secondly, in both layers (Blokhuis, 1986) and broiler breeders (Savory and Maros, 1993), expression of non-food directed oral behaviour appears to be activated by scheduled feeding.

There is also evidence that blood indices of stress (heterophil/lymphocyte ratio, basophil and monocyte frequencies, plasma corticosterone concentration) are higher in restricted-fed broiler breeders than in unrestricted birds (Katanbaf et al., 1988; Maxwell et al., 1990, 1992; Hocking et al., 1993), and are correlated positively with the level of food restriction imposed (Hocking et al., 1996).

Taken together, these facts indicate that current commercial food restriction of broiler breeders during rearing causes hunger, frustration and stress. The modern broiler breeding industry is thus caught in a welfare dilemma, because on the one hand stock may be suffering through chronic hunger, while on the other hand less severe restriction leads to problems in health and reproduction. This dilemma has been created by the breeding companies themselves, through their sustained selection for faster and more efficient broiler growth.

It has been suggested that qualitative restriction of nutrient intake might be a less stressful alternative to quantitative restriction for limiting growth rate of broiler breeders (Mench, 1993; Savory et al., 1993). In an experiment in which qualitative food restriction treatments (diet dilution with sugar-beet pulp, oat hulls or sawdust; appetite suppression with calcium propionate), with free access to food at all times, were compared with quantitative restriction treatments (Savory et al., 1996), several conclusions were drawn. Different methods of qualitative restriction can be used to control (female) broiler breeder growth rate within desired limits. Problems with these include reduced uniformity in weight gain, increased excreta production and/or increased cost. Although they may suppress abnormal oral behaviours, they do not alter the increased general activity correlated with reduction of growth rate, which may more accurately reflect associated hunger. Suppression of abnormal oral behaviours may only rarely correspond with reduction in blood indices of stress, and so cannot be taken to indicate improved welfare. Some methods can add to physiological stress. There was insufficient evidence of improved welfare, based on behavioural and physiological criteria, to justify advocating the suitability of any of these methods for commercial use.

In another experiment, feeding motivational state of female broiler breeders reared with different qualitative and quantitative restriction treatments was measured with an operant conditioning procedure (Savory and Lariviere, 2000). There was some evidence that feeding motivation may be at least partially suppressed in the short-term with qualitative restriction, due to a “gut-fill” effect. However, as a fundamental positive relationship between (mean) feeding motivation and reduction of growth rate was not altered by using qualitative rather than quantitative food restriction, these results supported the earlier conclusion (Savory et al., 1996) that broiler breeder welfare is not improved with qualitative restriction. General activity level (inversely reflected by time spent sitting) was closely correlated positively with both reduction of growth rate and feeding motivation, regardless of treatment (Savory and Lariviere, 1999). These interactions probably underlie the positive correlation between level of food restriction and expression of abnormal behaviour (Savory and Maros, 1993).

To see whether continuous food restriction is necessary throughout the rearing period, an experiment was done where (Hybro) broiler breeder females were fed either ad libitum (A) or on recommended restriction (R) during three stages of development (weeks 2–6, 7–15, 16–25), according to eight combinations/treatments (RRR, RRA, RAR, RAA, ARR, ARA, AAR, AAA). High numbers of settable eggs resulted from any treatment with food restriction from 7 to 15 weeks of age, and the highest number of settable eggs was with the ARA treatment, where birds were fed ad libitum before and after 7–15 weeks (Bruggeman et al., 1999). These results should probably be treated with caution because some of the body weight information seems anomalous (body weight may be a major determinant of reproductive output (see above)), and because no information is given on mortality level or health status. Nevertheless, they suggest that high reproductive performance can be achieved with only temporary food restriction, and more research is required to fully understand interactions between food restriction, body weight, health and fertility.

At one time it was probably true that recommended restricted feeding programmes for broiler breeders during rearing represented minimum amounts of food required to achieve maximum subsequent production performance. In its Report on the Welfare of Broiler Breeders (FAWC, 1998), the UK Farm Animal Welfare Council concluded that “whilst extreme feed restriction and ad libitum feeding are both unacceptable for the modern broiler breeder, a degree of control is necessary to optimise bird welfare”. It recommended that “The level of feed intake throughout rear should be managed to achieve a steady growth, not less than 7% week-on-week, and the appropriate weight and condition at point-of-lay”. This happens to coincide with a consistent weekly increment in (female) body weight of about 7% from 12 to 23 (point-of-lay) weeks of age, as currently recommended for (Ross 308) female broiler breeders (Ross Breeders, 1995; Aviagen, 2001). Such weekly increments are higher from 0 to 12 weeks. Thus, instead of proposing any relaxation in the level of food restriction, the FAWC (1998) report upheld the status quo. Moreover, although the target body weight for female broiler breeders at 23 weeks (point-of-lay) was increased by 10% in 1995 and 2001, compared with 1988, this has not kept pace with a 20% increase in growth rate of the progeny between 1988 and 2002 (Savory, 2002). The FAWC (1998) report went on to say “it is necessary to establish, as a matter of urgency, the point at which feed restriction creates a situation when the bird cannot cope with the hunger which results", without defining what was meant by "cannot cope". Clearly, birds can cope with existing levels of restriction, albeit in a state of chronic hunger.

Food restriction is relaxed when broiler breeders reach sexual maturity, but continues in mild form throughout adulthood in order to promote fertility and control body weight gain. It is desirable in adult flocks to separate the sexes during feeding, so that each can receive its prescribed ration (Aviagen, 2001). Various forms of special feeding equipment have been designed to achieve this. One, with a high trough for males that females cannot reach and a lower one with a grid that allows access to the narrower heads of females only, can lead to problems with facial abrasion, swelling and infection in females with the widest heads (Duff et al., 1989; Hocking, 1990). Rations are usually provided once a day, by chain delivery systems.

Feeding time for adults (and growing birds) is typically soon after lights on early in the morning, but this is also when many eggs are laid, so motivation to feed then may often conflict with motivation to lay an egg. This may be a cause of the relatively high incidence of eggs laid on the floor, instead of in nestboxes, in broiler breeder flocks. Currently there is an increasing tendency for adult flocks to be fed nearer to midday, because this has been found to reduce the problem of floor-laid eggs (Grampian Country Food Group and Sun Valley, personal communication).

As with growing broiler breeders, general activity levels in adult flocks are higher than in broiler progeny, and this is reflected by increased incidence of pecking damage due to feather pecking, cannibalism and aggression (which are seldom seen in the progeny). Agonistic behaviour may be particularly apparent in periods preceding regular feeding times, when arousal states (in hungry birds) are likely to be high. Lacerations on females' backs and tail regions are also common, due to scratching by males' claws and spurs during mating. These problems have not been studied systematically, but in a survey of three adult broiler breeder flocks, "vent cannibalism" and "cellulitis" (due to pecking damage or laceration) accounted for 24% of all female mortality (Jones et al., 1978).

The most severe food restriction applied to broilers is that imposed on selected pedigree ("elite") stock, which are used for producing new lines of broiler breeders, and which represent a very small proportion of all broiler breeders. Typically, these birds (males and females) are fed ad libitum to 6 weeks of age, when those that achieve desired growth criteria are selected for breeding and those that do not are culled. The problem is that, because they have been fed ad libitum, the birds that are selected already weigh the same at 6 or 7 weeks of age as normal broiler breeders are intended to weigh at point-of-lay. To maintain pedigree birds in good health, therefore, and to ensure satisfactory subsequent fertility (which may also be selected for), it is necessary to allow only slight body weight gain between selection at 6 weeks of age and point-of-lay at 24 weeks. They thus have to be subjected to food restriction that is considerably more severe than that applied to normal broiler breeders. Concerning this practice, the FAWC (1998) report recommended that "once the selection procedures are complete, weekly recording of weight gain must be used to check that these birds achieve a steady, progressive week-on-week increase in body weight gain". Presumably, however, such a recommendation could not prevent these birds suffering from severe chronic hunger.

Slower-growing genotypes are often used for free-range and organic production of broiler chickens, where the minimum age at slaughter is 81 days. Because these genotypes are slower-growing, the level of food restriction required to suppress the growth rate of their parent flocks is less severe than that applied to fast-growing lines.

7.4 Nutrient Imbalance

7.4.1 Deliberate Imbalance

In commercial contexts where laying hens are subjected to a forced moult at the end of their first laying year, this is usually achieved in a few days through total food withdrawal (see Section 7.3). However, it can also be achieved more gradually by altering the balance of certain dietary minerals, namely with low levels of calcium or sodium, or with high levels of zinc, aluminium, magnesium or iodine (Wolford, 1984; Hussein, 1996; Ibrahim, 1998). Such mineral imbalances are all associated with reductions in food consumption and cessation of laying. Their use for inducing a moult has not been adopted widely in the egg industry, although there is evidence that they are associated with lower mortality rates compared with total food withdrawal (Hussein, 1996).

7.4.2 Non-deliberate Imbalance

Mistakes in feed manufacture sometimes occur which can result in fowls being oversupplied or undersupplied with particular dietary constituents. Such errors usually impact in some way on the birds' health and welfare. For example, even a small oversupply of dietary sodium will cause an increase in the water intake to food intake ratio, and hence also increases in the types of welfare problem associated with wet floor litter. A greater oversupply of sodium can be fatal, whereas sodium deficiency can cause increased activity, toe pecking and cannibalism in laying hens (Hughes and Whitehead, 1979). Cases of rickets associated with calcium and/or phosphorus deficiencies have been reported in growing layers and broilers (Anonymous, 2002, 2003), and a shortage of riboflavin in dietary vitamin and mineral premix caused classic deficiency symptoms in at least one broiler flock (in 1993, T. Pennycott, personal communication).

Balanced layer and broiler diets are formulated to meet all the predicted nutrient requirements of birds that are performing (laying, growing) according to expected "standard" levels. In any flock, however, there will inevitably be some birds that are performing below the standard level, and perhaps also some that are performing above standard. Presumably, therefore, a common diet that is supplied to all birds will be providing a surplus of (unspecified) nutrients to the former, and a deficiency of nutrients to the latter.

This is likely to be the case with calcium for laying hens. Typically, the level of dietary calcium (but not phosphorus) is increased from about 1% in a grower (pullet) diet to 3.5–4% in a layer diet, in order to provide for a greater need for calcium associated with eggshell formation. This occurs when an egg is in the shell gland (uterus). It depends on a complex mechanism involving hormonal control, variation in plasma levels of calcium and phosphorus, turnover of these minerals in (primarily medullary) bone, their absorption from ingested food, and re-absorption of phosphate ions by the kidneys (Miller, 1992). Excretion of calcium that is presumably derived from the diet is increased when eggshells are not being formed (Buss et al., 1980), and so the lowest producing hens presumably excrete most calcium. High producing birds eventually become osteoporotic as their bone is progressively depleted of calcium. This condition cannot be prevented by further increasing the level of this mineral in the diet, and the prevalence of bone injury in end-of-lay hens is a major welfare concern (Knowles and Broom, 1990; Gregory et al., 1993). If hens are fed on a calcium-deficient diet and allowed free access to a separate calcium source such as oyster shell, consumption of calcium increases in the first weeks of lay as egg production also increases (Classen and Scott, 1982), and a specific appetite for calcium is seen whenever an egg enters the shell gland (Hughes, 1972; Nys et al., 1976). Such self-selection of calcium would presumably reduce excretion of (unused) dietary calcium, and there is even evidence suggesting that it may reduce mobilisation of bone minerals (Mongin and Sauveur, 1979).

There may also be situations where fowls over-consume protein. For example, in the event of ambient temperature being too low, or of body insulation being reduced due to feather loss, then fowls would need to increase their energy intake in order to produce more heat for regulating body temperature. In doing so, they would over-consume protein from a balanced diet containing a fixed ratio of protein to energy. So too, presumably, would slower growing individual broilers in a flock provided with standard balanced diets over-consume protein. Any such overconsumption of protein will result in increased excretion of nitrogen, in both undigested protein and uric acid (Ward et al., 1975). In addition, increased protein intake will cause greater water consumption, and hence also an increase in the water intake to food intake ratio (Marks and Pesti, 1984). Together, these effects are likely to lead to poor litter quality and increased ammonia production, and thereby compromise bird welfare.

Finally, there are risks of inadequacies in some essential amino acids (and hence of amino acid imbalance) that are associated with current bans in the EU on both the use of meat and bone meal in all feeds, and the use of synthetic amino acids (e.g. methionine, lysine, threonine) in organic feeds. Apart from the fact that amino acid imbalances can suppress food intake and so depress growth rate (National Research Council, 1994), both bans pose a more specific threat to layer welfare in that they have been implicated with increased risk of pecking damage. Thus, there have been anecdotal reports of increased feather pecking and cannibalism in layer flocks following a change in dietary protein source from mainly animal to mainly plant (e.g. Curtis and Marsh, 1992), although this was not confirmed convincingly in a recent experimental comparison of animal and plant protein sources (McKeegan et al., 2001). The ban on synthetic amino acids (and vitamins) in organic feeds is of greater concern, because it has been shown experimentally that low methionine (organic style) diets can cause significantly poorer feather condition and more injury and mortality due to cannibalism in laying hens, when compared with methionine-supplemented diets (Daenner and Bessei, 2000; Elwinger and Wahlstrom, 2000; but see Kjaer and Sorensen, 2002). Organic egg producers are well aware of this problem, but attempts by some EU countries to obtain formal derogation from this ban have been unsuccessful. All free-range hens, whether organic or not, also run the risks of mortality because of crop impaction due to consumption of uncut grass (Christensen, 1998; Kjaer and Sorensen, 2002), and of infestation with various internal parasitic worms through eating earthworms containing either eggs or larvae.

7.5 Water Consumption and Its Relationship with Feeding

Water must be regarded as an essential nutrient, although it is not possible to state precise requirements (National Research Council, 1994). Unlike some bird species, which suck up water using negative pressure (Zweers, 1982), poultry depend on gravity for transferring water to the alimentary tract. When drinking from bell or cup drinkers (which are usually situated below head height), domestic fowls make a series of angled dips of the open beak into the water, and raise the head between each dip to let the water pass from the mouth into the oesophagus. When drinking from nipple drinkers (which are usually above head height), they extract water with varying efficiency and let it trickle down while keeping the head raised.

Typically, fowls spend more time drinking from nipples (about 6% of time, McLean et al., 2002) than from bell or cup drinkers (about 2–3%, Savory and Mann, 1997), because water flow rate is limited with nipples. Lines of nipple drinkers are used routinely in the production of broilers, at 9–12 birds per nipple, and these are raised at least twice a week in such a way that the growing birds always have to stretch slightly to obtain water (Lott et al., 2001; Aviagen, 2002). This is likely to become increasingly difficult for slower growing birds, thereby creating a potentially serious welfare problem for a proportion of any flock (and hence contravention of "freedom from thirst, hunger and malnutrition"). When a high nipple drinker line is combined with a high ambient temperature, this can also become a serious welfare problem because there is evidence that panting broilers have difficulty in drinking from high nipples, and so their consumption of water may be constrained (by both panting and the limited flow rate) at a time when their need for it is increased (May et al., 1997; Bruno et al., 2001).

Any substantial reduction in water consumption by slower growing broilers would inevitably reduce their food intake as well, and so make their growth even slower, because of a strong positive relationship that exists between daily water and food intakes (Savory, 1978). Hence, any temporary interruption in a water supply will invariably suppress food consumption. Indeed, food intake is the main determinant of water requirement when ambient temperature is within the thermo-neutral zone, and most drinking occurs in close association with spontaneous meals (Yeomans, 1987). Typically, fowls consume about 1.6–2.0 times as much water as food per day, by weight, and this water intake to food intake ratio tends to be lower with nipple drinker systems than with bell drinkers (Bray and Lynn, 1986; Middelkoop and van Harn, 1992; Aviagen, 2002). Food consumption may (Ipek et al., 2002), or may not (Bray and Lynn, 1986) be reduced with nipple drinkers. Water content of faecal droppings and floor litter moisture content also tend to be lower with nipples (Bray and Lynn, 1986; Middelkoop and van Harn, 1992). This benefits bird welfare because drier and more friable litter is associated with both reduced ammonia production (Kristensen and Wathes, 2000) and reduced incidence of the various forms of contact dermatitis lesion (Martland, 1985). Nipple drinkers thus have potential advantages as well as disadvantages (see above) for broiler welfare.

Some fowls drink more than would be expected from their daily food intake, possibly as a consequence of environmental stress (Yeomans, 1986). Such excessive drinking (polydipsea) can be especially marked in growing broiler breeders, in response to the chronic food restriction to which they are subjected (Savory et al., 1992; Savory and Maros, 1993). Access to water is often removed routinely from both growing and adult (restricted-fed) broiler breeders, soon after feeding time each day, to reduce problems with wet floor litter resulting from wet droppings. This does not compromise the birds' welfare as long as it is done after food-related thirst has been satisfied and ambient temperature is within the thermo-neutral zone (Hocking et al., 1993).

When ambient temperature is above the thermo-neutral zone, birds need to drink more water to replace evaporative water loss due to panting. This can also occur when ambient temperature is within recommended limits, in broilers that are reared at higher stocking densities, because of reduced ability to dissipate heat (due to decreasing space between birds) coinciding with greater heat production (due to increasing daily food intake). Thus, in a comparison of broilers grown at 28, 34 and 40 kg/m^2 terminal stocking densities, the lowest density treatment was associated with significantly less observed panting by birds in weeks 5 and 6 of life, and drier and better quality floor litter then (McLean et al., 2002). There was also more panting observed, and damper and poorer quality litter, in pens containing female birds than in those containing males, and it was suggested that this may reflect a higher level of body insulation (and hence reduced ability to dissipate heat) in females, because of their faster feathering and greater body lipid content. The panting in weeks 5 and 6 coincided with an increase in atmospheric relative humidity, and the combination of this together with the observed ambient temperature may well have raised "apparent equivalent temperature" (Mitchell and Kettlewell, 1993) sufficiently to have been a cause of the increased panting. On the other hand, the increased panting may itself have contributed to the increased atmospheric relative humidity because of greater evaporative water loss, and consequential increased water intake through drinking to replace the water lost. Hence, it is difficult to separate cause and effect. Ultimately, the panting was due mainly to increased heat production associated with greater food consumption, and so, if we assume that panting reflects a bird's attempt to maintain thermal comfort, here is an example where nutrition (both food and water intakes) impinges on "freedom from thermal and physical discomfort".

As mentioned above (see Section 7.4), water consumption and the water intake to food intake ratio are also sensitive to variation in dietary mineral and protein concentrations. In any instance where the water intake to food intake ratio is raised at moderate ambient temperatures, litter moisture content will also be raised because droppings are wetter and there tends to be more water spillage. This reduces litter quality and increases the risk of both contact dermatitis and ammonia pollution (see above). High atmospheric ammonia levels cause increased incidences of keratoconjunctivitis, respiratory problems and other forms of disease (Kristensen and Wathes, 2000). Poor litter quality attributable to nutritional causes can thus contravene "freedom from pain, injury and disease".

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Chapter 8
The Impact of Disease on Welfare

Andrew Butterworth and Claire Weeks

8.1 Introduction

Welfare is usually defined in terms either of an animal's ability to cope (Broom, 1986) or of health and behavioural needs. Indeed the very word "dis-ease" implies a state lacking "ease" or well-being. We feel it is important to consider disease holistically: that is to consider the animal's ability to resist stress and the environmental challenges it faces. Whereas the outcome of poor welfare is expressed as disease, the relative contributions of various stressors will vary with each individual. The other chapters consider genetics, nutrition and environment in terms of the welfare of poultry. However, given the same housing, air, feed and water, some birds may become diseased and some remain healthy. Intrinsic biological variation results in a range of nutrient reserves and immune status at hatching, plus differences in genetic make up, social status and behaviour that interact with each other and further factors to provide different outcomes for the individual. In the pragmatic world of farming, flock health status may be frequently chosen as the index of welfare, but it is important not to lose sight of the health and well-being of each individual, even in flocks numbering tens of thousands of birds.

For the individual animal, it matters not whether any disease it suffers from is common or rare, is created by systems it lives in, or by natural susceptibility to the disease. In terms of the impact on the welfare of the global population of poultry, common conditions such as enteritis, footpad lesions, cellulitis, distended crop and respiratory disease have the greatest significance because they are often considered as routine, and if they do not cause significant economic loss, may be accepted as established hazards about which little can be done. By virtue of the numbers of animals affected, these common irritant, non life threatening conditions become very significant.

For example, crop distension might sporadically affect 0.1% of birds in a broiler flock, and sometimes bigger numbers in turkey flocks (Peckham, 1984). This is not

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usually a life threatening condition, but will compromise the bird, and be reflected in reduced growth. A shorter bird may find it harder to access resources in the shed. If the bird is significantly smaller, it may be culled on farm (welfare concerns over on farm slaughter) or be too small to be effectively stunned in the electrical stunning bath at the slaughter plant. This condition is a low level “sporadic” condition of little economic impact, but may, for the individual bird, seriously reduce the quality of its life. If we assume that crop distension is intermittent, but can be found world-wide, then 0.1% of 40 billion meat chicken (estimate for world production) gives 40 million birds a year may have their broader “welfare” compromised by this low level condition. For other common, but economically insignificant, conditions such as pododermatitis, the numbers of poultry affected worldwide can be astounding. In the absence of large-scale surveys of the incidence of foot pad dermatitis (pododermatitis) in chicken, taking assumed figures based on small surveys in Europe, of 25% in broilers and 5% in layers, the number of individual birds affected annually could be some 10 billion plus.

Recognising the complex aetiology of disease, this chapter will outline indicators of disease and microbiological agents of disease, and will attempt to hint at the possible “other factors” and interaction of gene and environment that may contribute to disease. Skeletal and metabolic disorders, by which we mean any condition not caused directly by an infective organism, will be considered in depth because of their widespread occurrence and increasing significance for poultry welfare. *We do not attempt to describe all poultry diseases, but rather to use selected conditions as illustrations of the welfare consequences of ill health.*

8.2 Indicators of Disease

The following signs are all indicative of a bird that is in a state of crisis. From a welfare point of view they are symptomatic of substantial stress, and of a reduced ability to cope with the cumulative and combined effects of current and previous stressors. They reflect strategies that have evolved to conserve and re-direct energy in the body towards combating disease and regaining health. Their presence indicates the need for human intervention to support the recovery of sick birds, and equally importantly to try to prevent the spread of disease, and to recognise possible causes, so that corrective and preventive action may be taken. Birds are seldom treated as individuals (apart from culling) but rather as populations; thus the decision to treat whole groups is generally based on the cost effectiveness of treatment.

8.2.1 Malaise

Typical signs and symptoms of an unhealthy bird include

- Withdrawal: the bird isolates itself as far as possible from other members of the flock and from interactions with them, so that the sick bird is to be found under

feeder or drinker lines, or at the edges or corners of houses or cages. The bird also becomes less responsive to most external stimuli.
- Hunched posture: the neck is retracted down towards the body, the tail may droop, the general appearance is more rounded and contracted and the eyes are often closed.
- Dull feathers: the feathers no longer refract the light and particularly in brown-feathered birds look darker. This may be due to the bird's loss of interest in or lack of energy for preening and feather maintenance, but can also be a sign of an inadequate diet or severe parasite infestation.

8.2.2 Pain

In evolutionary terms, a prey animal with manifest signs of pain is more likely to be selected by a predator, thus domestic fowl show few visible signs of pain on visual inspection. However, a bird that is in pain will indicate behavioural distress (including escape behaviour) and may vocalise if handled and the affected area is gently palpated. In poultry there is evidence of pain in several musculoskeletal disorders and infected lesions that will be discussed in the relevant sections below.

8.2.3 Dehydration and Emaciation

These are always symptomatic of poor welfare and a state of disease. As modern systems of poultry husbandry commonly provide adequate feed and water ad libitum, emaciation and dehydration reflect an inability of the individual bird to access these resources. Occasionally this is due to social stress, but more often to lameness or disability due to disease (Butterworth et al., 2002).

8.2.4 Decreased Productivity

Reductions in egg shell quality, egg output or growth rate may indicate that the bird is re-directing nutrients to the repair of damaged tissues. Whereas high productivity does not in itself equate with good health and welfare, reduced productivity (weight gain, or maintenance of weight), in the same thermal conditions is often a sign of disease or distress.

8.2.5 Immunosuppression and Reduced Liveability

Good flock liveability is both a welfare and an economic goal, and there has been much research into nutrients that enhance immune defences. Trace elements such as zinc, iron, copper, selenium and manganese are essential for resistance to disease and normal immune function (Fletcher et al., 1988). The particular importance of zinc in poultry was reviewed by Kidd et al. (1996). Birds are susceptible to a number of diseases which result in immunosuppression, and these diseases are discussed under the headings Gumboro disease, Chicken Infectious Anaemia, Oncogenic viruses and fungal toxins. The use of intermittent lighting schedules that also reduce daily illumination may improve liveability and reduce mortality in laying hens (Lewis et al., 1996). Immune function was improved in a line of White Leghorn hens that was selected for longevity (Cheng et al., 2001). As well living for longer, the birds' also showed reduced cannibalism and flightiness, plus improved feather score.

8.3 Metabolic and Physiological Disorders

In this section we include those disorders associated with abnormal metabolic function. These usually develop as a result of unbalanced genetic selection by human beings, and frequently affect more than one tissue or organ in the body. Scheele (1997) argues that homeostatic dis-regulation results from an imbalance between production rate and maintenance requirements, which leads to diseases in the organs that supply energy. Thus it is not unusual for several conditions, with essentially the same root metabolic cause, to be manifest in a flock or even a single bird. For example, the review by Sanchez et al. (2000) showed that broilers selected for rapid growth, high breast yield and high feed conversion efficiency can often barely supply their muscles with oxygen and also show a reduced ability to adapt to metabolic stimulation by factors such as altitude, climate or energy/protein-rich diets. This substantial compromise of the health and welfare of very young (under 6 week) birds, compared with slower-growing broiler strains, was attributed by these authors to:

- reduced lung volume: body weight ratio
- decreased ability to fix oxygen in the blood
- higher blood viscosity
- frequent cardiac arrhythmias.

In consequence, many broilers are predisposed to pulmonary hypertension and ascites. Incorporating selection criteria for pulmonary, cardiovascular and haematological characteristics into the genetic selection model and matching these against growth criteria could substantially reduce such problems.

8.3.1 Ascites

Ascites is an accumulation of fluid in the peritoneal cavities, most commonly caused by increased pressure in the blood vessels, which forces out excess fluid and inhibits re-absorption of tissue fluid. Another common cause is right ventricular failure. Mortality in affected flocks is over 1% and may rise to 20%, although incidence averaged 4.7% in a 1996 international survey (Maxwell and Robertson, 1997). Most aspects of the disease are considered by Julian (1993). The condition may be reduced or prevented by slowing metabolism via genetic, dietary or husbandry measures (such as increased periods of darkness, Gordon, 1997). In their review of causal factors, Decuypere et al. (2000) suggest that a fundamental cause is the imbalance between oxygen supply and the oxygen required to sustain rapid growth rates and high food efficiencies. They also provide evidence for the close association of the quantity, form and quality of the diet and the incidence of ascites.

8.3.2 Cardiovascular Disorders

Whereas cardiomyopathy and ruptured aortas are major causes of mortality in turkeys, they are comparatively rare in broilers. Apart from ascites (above), flip-over or SDS (sudden death syndrome) is the main condition associated with cardiovascular disease in broilers. Mortality levels in affected flocks are typically 0.5–2% with males predominantly affected (Julian, 1996). The absence of clear symptoms on post-mortem, and its occurrence in apparently healthy, fast-growing birds indicates that it is likely to be a metabolic disease, in which an imbalance of electrolytes or metabolites causes ventricular fibrillation. Under research conditions, an imbalance of calcium and phosphorus in the diet can significantly increase SDS (Scheideler et al., 1995). Stress, induced by high stocking density (Imaeda, 2000), bright lights and disturbance by humans may also increase incidence.

8.3.3 Haemorrhagic Fatty Liver Syndrome

In this condition, abnormal accumulation of lipid in the liver, is due primarily to an inappropriate diet, particularly the ad libitum provision of feed high in carbohydrate and low in fat. Such diets are commonly used to increase egg production, but lead to excess storage of fats in the liver. The livers of laying hens become putty coloured owing to contents of up to 70% lipid (mostly triglyceride) and they also haemorrhage. Excessive abdominal fat is seen, and the kidneys are often pale and swollen. Mortality is generally low, but morbidity high and egg production may fall. Scheele (1997) noted that the condition was the most important disease of laying hens in the Netherlands. It is more common in caged layers which cannot exercise to use up the excess energy. When formulating diets for birds it is important to realise that their carbohydrate and lipid metabolism differs from mammals. In particular, the liver rather than the adipose tissue is responsible for lipogenesis. Adding lipase to the diets of laying hens may increase the incidence of liver disease whilst improving the PUFA (polyunsaturated fatty acid) content of yolk fat (Lichovnikova et al., 2002).

8.3.4 Reduced Longevity

An important cause of cellular ageing and reduced lifespan in organisms is oxidative stress. A reduced oxygen supply to body tissues is one way in which improved food conversion efficiency can be achieved. If this occurs in conjunction with increased demands on the metabolism for growth and production, then increased free radical production and damage to DNA is likely. This could in part explain the ever-reducing lifespan of farmed species. Many avian species, however, have a relatively high resistance to oxidative stress (Ogburn et al., 1998) and a stronger antioxidant-defence system than mammals of comparable size (Klandorf et al., 1999). This could help to account for the astonishing increase in productivity of fowl during the past half century. Whereas the ability of birds to cope with a relatively hostile biochemical environment may have enabled them to do this, concurrently it appears to have rapidly advanced the ageing process.

Selective breeding by man has reduced the lifespan of meat-type fowl so dramatically that it is now very difficult to keep parent birds (broiler-breeders) alive for long enough for them to reach sexual maturity and reproduce. If broilers are not slaughtered at their intended market age of around 40 days old, then they begin to die of age-related conditions soon after (Butterworth et al., 2002). Many scientists predict that the lifespan of the modern broiler fed to appetite is about 12 weeks, but for ethical reasons have not run the trials to confirm this. The equivalent in humans would be attaining the body weight of an adult at pre-school age, and living to an average of only 7 years of age.

8.4 Skeletal Disorders

8.4.1 Osteoporosis in Layers

Osteoporosis is rarely an issue in meat-strain birds, or even in broiler-breeders, because their egg output is comparatively low. The unfortunate choice of the term "leg weakness" to describe lameness in meat-strain birds led some to assume that bone strength was reduced, which is not usually the case. Reduced bone strength is however, virtually ubiquitous, to some degree, in modern strains of layers that are managed for high egg output. Osteoporosis is a reduced mineralisation of the main structural bones of the skeleton which weakens them, leading to torsion (particularly of the keel bone) and to fractures. The birds are unable to obtain sufficient calcium from the diet or by release from medullary bones (which act as calcium reservoirs) to form the egg shells and so they mobilise skeletal calcium. The skeleton becomes increasingly weak as lay progresses, and older birds are more likely to suffer "*cage layer fatigue*" in which, as well as widespread bone abnormality, paralysis occurs due to nerve damage from weakened bones in the vertebral column. Caged birds also have insufficient space to exercise, and in particular to perform weight-bearing exercise and therefore are prone to *disuse osteoporosis*.

Osteoporosis is a major welfare issue because millions of birds are affected and may suffer pain from broken bones (see below). The widespread occurrence of this disease indicates that the laying hen cannot adapt its calcium metabolism sufficiently to cope with the stressful demands of modern production and husbandry. An inability to cope is a welfare issue (Broom, 1986). The main changes that place an unreasonable demand on the physiology of the layer are:

- Prolonged and continuous egg laying. Hens evolved to lay in clutches with periods in between that enabled their skeletal reserves to be replenished.
- Advancing the age of sexual maturity. By forcing birds into lay when young, skeletal growth is incomplete even before the demands of egg laying commence. Furthermore, oestrogen activity has a greater effect on skeletal integrity than diet, and thus should not be prematurely stimulated in the immature bird.
- Insufficient weight-bearing exercise in caged birds (see Baxter, 1994).

8.4.2 Lameness in Broilers

Lameness in broilers stems principally from various skeletal disorders, but is so important from a welfare point of view that it is considered under a separate heading. According to one authority (Webster, 1995), lameness in broilers constitutes "in both magnitude and severity, the single most severe, systematic example of man's inhumanity to another sentient animal." There is widespread concurrence that it is a major welfare concern, particularly as so many millions of individual animals are affected.

8.4.2.1 Assessment and Prevalence

Lameness is widely assessed using the gait scoring system, devised by Kestin et al. (1992), that assigns a gait score (GS) from 0 (normal, fully mobile and agile) to 5 (incapable of walking) based on visual appraisal by humans of the gait of a broiler that is encouraged to walk. With trained and standardised assessors, and with an appropriate sample of broilers (Kestin and Knowles, 2003), the method can estimate the distribution of gait scores in a commercial flock – or in other words, the magnitude and severity of lameness. The prevalent opinion is that broilers with a gait score of 3, 4 or 5 have increasingly compromised welfare. On this basis, recent surveys have estimated the proportion of broilers affected (GS>2) to be 2.5% (Knowles et al., 2008), 14.8% (Berg and Sanotra, 2001, a pilot study in Sweden of 400 broilers in 8 flocks at 29–33 days of age), 30.1% (Sanotra et al., 2001, a survey in Denmark of 2,800 broilers in 28 flocks at 31–42 days of age). There are a number of possible explanations for such widely differing estimates of the prevalence of lameness in broilers. One is inter-observer reliability, and the inevitable inaccuracies associated with a subjective method of evaluation. This can be overcome to a large degree by training, validation and the use of standards (such as a large reference database on videotape of the locomotion of broilers of each different gait score). Several other factors that are known to affect lameness are discussed below. Many of these varied between surveys and could account for some of the differences.

To overcome the potential errors associated with subjective methods, a few objective methods of measuring lameness have been developed. Computer analysis using filmed images or pedobarographs has proved to be accurate and reliable in characterising gait (Corr et al., 1998, Reiter, 2002, Savory, 2003, personal communication) but also expensive, time-consuming and not suited to fieldwork. A simple new method based on latency to lie in very shallow water is being developed and has been used in trials on commercial farms (Weeks, 2001, Weeks et al., 2002, Berg and Sanotra, 2003). Results have initially been compared against gait scoring with highly significant correlations. Once fully refined, the test is expected to be used for auditing, breeder selection and accurate field assessments of lameness. From a welfare perspective, the new test has the advantages of being a bird-based assessment requiring no human interpretation, and of the duration of the test decreasing to a few seconds with increasing lameness.

For all methods of assessing prevalence and severity of lameness an appropriate sample of birds needs to be selected. For a given level of precision of the estimate, the number of birds required for the sample will vary according to the proportion of lame birds in the flock (Kestin and Knowles, 2003). In practice, in a commercial broiler house with fittings in the way, it is difficult to select a truly random sample of birds and this affects the accuracy of any estimate.

8.4.2.2 Genetic Influences on Lameness

As discussed in Chapter 7 by Savory, selection for fast growth and increased food conversion efficiency has had an adverse effect on several aspects of broiler welfare. Principal among these is increased susceptibility to lameness, although this varies slightly between genotypes (Kestin et al., 1992, 1999). A survey of leg problems in commercial broiler flocks in Sweden found the proportion of lame broilers (gait scores >2) was significantly greater ($P<0.001$) in Cobb genotypes, at 26.1%, than Ross 208 genotypes, at 14.1% (Sanotra et al., 2003). Several studies have shown that high levels of lameness are significantly associated with high growth rate and precociously heavy body weight, and Kestin et al. (2001) demonstrated this across a particularly wide variety of genotypes (Fig. 8.1). Previous studies (Kestin, 1992, Sorensen et al., 2000) have also shown that both the proportion of broilers affected by lameness, and the severity of lameness, increases with age. As would be expected in growing broilers, weight also generally increases with age, but this only applies to birds that can still walk and have adequate access to feed and water (up to GS 3). Those birds classified as GS 4 or 5 are unable to gain adequate access to feed and water, and in consequence their growth is impaired (Fig. 8.2). Clearly the health and welfare of such very lame broilers is so poor that they should be culled, and good producers will have a thorough culling programme. Leg culls in Northern Ireland were 0.5% of males and 0.4% of females, McNamee et al. (1998).

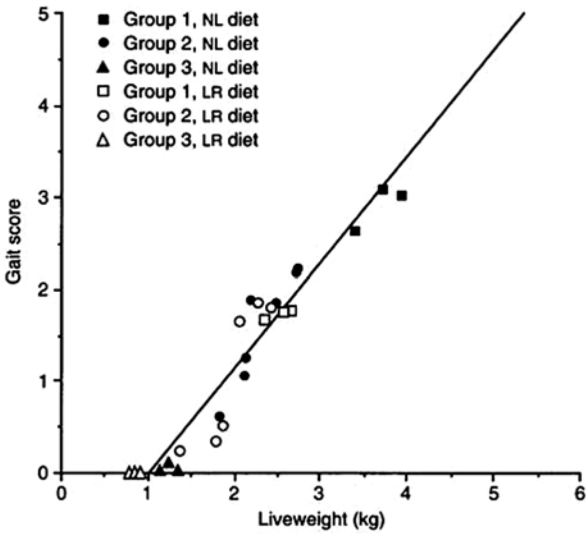

Fig. 8.1 Relationship between lameness (gait score) and liveweight of 3 genotype groupings of 13 genotypes at 54 days of age fed a non-limiting (NL) or Label Rouge (LR) diet. Reproduced with permission, from Kestin et al. (2001). Regression coefficient 1.262 ($P<0.001$). A similar relationship was found at 81 days of age

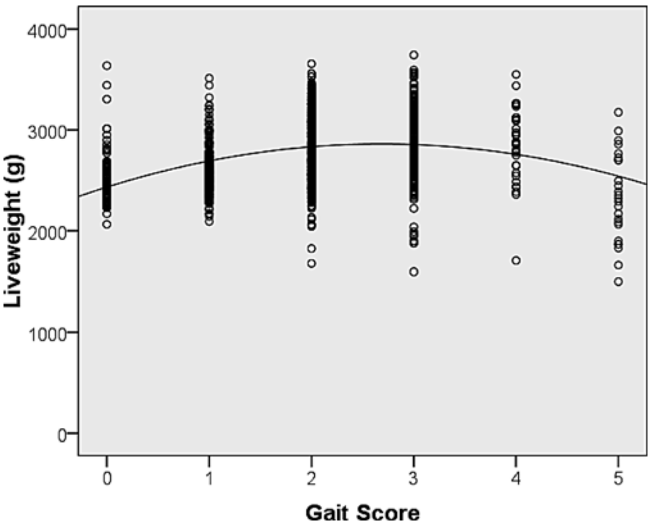

Fig. 8.2 The curvilinear relationship between Gait Score (lameness) and body weight. The lamest birds (GS 4 and 5) cannot access feed and water freely

8.4.2.3 Husbandry Influences on Lameness

Research has shown that several variables can affect the expression of lameness in a flock of broilers. It is important to note that many of these affect liveweight and that often any benefits are due primarily to this weight reduction. Thus, to determine whether changes have a value per se, correction must be made for alterations in body weight. Lameness increases in prevalence and severity with increasing stocking density (Hall, 2001; Sørensen et al., 2000). The free floor space available for exercise decreases with increasing stocking density and could account for some of the increase in lameness. Several studies support the hypothesis that reduced exercise increases leg problems (Reiter and Bessei, 1998; Bizeray et al., 2000). The effects of light on broiler welfare are complex, however certain lighting patterns may reduce the incidence of leg disorders (reviewed by Gordon, 1994; Sorensen et al., 1999). Improvements in leg health may be due both to the stimulation of bouts of activity and also to periods of high quality rest and improved metabolic health (Gordon, 1994). This explanation could equally apply to the reported benefits of providing feed in meals rather than ad libitum (Su et al., 1999). To reduce leg problems effectively, feed restriction generally has to be severe enough to cause long-term growth reduction whether applied for short periods at a young age in broilers (e.g. Su et al., 1999) or throughout life in broiler parent stocks. It then becomes difficult to balance the resultant welfare benefits with the welfare problems. In the case of broilers other methods should preferably be employed to improve leg health. Because use of perches by broiler is so low, particularly after about 4 weeks of age, they have no effect on leg health. Most trials using environmental enrichment to stimulate activity also have negligible effect on health although they may alter behaviour.

Recent experiments have begun to examine effects on lameness and other responses to combinations of husbandry measures such as lighting schedules and stocking density (Sanotra et al., 2002). There is now a need for the combined effects of all factors known to affect lameness and other aspects of broiler welfare to be studied in a systematic way in commercial scale trials.

8.4.2.4 Causes of Lameness

In simplistic terms, modern broilers have been selected to have the potential for extremely rapid muscle growth. If this growth of soft tissue occurs at a very young age, then it may exceed the capacity of the skeletal system to support it. Moreover, broilers have been selected for increased breast muscle size. This confers biomechanical disadvantages owing to the width of the breasts in much the same way as the enlarged udders of modern dairy cows force abnormal gait of their hind limbs. Reiter (2002) contrasts the rolling gait of broilers, which need to shift the centre of gravity over each leg in turn with each step, with layers that walk normally because both feet are beneath their centre of gravity.

The principal musculo-skeletal disorders associated with lameness in broilers were reviewed in 1993 by Thorp. Although these are conveniently considered separately from infectious causes, reviewed by Butterworth (1999), there may be overlap. For example, abnormal growth plate development, or wear and tear in distorted joints, may predispose to colonisation of the synovial fluid and membranes by opportunist infectious agents such as *staphylococci* or *reoviruses*. Following acute infection, chronic conditions such as tenosynovitis and arthritis may develop. The inflammation and pain associated with infectious causes of lameness generally results in a substantially reduced ability and inclination to walk, that is to a gait score classification of 4 or 5 (Jordan, 1996, Kestin et al., 1994). From *post mortem* examination, it estimated that staphylococcal tenosynovitis accounts for 3–4% of cases of lameness (Pattison, 1992, Reece, 1992) and the incidence in broiler breeders is higher, since the disease has longer to develop.

8.4.2.5 Consequences of Lameness

The disabling consequences of lameness have particular significance for broiler welfare if they cause behavioural frustration, prolonged discomfort or pain.

Many studies have shown significantly altered behaviour patterns, particularly reduced activity, in lame and heavy birds (Murphy and Preston, 1988; Newberry et al., 1988; Blokhuis and van der Haar, 1990; Bessei, 1992; Weeks et al., 1994). More recently, Weeks et al. (2000) observed that, on average, lame broilers (GS 3) lay down for 86% of their time, which was significantly longer than the 76% of sound birds (GS 0). Walking declined with age but occupied an average of 3.3% of the time of broilers approaching slaughter weight. Lameness significantly reduced this to a minimal 1.5% in the worst affected birds. For lame birds, the time spent on their feet idling or preening was significantly less than sound birds, and this could indicate a reduced quality of life. More importantly, there was evidence of frustration of normal feeding behaviour. When the feeders were set lower than usual, lame broilers lay down to eat for almost half their feeding time, whereas sound birds predominantly chose the usual standing posture for eating. Moreover, detailed observations using video records revealed that lameness altered the feeding strategy of broilers. The sound birds visited the feeder an average of more than 50 times in 24 h, but the number of visits to the feeder was reduced with increasing lameness to an average of around 30 visits in the lamest broilers. However, meal duration was adjusted to give no overall differences in time spent feeding per day (Fig. 8.3).

The alterations of the time budget, in particular the reductions in activities performed whilst standing, and the different feeding strategies adopted, are consistent with lameness imposing a cost on the affected broilers to the detriment of their welfare. In an experimental study of dustbathing behaviour, Vestergaard and Sanotra (1999), found that lame broilers with tibial dischrondroplasia (TD) dustbathed on significantly fewer days and showed reduced dustbathing behaviour. These birds also had longer periods of tonic immobility when tested at six weeks of age than birds without TD, and the authors suggested that an inability to dustbathe might increase the sense of fear. Their study also indicated that it was the pain associated with lameness that reduced dustbathing behaviour. Very severe lameness may result in reduced ability to access food and, more critically, water drinkers – particularly if nipple and cup drinkers are set at a height which requires that birds have to “stretch” to reach them. Birds with this degree of lameness should always be humanely culled. The consequences of not doing so were revealed in a study carried out in the UK by

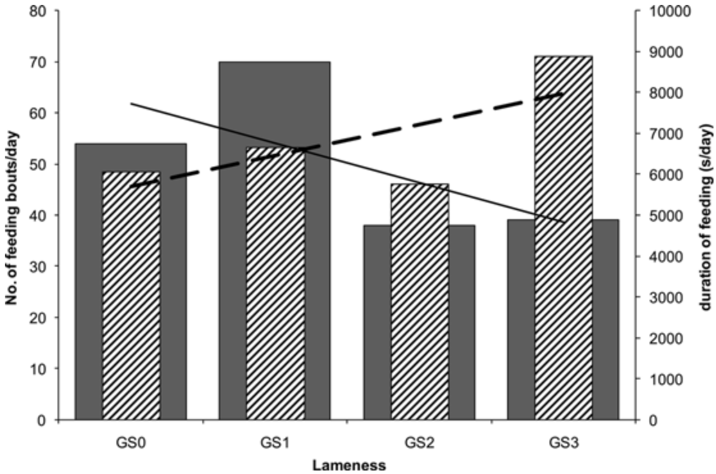

Fig. 8.3 With increasing lameness from none (GS0) to pronounced (GS3), broilers reduce the number of feeding bouts (*solid grey*) but increase the duration of each bout (*hatched*) so that overall time spent feeding remains similar (after Weeks et al., 2000)

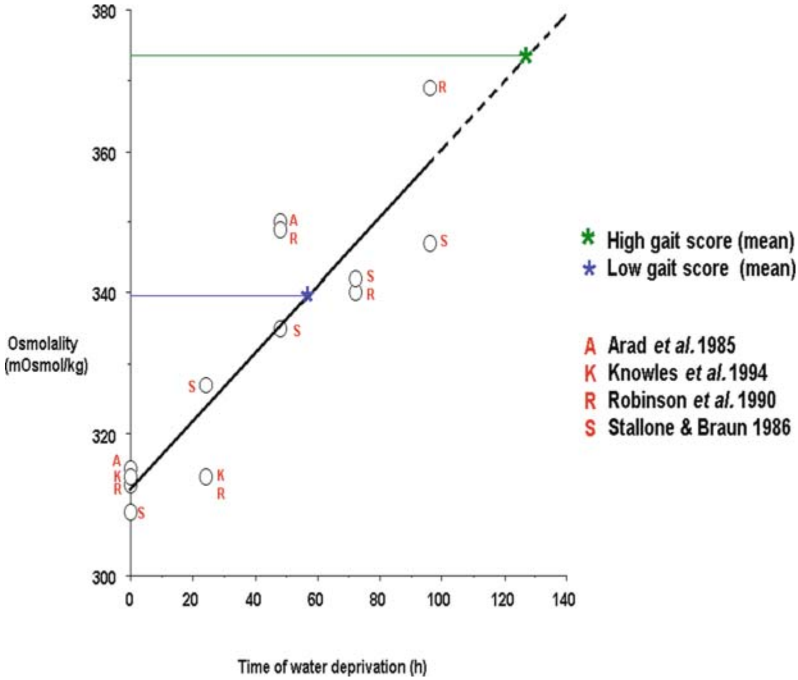

Fig. 8.4 The effect of time of dehydration on plasma osmolality in domestic fowl. A best fit line x–y has been drawn for the data available from previous work (Arad et al., 1985; Knowles et al., 1994; Robinson et al., 1990; Stallone and Braun 1986).The mean plasma osmolality values for the high gait score (H) and low gait score (L) birds in this case study are also indicated, as are error bars for the standard error of the mean

Butterworth et al. (2002) who associated chronic dehydration with severe lameness (see Fig. 8.4).

There is increasing evidence that broilers in high gait score categories, many of which will be in the acute stages of bacterial chondonecrosis (BCN), are in pain (Duncan et al., 1991; Gentle and Thorp, 1994; Thorp, 1996; Danbury et al., 1997; Pickup et al., 1997; McGeown et al., 1999; Danbury et al., 2000). Osteomyelitis in human beings is recognised to be a painful and debilitating condition (Whalen et al., 1988), and chickens have been used as an experimental model of haematogenous osteomyelitis in human beings (Emslie et al., 1983). Thus we propose that BCN and osteomyelitis should be considered to have a substantial adverse welfare impact on affected birds.

8.5 Injuries and Disease Associated with Poor Husbandry

8.5.1 General

All forms of disease may be associated with poor stockmanship, but more widespread is the inadequate provision of quantity rather than quality of care. It is important to identify sick birds swiftly. Removal of diseased animals promptly is likely to reduce the spread of any infectious disease throughout a flock. Diseased birds are exhibiting poor welfare through distress and pain, and should be treated or culled without delay. However, in the majority of modern, intensive, production systems this is virtually impossible to achieve owing to the thousands of birds under each person's care.

On a typical site there could be a total of 160 thousand broilers in several houses, but only 2 stock-people. If each bird were to be visually examined daily, then even if both people spent 8 h, this would allow only 0.28 s per bird. In reality there are many other tasks to fill the working day and so sick birds get overlooked, especially in systems such as multi-tier cages for layers where it is physically very difficult to actually see into every cage. The potential for poor welfare is built into such systems where the number of human carers is dictated by economic rather than animal welfare considerations. In the EC, future legislation may force an improvement: the current proposals for a new broiler welfare directive indicate that all birds should be inspected twice daily from a distance of less than 3 m.

8.5.2 Bone Breaks

These are a major cause of poor welfare in laying hens and a concern during their handling. The number of freshly broken bones found in live birds prior to slaughter and the number of old healed breaks found at slaughter are unacceptably high (Knowles and Wilkins, 1998). The bones of most layers, especially those housed in cages, are weakened by osteoporosis which increases their susceptibility to breaks.

Birds from more extensive laying systems often have stronger bones (Gregory et al., 1991; Fleming et al., 1994) and suffer fewer breaks during depopulation, but they can have a greater prevalence of old healed breaks. For example, Gregory and Wilkins (1996) reported a rate of healed bone fractures of 23% at 72 weeks in one study. The old breaks may occur as a result of collisions due to poor design within these housing systems. The number of breaks occurring just prior to slaughter can be reduced by increasing bone strength, and by handling birds with more care. For example, Gregory et al. (1993) found the incidence of broken bones in end-of-lay hens removed by two legs from cages was less than half that in birds removed by one leg. The numbers of breaks occurring during lay can be reduced by better design of housing systems and the physical environment within them.

8.5.3 Bumble Foot

This condition is essentially an acute infection of the soft tissues (pad) underneath the foot and arises from minor skin abrasions that enable the entry of bacteria such as *Staphylococci* spp. The body's immune response produces considerable amounts of pus and often inflammation, which may be accompanied by pain. Because of the relatively poor circulation of the foot, the condition tends to persist for weeks. If treated individually by lancing and cleaning the foot or antibiotic therapy, bumble foot can be cured. This is seldom done on modern large production units to the detriment of bird welfare. Affected birds find it difficult to walk and they may approach feed and water less and thus have reduced production. Prevention lies in separating the bird from its faeces (as in conventional wire battery cages) or, preferably, in housing on a clean soft substrate. The condition is increasing in prevalence as cages modified by perches and alternative laying systems become more common (Tauson and Abrahamsson, 1994).

8.5.4 Foot Pad Dermatitis and Hockburn

The type of litter substrate and its moisture levels and ammonia content affect the incidence of these skin lesions which are a form of contact dermatitis. Su et al. (2000) found lower incidences of foot burn and of lameness on wood shavings compared with chopped straw. Tucker and Walker (1992) also reported reduced hockburn on drier, friable litter.

8.5.5 Respiratory and Eye Conditions Associated with Aerial Pollutants

In general, intensive poultry housing has the largest concentration of aerial pollutants of all farm animal housing, with inhalable dust concentrations of up to 10 mg per m^3 and respirable dust (particles small enough to enter the lungs) of 1.2 mg per m^3 (Hartung, 1998). This survey also found concentrations of endotoxins in laying hen housing up to 860 ng per m^3 of inspirable dust. Overall mean inhalable and respirable dust concentrations in a different survey were 3.60 and 0.45 mg per m^3 in poultry buildings, with the high concentrations in broiler houses and in percheries for laying hens giving particular concern for both stockmen and animal health and performance (Takai et al., 1998). Dust concentrations are higher where litter is present.

Ammonia concentrations may vary over time and location within a house as well as between houses. Typical European mean values are 21 ppm in broiler houses and 3 ppm in cage layer houses (Seedorf and Hartung, 1999). Exposure to ammonia may reduce poultry welfare by causing irritation to mucous membranes in the eyes and respiratory system, increasing susceptibility to respiratory disease and reducing productivity (Kristensen and Wathes, 2000). At concentrations above 60–70 ppm, ammonia causes irritation of mucous membranes and of the respiratory tissues resulting in keratoconjunctivitis, tracheitis and oedema in the upper airway, and damage to the cilia in the trachea. High levels of ammonia also seem to depress the birds' appetite (Jones and Roper, 1997). At low concentrations it is likely that ammonia contributes to the severity of respiratory disease caused, for example, by Infectious Bronchitis (IB), or Mycoplasma infection.

Many viral, bacterial, fungal and parasitic disease organisms rely on aerial transmission to other birds and human beings. Steps should be taken to reduce shedding, spreading and concentrations in the air. For example, the risk of contamination by Salmonella may be reduced where air flow rates over litter or manure deposits exceed 15.6 m per minute (Mallinson et al., 2000).

The use of formalin vapour to control aerosol pathogens within the hatching chambers in broiler and pullet hatcheries has welfare benefit in terms of reduced incidence of yolk sac infection, usually caused by *E. coli* infection during the first days of life, but the highly irritant formalin vapour environment into which the chicks hatch is likely to have an impact on the birds in terms of upper respiratory and ocular irritation during the hatching period.

8.6 Infectious Diseases

Whilst it is tempting to give high priority to the "big gun" diseases in poultry, it is the low level, chronic conditions that have the most insidious impact on global poultry welfare because these conditions are often sporadic, they are hard to resolve, and there may not be strong economic pressure to resolve them. But, for the individual bird, of which there are estimated to be approximately 40 billion meat birds each year, and 5 billion layers at any given time, the combined impact of these conditions is very great. For this reason, the following summary of selected infectious diseases includes some which would not normally be considered as "big guns", but by their common, low level nature, are likely to have substantial impact on global poultry welfare.

8.6.1 Parasitic Diseases

Through evolution, the majority of birds reached a state of equilibrium with parasites that caused tolerable debility, but rarely severe disease. The extremely rapid intensification of the industry during the last half century has disrupted this balance in favour of the parasites and at the potential disadvantage of their bird hosts. Antihelmintics provided a short term solution, but concerns for human health, and resistance of parasites to the drugs is forcing new strategies for controlling disease. Parasitism tends to be worse in free-range and large group floor housing systems that otherwise have many potential welfare benefits. Since morbidity and mortality can reach unacceptably high levels, solutions need to be found. This is likely to be a key area of concern for the welfare of poultry in many alternative systems of husbandry.

8.6.1.1 Coccidiosis

Coccidiosis is a significant poultry disease found universally in chicken, turkeys, ducks and game birds worldwide. Species of the protozoan parasites *Eimeria* and *Tyzzeri,* which cause coccidiosis are often very host specific, and site specific within each host. The disease is variable in its severity, but may result in frank enteric disease, due to damage to duodenum, caecum or rectum, with diarrhoea, which may result in increased mortality, depression and anaemia. Alternatively, the disease may not present any clinical signs, but show as poor growth. Because coccidia produce resistant oocysts, which can persist in the environment for long periods, coccidiosis is very difficult to eliminate from intensively farmed poultry, and control relies on vaccination, or use of scrolling generations of antiparasitic drugs which become ineffective as the parasite develops resistance. The welfare impact of coccidiosis on poultry is substantial because the potential for enteric disease or poor thrift is universal. The need for vaccination and use of coccidiostats in intensive systems ties animal health to the ability of the pharmaceutical industry to keep one step ahead (or at least keep pace) with the malleable resistance of the parasite.

8.6.1.2 Arthropod Ectoparasites

The developments in housing, and the increasing size of flocks have led to changes in the relative importance of different ectoparasites, and some previously uncommon parasites have become common, whereas some previously problematic conditions have almost disappeared. For example, the Red Mite (chicken mite) does not as readily infest layers in metal cage systems because of the absence of wood, roosts and static litter. Many arthropod parasite lifecycles are stopped by the short production cycles seen in broiler chicken, or by repeated house disinfection and cleaning. However, in systems which take the birds to greater ages, or which cannot easily be cleaned (free range, wooden houses), then arthropod parasites can become a very significant cause of disability in the birds. Intensively farmed poultry are affected by Lice (especially caged layers), Red Mite (broiler breeders and free range units), Northern Fowl Mite (turkeys and broiler breeders) and Scaly Leg Mites (older birds) along with fleas, ticks and flies. Lice and mites cause irritation, feather loss, and skin damage. In systems where there are parasite challenges and dustbathing is not possible, it might be assumed that prevention of this normal behaviour which can decrease the burden of parasites, reduces welfare.

8.6.2 Chronic Diseases

8.6.2.1 Cellulitis

Localised skin infection in poultry is common. In broilers, breast blisters and cellulitis result from breaks in the skin and subsequent colonisation by opportunistic bacteria such as *E. coli* or *Staphylococci* spp.. *E. coli* cellulitis may secondarily cause subcutaneous and cutaneous skin infection with inflammation and oedema, particularly in the thigh and lower abdomen (Randall et al., 1984; Peighambari et al., 1995a; Onderka et al., 1997). In welfare terms, the likely impact of these skin conditions can be assessed by evidence provided by, for example, reports from slaughterhouse meat inspection (Yogaratnam, 1995).

8.6.2.2 Egg Peritonitis

This can be an important cause of sporadic death and poor welfare through disease in layers and breeding birds. Impacted egg material, or material from the oviduct may enter the peritoneal cavity, eventually causing localised abscesses, salpingitis and peritonitis. The cause appears to be a combination of hormonal effects and bacterial infection within the peritoneal cavity.

8.6.2.3 Mycoplasmosis

Mycoplasmas, most notably *M. gallisepticum* and to a lesser extent *M. synoviae,* cause significant respiratory disease in broilers and "egg drop" in broiler breeders or hens when the bird is subject to simultaneous infection or immunosuppression with infectious bronchitis (IB) or infectious bursal disease (IBD) (Jordan, 1996). Uncomplicated infections may cause no clinical signs or mortality, but it would appear that at the present time, Mycoplasmae are becoming a more significant cause of welfare insult through respiratory disease and lameness in intensively farmed birds of over 45 days of age.

8.6.2.4 Pendulous Crop

In chickens, the formation of an over-large, fluid-filled crop leads to poor growth and chronic ill thrift. Small birds will be culled on farm, or may suffer problems at slaughter as a result of the setting up of the stunning equipment for bigger birds. This common but sporadic problem appears to have a genetic component. Feed type, whole grain feeding, litter type and previous exposure to disease also have a role to play in development of pendulous crop.

8.6.3 Contagious Diseases

8.6.3.1 Avian Influenza Viruses (Fowl Plague)

These viruses are a cause of intermittent serious disease, with the potential for high morbidity and mortality in intensively reared poultry. Influenza A (H5N1) virus is a highly pathogenic and contagious influenza virus affecting birds. The first outbreaks of H5N1 occurred in Cambodia, China, Indonesia, Thailand and Vietnam in 2003, and 100 million birds were destroyed in order to control the outbreak. Highly pathogenic H5N1 is now found in a number of European countries, and low pathogenicity varieties are found in wild bird populations in North America. The general trend has been for improved control through vaccination and biosecurity in farmed birds – with a reduction in the number of outbreaks, but a gradual increase in the pathogenicity in wild birds. The number of human cases of Avian Influenza is 433 cases (262 deaths) to June 2009 (WHO 2009).

For an individual bird which becomes infected, the disease has severe and profound consequences with depression, coughing, respiratory distress, nasal and ocular discharge, a swollen face, diarrhoea and finally, paralysis and death in up to 80% of cases where compulsory slaughter has not intervened. From a welfare perspective, along with the direct effects of disease, a significant welfare "threat" to farmed birds is the potential for poorly controlled destruction of birds. In a disease outbreak situation it is possible for the normal standards of handling and humane slaughter to be overwhelmed by the sense of "urgency" to protect people and other farmed birds. Recent video and news footage shows very poor regard to care and humane treatment for the birds in the culling area. Whilst it is clear that robust disease control measures are important in preventing the uncontrolled spread on AI, it should not be forgotten that a measure of "humanity" is how we treat animals in time of "crisis" – and the evidence provided by the response in some countries has not been encouraging in this respect.

8.6.3.2 Chicken Anaemia Virus

Chicken anaemia virus (CAV) is a common worldwide infectious disease of chickens caused by a Circovirus. If breeder birds are exposed to CAV before they come into lay, the disease is sub-clinical, but, if they are exposed when they first come into lay, the virus, transmitted via the egg, leads to destruction of the bone marrow and the thymus, spleen and bursa of Fabricius in their offspring. Young birds show signs of this immune depletion from about 10 days of age, and mortality is usually around 10%, but can be up to 60%. Infected bird show haemorrhages under the skin and in the muscles, and gangrenous dermatitis may occur.

Because of the anaemia and immunosuppression which results from lymphoid tissue damage, birds which recover are more susceptible to concurrent or secondary disease.

8.6.3.3 Gumboro Disease

Gumboro disease (Infectious Bursal Disease, IBD) is a highly infectious global disease that affects young chickens, including layer and breeder stock, turkeys and ducks, usually before the age of six weeks. Strains of the IBD virus (IBDV, genus *Birnavirus*), which vary from continent to continent, affect B lymphocytes and macrophages in the focal lymphoid tissue, particularly in the bursa of Fabricius (BF), tonsils and spleen. Some genotypes and strains of bird appear to be less susceptible (e.g. White Leghorn), as do older birds in which lymphoid tissue has become involuted. Birds shed the virus in their faeces, and, because of the resistant nature of the IBD virus, it is readily mechanically transmitted between farms.

Damage to lymphoid tissue by the virus in early life reduces the birds resistance to concurrent or secondary disease challenges, and may also affect the birds ability to mount effective responses to vaccines for diseases such as Marek's disease, Newcastle disease, IB and coccidiosis. In acute disease, birds become rapidly depressed, inactive, sitting with ruffled feathers, trembling, anorexic, dehydrated and soiled by watery diarrhoea. Vent pecking may become common for a period. Initial (acute) morbidity can be up to 100%, but in many cases infection may be subclinical, and "worse case" mortality is usually less than 20%. Even if the initial challenge does not produce clinical disease, the bird is subsequently permanently immunosuppressed, and this is the major animal welfare and economic impact of the disease.

Vaccination, including that of parent stock to provide maternally derived antibody, has reduced the impact of Gumboro disease worldwide, but strain variation makes complete protection complex. The immunosuppression resulting from Gumboro infection contributes to many cases of respiratory and enteric disease in chickens. The effect of Gumboro disease on the global population of (particularly) broiler chickens, cannot be overstated, as IBD has a significant impact on bird susceptibility to other disease organisms, including gut parasites.

8.6.3.4 Infectious Bronchitis

Infectious bronchitis (IB) is a highly infectious viral disease caused by the infectious bronchitis coronavirus (IBV). IB affects layers and broilers to cause initial respiratory distress, sneezing, gasping, facial swelling, and malaise and retarded growth with low mortality, but high morbidity. If the birds are infected at between 3 and 6 weeks of age, the infection may additionally damage renal tissues causing depression and mortality of up to 30%. However, in some outbreaks the initial disease can be asymptomatic, but in laying birds, damage to the oviduct results in reduced egg production, or can cause "blind" layers – where the egg is passed into the body cavity due to damage to the oviduct. IB is controlled to a large extent by aerosol and water vaccination (*see section on Vaccination below*).

8.6.3.5 *Marek's Disease*

Marek's disease, caused by avian herpes viruses, commonly affects birds from 6 weeks or more. Six sub-classifications of Marek's disease have been suggested, although the disease may take a form which presents a mixture of the following forms (Herenda and Franco, 1996);

(a) Per-acute, manifested by sudden death.
(b) Anaemia, in 3–6 week old chickens.
(c) A "classical" presentation with thickening of peripheral nerves and subsequent nerve damage, resulting in progressive spastic paralysis of the legs and wings, sometimes with torticollis (head and neck twisting) and sometimes with respiratory distress. Lymphomatous tumours appear in the skin, gut, eye, ovary, lungs, heart and liver. Total mortality in the "classical" form is usually less than 15%, with a low incidence at any one time, and disease appearing over many months.
(d) Acute disease, in birds of 6–12 weeks of age and characterised by sudden death or lymphomatous tumours in the gut, spleen, kidneys, brain and spinal cord.
(e) Skin leucosis is the most common form of Marek's disease seen in meat producing birds, in which multiple skin tumours are seen. Birds at slaughter age may show this form as thickening and enlargement of the feather follicles.
(f) Transient paralysis in 12–18 week old pullets.
It is likely that a proportion of culls in commercial broiler flocks, especially those showing progressive leg paralysis or recumbency, and during the late part of the broiler growing cycle, are due to breakout of Marek's disease despite selection for resistance in breeder stock and vaccination.

8.6.3.6 Newcastle Disease

Newcastle disease is caused by an enveloped RNA virus, a *Paramyxovirus* (NDV). Over 200 species of birds are reported to be susceptible to NDV although some birds e.g. ducks and geese, show few clinical signs, even if infected with strains virulent for chickens. The history of NDV is marked by global panzootics in which disease spreads across the world, with the initial occurrence in all cases in the far or Middle East. It is suggested that NDV may spread over huge distances as an aerosol, although this has never been clearly demonstrated. Human and bird vectors are more likely to have been the disseminators of disease in all recent outbreaks. Racing pigeons are vaccinated against paramyxovirus 1, and exotic birds are quarantined to help prevent international spread. The NDV viruses are very persistent, surviving for several weeks at low ambient temperatures (Alexander et al., 1998). Vaccination is the cornerstone of protection from NDV for intensive poultry production, and in terms of animal welfare, NDV provides a good example of vaccination as a valuable tool in protecting animal welfare. Some people might argue that it is the intensive nature of poultry production that creates the potential international movement of the NDV, and creates the conditions in which huge numbers of birds are "at risk" within the same airspace or on the same site. The welfare of birds which become infected with NDV is impacted either (a) by the disease itself or (b) by methods used to eradicate the disease on farm.

Welfare Impacts of Newcastle Disease

In the most virulent viral infection, the per-acute form, sudden death may be the presenting sign, but depression, lameness, diarrhoea with haemorrhagic lesions in the gut, particularly the proventriculus, swelling of the head and neurological signs may precede death and mortality can be up to 100%. In the moderately virulent form, severe respiratory disease with inflammation of the trachea and haemorrhages in the lung, beak gaping, coughing, sneezing, gurgling and rattling, yellowish-green diarrhoea and nervous signs occur, and mortality may be 50%. In laying hens, diarrhoea and pronounced egg drop (reduced egg production) occurs. In the low virulence presentation, mild respiratory distress occurs in chickens and turkeys, but if other diseases are present at this time, the "severity" of the NDV will be increased. The welfare impact of NDV is profound for the affected bird or flock. Serious disease of this nature prevents feeding, drinking and activity, and because of the numbers of birds affected in virulent outbreaks, stockman "care" is not feasible.

Welfare Impacts of Eradication Methods

Newcastle disease and Avian Influenza represent serious disease in commercial poultry, and in most countries, an outbreak is subject to vigorous culling to reduce the risk of transmission (e.g. 92/66/EEC). It is the practical difficulties of implementing humane on-farm compulsory destruction of birds that creates potential welfare problems. In the UK (Animal Health Act 1981, Diseases of Poultry Order 1994), and under similar legislation in many countries worldwide, diseased and "at risk" birds are compulsorily killed by gassing, neck dislocation or poisoning. The logistical problems of killing birds on-farm in a humane manner are huge. Manual killing of large numbers of birds is exhausting for the operatives, and is likely to lead to poor control of welfare at killing. Pneumatically operated mechanical stun/kill guns have recently been developed that may reduce these difficulties (www.awtraining.co.uk). It has been proposed in a number of countries that mobile stunning and slaughter lines could provide emergency capability to kill large numbers of broilers, layers or turkeys on farm in the event of NDV, but as yet, no such capability exists.

8.6.3.7 Oncogenic Viruses

Birds appear to be unusually susceptible to oncogenic disease, and, particularly in systems which raise birds to maturity, tumours may become a significant cause of morbidity and mortality. Reticuloendotheliosis viruses, chick syncytial virus, spleen necrosis virus and duck infectious anaemia are examples of oncogenic (cancer causing) viruses which may cause tumour formation by inducing the *myc* oncogene.

8.6.3.8 Salmonella

To date, there are nearly 2,500 serovars of *Salmonella* described, but in commercial broilers, *S. enteritidis* and *S. typhimurium* dominate. Individual Salmonella serotypes fluctuate in significance, with fluctuations in the relative importance of phage types 4, 7, 6, 8, 13A, 29, and 34 in recent years. Salmonellosis usually affects young birds of less than 1 month of age. The morbidity rate for Salmonella infections is very variable, and mortality is usually low, at less than 20%. Birds affected by Salmonella may become depressed, inactive, with visual impairment and pasting of faeces around the vent. If broilers are affected before 4 weeks of age, there is often significant variation in the weight of birds by slaughter age. This size variation can result in welfare problems through differences in ability to reach drinkers, and some birds may be inadequately stunned as a result of difficulties in adjustment of automated electrical stunning and neck cutting machinery to suit flocks containing a wide range of bird sizes.

8.6.4 Fungal Toxins

Mycotoxins, are complex chemicals produced by fungi and moulds which can cause problems of toxicity in commercial poultry if spoiled grain is fed. Trichothecenes (*Fusarium, Stachybotrys*) can cause immunosuppression, anaemia, defects in feather and skin growth and reduced growth, lethargy, paralysis and seizures (Bermudez et al., 1997). Aflatoxin (*Aspergillus*) can cause suppression of growth and haemorrhage into the skin and muscles, bruising, reduced sperm count in breeder birds, and immunosuppression, resulting in increased susceptibility to secondary infections. Young birds and ducks are particularly sensitive to ochratoxin, usually produced by *Penicillium veridicatum* mould, and may show depression, dehydration and renal failure (Wu et al., 1993, 1991). Infection of vertebral bone with *Aspergillus fumigatus,* most probably via the thoracic air sacs may cause spinal cord compression and paraplegia in chickens (Thorp, 1998).

8.7 Prophylaxis

Clearly the majority of husbandry, nutrition, environment or genetic interventions that have the aim of improving poultry welfare may also benefit the expression of disease. As well as those suggested in other chapters, of which the provision of a good balanced diet that includes adequate vitamins, mineral and trace elements, clean fresh water and air and plenty of space for exercise are the most vital, some other measures are given below.

8.7.1 Vaccination

Vaccination is a very important disease control tool in almost all commercial poultry production systems. This is because the breeding, hatching, transport and growing of birds in large groups, and their exposure to environmentally derived and endogenous disease, particularly viral conditions, is a very significant threat to the health and productivity of poultry. Some people view the large scale use of multiple vaccines for poultry as evidence of an industry which needs technical "props" to maintain animal health in the face of difficulties in maintaining biosecurity, challenge by wild bird derived or environmental infection, and control of endogenous disease, whilst others see control of a number of poultry diseases as a victory for technological advances. A pragmatic view is that the benefits to the individual bird in terms of avoidance of disease balances the fact that prevalent production methods make vaccination virtually essential to control diseases. Examples of common vaccination programmes are shown in Table 8.1. Poultry diseases for which there are widely used vaccines are shown in Table 8.2.

Table 8.1 Examples of common vaccination programmes for broilers

Age	Vaccine	How administered
Day 1 When sexed/sorted at hatchery	Infectious Bronchitis IB + (sometimes) Newcastle Disease ND	Aerosol (Sometimes by injection)
Day 7–16	Infectious Bronchitis IB + Infectious Bursal Disease IBD	In drinking water
Day 14–21	Infectious Bursal Disease IBD	In drinking water

Table 8.2 Some poultry diseases for which there are vaccines available

Viral disease	Bacterial disease	Coccidia
Avian Encephalomyelitis	*Escherichia coli* (Airsac disease, septicaemia)	Paracox – *Eimeria* lines
Chicken anaemia	*Pasteurella and Erysipelothrix*	
Duck plague	*Salmonella enteritidis*	
Egg drop syndrome	*Mycoplasma gallisepticum*	
Infectious bursal disease		
Infectious bronchitis		
Newcastle disease		
Turkey Herpesvirus		
Reovirus		
Marek's disease		
Paramyxovirus		
Turkey rhinotracheitis		

8.7.2 Probiotics

In his recent review of probiotics in broiler production, Ghadban (2002) defines probiotics as "biological products, which stimulate the immune system and increase its defensive activity against pathogenic bacteria". Whereas research may be driven to solve problems of food-borne pathogens for humans, such as Salmonella, feeding probiotics may improve the health and welfare of the birds. The intended mode of action of microrganisms used as probiotics is competitive exclusion of pathogenic and toxicogenic organisms in the intestines of fowl and they must therefore be robust enough to survive the digestive processes of the crop and gizzard. Widespread use of probiotics may be limited in the future because of safety concerns about the large quantities of industrially produced cultures that can also be distributed into the environment (Reuter, 2001).

8.7.3 Antibiotics

8.7.3.1 Growth Promoters

The routine use of antibiotics in feed as growth promoting agents is now recognised as bad practice from two perspectives. It has led to bacteria developing resistance, thus limiting the choice and efficacy of therapeutic antibiotics in both veterinary and human medicine. Second, it can mask the effects of relatively poor diets, environments and husbandry. Thus many countries, particularly in Europe are banning their use, so that producers will need to promote good bird health via the fundamentally more sound and sustainable approaches of a diet that promotes good digestion and a healthy balance of intestinal flora (Bedford, 2000), and management techniques that include improved biosecurity.

8.7.3.2 Therapeutics

Undoubtedly the use of antibiotics to treat infectious diseases caused by bacteria has reduced the suffering and improved the quality of life of millions of birds. However, they tend to be used on a flock basis when the proportion of birds that are sick is high enough to justify the cost of mass medication. Before this point and if it is not reached, sick birds suffer from lack of treatment. Beyond it; some healthy birds are treated unnecessarily, which has implications for increasing the antibiotic resistance of bacteria and for environmental pollution. There are therefore sound reasons, not least for the welfare of individual birds, for therapeutic agents to be used on individuals within a husbandry system that promotes good health through other measures.

8.7.4 Anti-coccidials

The welfare impact of Coccidiosis can be very significant (see section on the disease) and, for the individual bird, effective prevention or adequate control can be seen as a valuable contribution to the wellbeing of the animal. Infection with *Eimeria spp.* results in a strong immune response in the fowl. When numbers of parasites in the environment are low, there is seldom a health and welfare problem for the birds. However modern, intensively stocked floor-rearing systems, especially of breeders, results in such a high challenge that Coccidiosis frequently ensues. Coccidiosis is controllable by three possible artificial mechanisms, vaccination, removal from the body using cocccidiocides, or reduction of the worst effects of Coccidiosis by use of pharmaceutical products called coccidiostats which inhibit the parasite. Vaccination is a comparatively recent method for coccidian control, with live attenuated precocious oocysts from a range of *Eimeria* lines being given orally. Coccidiocides are used in pigeons, and occasionally in small groups of poultry to attempt elimination of coccidia, but by far the most common method for control of Coccidiosis worldwide at present is the use of coccidiostats. A number of compounds have coccidiostatic properties including, inonophores, quinolone antibiotics, nitrobenzamides, carbanilide, and the sulphonamide antibiotics. Over time, the efficacy of many coccidiostats has reduced as coccidial resistance has developed. The cost of these agents, and the changes in sensitivity of the coccidian to the agents means that control of Coccidiosis relies on a combination of management (hygiene, site depopulation and cleaning), treatment with coccidiostats, selection for birds with reduced susceptibility to Coccidiosis and vaccination.

The use of coccidostat drugs to control the disease has two main disadvantages: the need for a withdrawal period before both meat and eggs can be used for human consumption and the increasing resistance of the parasite to drugs. Thus more use is being made of live vaccines to the oocyst (infective) stage of the parasite's life cycle in order to promote immunity before the bird is exposed to a high challenge of parasites. Such vaccines are usually accepted for organic production. While they can replace the use of coccidiostat drugs in feed, many authorities recommend an integrated approach where both are used (Chapman, 2000). It is hoped that this will combat the increasing resistance to coccidiostats of the parasites. Other approaches to improving the efficacy of coccidiostats, such as the use of betaine, which helps to preserve the integrity of the intestines and to reduce lesions, are being explored (Bedford, 2000). Traditional techniques for limiting the build-up of parasite numbers, such as pasture rotation and low stocking densities should not be overlooked.

8.7.5 Disinfection and Biosecurity

Biosecurity is particularly important in large units because so many birds can be affected. The aim is to minimise the chance of any potential disease-causing organism from gaining entry to the house. Clearly predators, rodents, snakes, pets and wild birds should be physically excluded from even small poultry units. Measures such as electric fencing, and roofs over feeders can reduce faecal contamination or direct contact from other species in outdoor units. It is usually impossible to completely exclude micro-organisms, but an all-in all-out policy for a whole site is often adopted, allowing a period for thorough cleansing and then disinfection of housing with minimal potential for re-infection. Fumigation is generally needed to kill red mite and similar ectoparasites or fungi.

Simple biosecurity measures, such as twice-weekly replenishment of boot dips and water sanitisation, reduced the risk of Campylobacter infection of broilers by 50% (Gibbens et al., 2001). More stringent precautions would include sterilising feed, water and litter, filtering air, having personnel shower and change before entry and wearing of complete protective clothing. The presence of a hygiene barrier was found to be the most important biosecurity measure for the production of campylobacter-free broilers in a Danish survey of 88 broiler flocks (Hald et al., 2000). Delivery vehicles may be excluded from the farm premises and other essential vehicles can be washed and disinfected on arrival and departure. Records should be kept of all visitors, and the usual requirement is a declaration that they have not been in other poultry units within a week nor be suffering from any infectious disease. It is clearly important that live bird transport containers and vehicles be thoroughly cleaned between batches and farms.

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Chapter 9
Managing Poultry: Human–Bird Interactions and Their Implications

Paul Hemsworth and Grahame Coleman

9.1 Introduction

Human–animal interactions are a common feature of modern intensive livestock systems and these interactions may have marked effects on animal productivity and welfare. Research, particularly in the dairy and pig industries, has shown that the interactions between stockpeople and their animals can limit the productivity and welfare of livestock (Hemsworth and Coleman, 1998). Many of these interactions are routinely and, at times, habitually used by stockpeople. While these interactions may appear harmless to the animals, this research has shown that the frequent use of some of these routine behaviours by stockpeople can result in farm animals becoming highly fearful of humans. It is these high fear levels, through stress, that appear to limit animal productivity and welfare (Hemsworth and Coleman, 1998). For instance, training stockpeople to improve these interactions, results in reductions in fear and improvements in the productivity of commercial dairy cows and pigs (Coleman et al., 1999; Hemsworth et al., 1994a, 2002). These human–animal interactions may also influence a number of job-related variables and thus the work performance of the stockperson. For example, if the stockperson's attitude towards interacting with animals is poor and, in conjunction with the consequent effects that this may have on, for example, ease of handling, job satisfaction may deteriorate leading to adverse consequences for work motivation and, in turn, work performance (Hemsworth and Coleman, 1998). Less extensive research has been conducted on human–animal interactions in the poultry industries, but this research has generally supported the results of research on human–animal interactions in the dairy and pig industries (Hemsworth and Coleman, 1998).

The effect of human–animal interactions on livestock, including poultry, has generally been neglected in the past. This lack of interest was presumably due to industry personnel and animal scientists considering that either the frequency of

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these interactions were low enough to render negligible the effects of any negative interactions on the animals or that the type of interactions were harmless to the animals. However research in the 1980s and 1990s, such as that described above, has increased the interest in, and awareness of, the role of the stockperson on the productivity and welfare of farm animals. The aim of this chapter is to review some of the most recent research on human–animal interactions to demonstrate firstly their implications for poultry welfare and secondly the opportunities to reduce the adverse impact of these interactions on the animals. Where available the results on poultry will be used to demonstrate the implications of this topic, but because of considerable gaps in our knowledge on poultry, the results from other livestock industries such as the dairy and pig industries will be utilised. These weaknesses in our understanding of human–animal interactions in poultry production will also be highlighted to assist in directing future research.

Before analyzing the various ways in which human–animal interactions can affect welfare, it is necessary to consider how welfare is assessed. The assessment of welfare is a controversial subject. Variations in definitions of animal welfare, combined with variations in methodology and in turn interpretation, lead to disagreement (Hemsworth and Coleman, 1998). In considering the welfare of poultry, the following definition of Broom (1986) is favoured, "the welfare of an individual is its state as regards its attempts to cope". In this definition, the "state as regards its attempts to cope" refers to both how much has to be done by the animal in order to cope with the environment and the extent to which the animal's coping attempts are succeeding. Attempts to cope include the functioning of body repair systems, immunological defences, physiological stress response and a variety of behavioural responses, while the success of these coping attempts is likely to be reflected in biological costs to the animal, such as adverse effects on the animal's ability to grow, reproduce and remain healthy. Therefore, using such a definition, the risks to the welfare of an animal by an environmental challenge can be assessed at two levels: firstly, the magnitude of the behavioural and physiological responses and secondly, the biological cost of these responses (Barnett and Hutson, 1987; Broom and Johnson, 1993; Hemsworth and Coleman, 1998).

Fear is generally considered an undesirable emotional state of suffering in both humans and animals (Jones and Waddington, 1992) and one of the recommendations proposed by the UK Farm Animal Welfare Council in 1993 was that animals should be free from fear. In situations where human contact is aversive to animals, the threat to the welfare of these fearful animals arises because of injuries that they may sustain in trying to avoid humans during routine inspections and handling, the evidence that these animals are likely to experience a chronic stress response, and finally, the effects of this chronic stress response on immunosuppression (Hemsworth and Coleman, 1998), which in turn may have serious consequences for the health of the animals. Furthermore, if the stockperson's attitude towards the animal is careless or malevolent, the stockperson's commitment to the surveillance of and the attendance to welfare (and production) problems facing the animal may deteriorate. Therefore, the attitudinal and behavioural profiles of the stockperson may have marked effects on animal welfare via fear of humans by the animal and via work performance of the stockperson. This chapter will examine the role of these human–animal interactions on the welfare of commercial poultry.

9.2 Effects of Human Behaviour on the Fear Response of Poultry to Human Beings

There is substantial between-farm variation in the avoidance response of meat chickens to humans (Hemsworth and Coleman, 1998). This variation may be typical of the variation in the fear response to humans in other poultry systems and may, therefore indicate an opportunity to reduce the fear response of commercial poultry to humans.

The bird's response to a stockperson in an intensive livestock system may have components of both stimulus specific fear and general fear. While the initial response of a naive bird to humans may involve a response to novelty or unfamiliarity (i.e. general fearfulness), with subsequent experience of humans, there is the development of a specific response to humans (Hemsworth and Coleman, 1998). This initial response to humans may be similar to the bird's response to an unfamiliar object or to unfamiliar animals of another species. Furthermore, as suggested by Suarez and Gallup (1982), the predominant response of naïve domestic poultry to humans may be a response to a predator. As recognised by Duncan (1990), the original relationship between humans and the ancestors of domestic poultry was a predator–prey relationship and, as shown by Desforges and Wood-Gush (1975), domestication has reduced but not eliminated the magnitude of the bird's initial fear response to humans.

As a consequence of the amount and nature of interactions with humans, commercial poultry are likely to develop a stimulus-specific response to humans. Murphy and Duncan (1977, 1978) studied two lines of chickens, termed "flighty" and "docile" on the basis of their behavioural responses to humans, and found that early handling affected the behavioural responses of these two lines of birds to humans, with the docile birds showing a more rapid reduction in their withdrawal responses to humans with regular exposure to humans than the flighty birds. These line differences may be stimulus-specific since observations indicated that the docile birds did not necessarily show less withdrawal responses to novel stimuli, such as a mechanical scraper and an inflating balloon, than the flighty birds (Murphy, 1976). Jones et al. (1991) and Jones and Waddington (1992) examined the effects of regular handling on the behavioural responses of quail and domestic chickens to novel stimuli (such as a blue light) and humans, and found that handling predominantly affected the responses of birds to humans, rather than to the novel stimuli. Handled birds showed reduced avoidance of humans but their responses to novel stimuli were unaffected. These data indicate that experience with humans results in stimulus-specific effects rather than effects on general fearfulness. There is considerable evidence from studies on other species to indicate the development of a stimulus-specific response of farm animals to humans as a consequence of experience. For example, many studies have shown that handling treatments varying in the nature but not in the amount of human contact, resulted in rapid changes in the level of fear of humans by pigs (for example, Gonyou et al., 1986; Hemsworth et al., 1981a, 1987).

Therefore, although there will be some influence of novelty on the response of experienced farm animals to humans, which will occur with changes in the stimulus property of humans such as changes in behaviour, clothing and location of interaction, a major component of this response is likely to be experientially determined. There is some evidence that the behavioural response of relatively naive young pigs to humans, which may be predominantly a result of general fearfulness, may be moderately heritable, however, subsequent experience with humans affects the behavioural responses to humans (Hemsworth et al., 1990); the behavioural response of young pigs, when they were relatively inexperienced with humans, was only moderately correlated with their behavioural response to humans in adulthood.

Studies have shown that chickens and laying hens are particularly sensitive to visual contact with humans. Regular treatments involving the experimenter placing his/her hand either on or in the chicken's cage and allowing birds to observe other birds being handled have been shown to result in reductions in the subsequent avoidance of humans shown by young chickens (Jones, 1993). Interestingly, visual contact without tactile contact was more effective in reducing fear than picking up and stroking the bird, suggesting that handling with stroking, while reducing fear, may contain aversive elements for birds such as restraint. Hemsworth et al. (1994b) examined the effects of regular close visual contact with humans on the fear responses of young chickens to humans. At 6 weeks of age, birds that received regular human contact showed less avoidance of an approaching experimenter and had lower corticosterone concentrations after handling than birds that had received minimal human contact. A handling study on adult laying hens by Barnett et al. (1994) also demonstrates similar effects of visual contact with humans on fear responses of birds to humans. Regular visual contact with humans, involving positive elements such as slow and deliberate movements by the experimenter, markedly reduced the subsequent avoidance behaviour of mature laying hens to humans in comparison to minimal human contact that at times contained elements of sudden and unexpected human contact. The birds that had received regular visual contact with humans also had lower corticosterone concentrations following handling than the birds that had only minimal human contact.

A number of studies on poultry have utilised handling treatments involving stroking and/or carrying birds, and these have generally been imposed on young chickens of both meat and egg-production strains. Although some of the tactile components of the handling treatments may have contained negative elements, such as restraint and stroking birds, many of these treatments resulted in birds displaying reduced avoidance of humans (Hughes and Black, 1976; Murphy and Duncan, 1978; Jones and Faure, 1981). Habituation of the bird's fear responses over time with repeated exposure to humans is likely to be responsible for these observed reductions in fear of humans. Hughes and Black (1976) and Murphy and Duncan (1977) found little or no effects on avoidance behaviour of birds to humans if handling was imposed on adult birds, while Barnett et al. (1994) found that increased human contact, predominantly involving visual contact, reduced the subsequent avoidance responses of adult laying hens.

Observations on stockpeople at meat chicken farms reveal that visual cues from the stockperson may regulate the fear responses of commercial birds to humans. The speed of movement of the stockperson was correlated with the avoidance responses of birds to an experimenter (Hemsworth et al., 1996b; Cransberg et al., 2000). Frequency of tapping by the stockperson on objects while moving through the shed was positively associated with the avoidance responses to an experimenter, but, surprisingly, frequency of waving by the stockperson to move birds in order to inspect them as the stockperson moved through the shed, was positively, not negatively, associated with avoidance by birds of the experimenter. These correlations indicate that birds were most fearful of humans at farms in which stockpeople moved quickly through the shed, frequently tapping on objects in the shed and infrequently waving as they moved through the shed. It is possible that waving by the stockperson, which intuitively appears to be fear-provoking, may be either rewarding or mildly fear-provoking resulting in rapid habituation of the fear responses to humans. Alternatively, the positive relationship with waving may simply reflect the fact that non-fearful birds are likely to remain close to the stockperson as he/she moves slowly through the shed, necessitating the use of waving to move birds from under the stockperson's feet. Furthermore, this distinct pattern may alert birds to the imminent approach of the stockperson and reduce the chances of unexpected exposure which in itself may be highly fear-provoking. In contrast, speed of movement appears to be highly fear-provoking and the tactile contact that accompanies high speed of movement by the stockperson and the corresponding avoidance responses (flight and vocalisation) by birds that receive tactile contact from the stockperson may exacerbate these fear responses throughout the flock.

Therefore, farm animals in situations in which they frequently interact with humans, may, through conditioning, associate humans with rewarding and punishing events that occur at the time of these interactions and thus conditioned fear responses to humans may develop. Furthermore, habituation may occur over time as the animal's fear of humans is gradually reduced by repeated exposure to humans in a neutral context; that is, the human's presence has neither rewarding nor punishing elements. Through observational learning, seeing other animals being handled regularly may result in reduction in fear responses (Jones, 1993; Beveridge, 1996). Since animals find increased complexity attractive, human contact may be rewarding for farm animals in environments that lack complexity (Jones, 1993). Poultry appear to be particularly sensitive to visual contact with humans, and indeed positive visual contact, such as slow and deliberate movement, may be more effective in reducing levels of fear of humans than human tactile contact. Relatively little is known of the negative visual interactions from humans that may elevate fear levels in poultry, however rapid speed of movement by humans and sudden and unexpected exposure to the humans may be fear-provoking.

9.3 Effects of the Behaviour of Humans on Poultry Welfare

As discussed earlier, fear is generally considered an undesirable emotional state of suffering and variation between farms in fear of humans appears to be considerable in the livestock industries. The implications of this variation in fear on the welfare of commercial poultry is demonstrated by the evidence from both industry and laboratory studies of the effects that fear of humans has, generally via stress, on the productivity of livestock and it is therefore useful to review this literature to appreciate the effects that human–animal interactions can impose on the welfare of intensively-managed livestock.

Research in the dairy and pig industries over the last 20 years has revealed significant interrelationships between the stockperson's attitudes and behaviour towards their animals and the fear and productivity of these farm animals. For example, observations in the Dutch and Australian industries have revealed significant negative correlations, based on farm averages, between fear of humans and the productivity of dairy cattle and pigs (Hemsworth et al., 1981b, 1989; Breuer et al., 2000). The results of this research have generally been supported by handling studies on pigs which have shown that high levels of fear of humans, through a chronic stress response, can limit the growth and reproduction of pigs (for example, Gonyou et al., 1986; Hemsworth et al., 1981a, 1986, 1987, 1996a; Hemsworth and Barnett, 1991). Similarly, studies on dairy cattle by Rushen et al. (1999) and Breuer (2000) indicate that negative handling can depress the milk yield of cows. The results of the former study implicate the secretion of catecholamines under the influence of the autonomic nervous system affecting milk letdown while Breuer et al. (2003) found evidence of a sustained elevation in plasma cortisol concentrations in negatively-handled heifers. There is also evidence of a positive relationship between fear of humans and milk cortisol concentrations in commercial dairy cows (Hemsworth et al., 2000). The catecholamines also have the general physiological effect of increasing metabolic rate, while the corticosteroids catabolise protein and thus both of these processes may have a detrimental effect on milk yield.

Less extensive research has been conducted on human–animal interactions in the poultry industries, but results from this research support those conducted in the dairy and pig industries. Studies on poultry generally indicate that handling treatments likely to increase the birds' fear of humans, may depress the growth performance of chickens. For example, in experiments with young chickens, Gross and Siegel (1979, 1980) found that birds that received brief human contact, of an apparent positive nature, had greater growth rates, feed conversion efficiency and antibody response to an antigen and were more resistant to *Mycoplasma gallisepticum* than birds that received minimal human contact. Furthermore, water deprivation resulted in higher feed conversion efficiency in the former group of birds (Gross and Siegel, 1980, 1982) and, while weight loss after fasting was not affected by handling, birds that had received brief positive human contact were more resistant to *Staphylococcus aureus* (Gross and Siegel, 1982). Gross and Siegel (1981) found that chickens that received regular positive human contact from an early age had improved feed conversion efficiency and were more resistant to *Escherichia coli* infection, than birds that either received minimal human contact or had been regularly scared. As reported earlier, Barnett et al. (1994) found that regular visual contact, involving positive elements such as slow and deliberate movements, which reduced the subsequent avoidance behaviour of adult laying hens, resulted in higher egg production than a treatment which involved minimal human contact. The authors speculated that the lower productivity of birds in the latter treatment may be a consequence of a chronic stress response since there was evidence of immunosuppression in these highly fearful birds.

Studies conducted on meat chickens and laying hens in the field have also shown that high levels of fear of humans may limit the productivity of commercial birds. Significant negative relationships, based on farm averages, were found between the level of fear of humans and the productivity of commercial meat chickens and laying hens. The egg production of laying hens at the farm was inversely related to the level of fear of humans by birds at the farm (Barnett et al., 1992) and the efficiency of feed conversion of meat chickens was inversely related to the level of fear of humans by birds at the farm (Hemsworth et al., 1994b, 1996b). For example, avoidance by meat chickens of an approaching experimenter accounted for 29% of the variation in feed conversion efficiency across 22 commercial farms (Hemsworth et al., 1994b). Similarly, in an experiment examining the effects of cage position on fear and egg production of laying hens, level of fear of an experimenter was significantly and negatively related to egg production and efficiency of feed conversion (Hemsworth and Barnett, 1989). In observations on the behavioural response of laying hens to an experimenter, Bredbacka (1988) reported that egg mass production was lower in hens that showed increased avoidance of humans.

Thus there is evidence that high fear levels may reduce growth in chickens and egg production in laying hens. The mechanisms responsible are unclear, but as seen in fearful cows and pigs, a chronic stress response or even a series of acute stress responses in the presence of humans may be responsible for the depressed productivity in fearful poultry. The catabolic effects of ACTH and corticosteroids are well known in many species, including poultry (Siegel and van Kampen, 1984; Elsasser et al., 2000), while it is widely agreed that corticiosteroids impair reproduction in many species (Clarke et al., 1992). Therefore, regular negative handling, with consequent elevations of plasma corticosterone concentrations, is likely to impair the productivity of commercial poultry. The fact that productivity is limited is indicative of the magnitude of the stress response in these fearful birds and thus raises welfare concerns.

9.4 Other Human Characteristics That May Affect Poultry

In addition to human behaviour, there are a number of other human characteristics that will affect both the welfare and productivity of livestock. These characteristics include technical skills and knowledge, job motivation and commitment, job satisfaction and personality (Hemsworth and Coleman, 1998), and it is useful to briefly review these characteristics here.

9.4.1 Technical Skills and Knowledge

Knowing and being skilled at the techniques that must be used to accomplish a task are clearly prerequisites to being able to perform that task. Thus these job-related characteristics will be the most limiting factors to job performance in situations where specific technical skills and knowledge are required to perform the tasks. While there are little data from agricultural industries, this basic premise is generally accepted (Hemsworth and Coleman, 1998).

Some of the key characteristics that stockpeople require to successfully care for and maintain their animals include a good general knowledge of the nutritional, climatic, social and health requirements of the animal, practical experience in the care and maintenance of the animal and ability to identify quickly any departures in the behaviour, health or performance of the animal and promptly provide or seek appropriate support to address these departures.

9.4.2 Job Motivation and Commitment

It is convenient to group these two together for the purpose of this review. They generally refer to the extent to which a person applies his or her skills and knowledge to the management of the animals under his or her care (e.g. how reliable, thorough, conscientious, etc. a person is). Factors such as job satisfaction, meaningfulness of work, utilisation of skills, etc. will affect work motivation and commitment. High job performance in any industry relies on a combination of motivation, technical knowledge and skills and an opportunity to perform the job and clearly low motivation will limit job performance regardless of technical skills and knowledge of the individual.

There are various theories on how work conditions may affect job satisfaction and work motivation (Hemsworth and Coleman, 1998). For example, motivation to perform the tasks will improve with rewards such as feelings of pride or accomplishment. In fact a hierarchy of needs may influence motivation, with esteem needs (recognition by others) and self-actualisation (self-fulfilment) motivating workers once physical, safety and social needs of the individual are met (Maslow, 1970).

9.4.3 Job Satisfaction

This factor is influential because of its direct effects on other job-related characteristics such as job motivation and commitment, motivation to learn new skills and knowledge and thus in turn, technical skills and knowledge, etc., and therefore its indirect effects on job performance (Hemsworth and Coleman, 1998). Job satisfaction refers to the extent to which a person reacts favourably or unfavourably to his or her work and is considered to derive from the extent to which a person's needs or expectations are being met by the job.

As mentioned above, it is generally considered that job satisfaction is influenced by rewards (personal and financial), job design and enrichment (e.g. involvement in decision-making process), work performance, animal comfort and health and the working environment. As with some of the above job-related characteristics, there is little evidence in the agricultural industries that job satisfaction affects animal productivity. However, it is generally recognised that job performance in any industry is influenced by job satisfaction via its affects on job motivation and commitment, motivation to learn new skills and knowledge, etc. Several authors have suggested that a decline in job satisfaction is associated with staff turnover and absenteeism (e.g. Rusbult et al., 1988).

9.4.4 Personality

Personality factors appear to be useful in matching people to some kinds of jobs (e.g. Barrick and Mount, 1991) and there is limited evidence of this in agriculture. For example, discipline and conformity may be important factors in some jobs in which routine tasks are performed by teams of people, while independence, introversion and self-motivation may be important in others in which the tasks are more problematic and where the individual may at times work alone.

Research in the pig industry by Ravel et al. (1996) suggests that the importance of personality factors on piglet survival may vary according to the working place, with the relative importance of the traits depending on the type of farm. The trait of self-discipline appeared to be important at all farms studied. While high insecurity and low sensitivity were favourable traits in relation to piglet survival at small independent owner-operated farms, stockpeople who were highly reserved and bold, suspicious, tense and changeable were associated with higher piglet mortality at large integrated farms. Seabrook (1991) reported that litter size in sows was associated with stockpeople who had confident and independent personalities, emotional stability, rational behaviour and low aggression. In a study of single-operator dairy herds, Seabrook (1972) found that the highest-yielding herds were those where the stockpeople were introverted and confident. In contrast to these studies, Waiblinger et al. (2002) found that personality factors, based on the measures used by Seabrook (1972), were not significantly correlated with cow productivity. However, Waiblinger et al. (2002) found that some personality factors were correlated with the attitudes of stockpeople. Agreeableness, which is one of the "big five" personality traits and is generally considered to be associated with cooperation, good nature and tolerance in a person (Barrick and Mount, 1991), was correlated negatively with positive attitude towards awareness of cows and positively with positive attitude towards contact with cows while caring for them. Agreeableness also correlated positively with use of positive behaviours and tended to correlate negatively with the percentage of negative behaviours. In contrast to these findings, Coleman et al. (2000) and Coleman (2001) in a study of stockpeople entering the pig industry found no consistent relationships between personality factors, based on the "big five" measures of personality, and stockperson performance.

Beveridge (1996) found that empathy towards animals was positively associated with positive attitudes by stockpeople towards interacting with cows and positive beliefs about cows, but was not directly associated with stockperson behaviour towards cows. Coleman et al. (1998) found that empathy towards animals was associated with positive beliefs about pigs and about handling pigs and Coleman et al. (2000) and Coleman (2001) found that empathy was associated with positive behaviour towards pigs as well as a high level of intention to remain working in the pig industry. Coleman (2004) proposed that empathy may be a factor underlying the development of positive attitudes in stockpeople towards pigs.

Hemsworth and Coleman (1998) and, more recently, Coleman (2004) have argued that, while there is little evidence in the livestock industries relating personality and empathy directly to work performance of the stockperson, these characteristics may indirectly affect animal welfare and productivity by influencing the development of the attitudes of the stockpeople to their animals. The antecedents of attitudes are many and varied (Hemsworth and Coleman, 1998). Demographic variables, various general attitudes and personality traits may indirectly affect behaviour through their influence on attitudes and, while the important dispositional factor in predicting the behaviour of the stockperson is attitude, other dispositional factors, including personality and empathy, may operate indirectly through attitudes. Furthermore, personality factors may be useful in matching people to some kinds of jobs in the livestock industries. Independence, introversion and self-motivation for example may be important factors in which the tasks are more problematic and where the individual often works alone.

9.4.5 Relationships Between Stockperson Attitudes and Behaviour to Animals and Other Job-Related Characteristics

It is obvious that the stockperson's knowledge and skills in animal production together with the motivation to utilise these attributes, i.e. work motivation, are important determinants of the productivity and welfare of his/her animals. In trying to understand the relationships between the stockperson attitudes and behaviour and these other job-related characteristics, it is not too difficult to recognise that the attitude of the stockperson to the subject of his work, the animal, may influence a number of these other influential characteristics and thus the work performance of the stockperson. For instance, the attitude of the stockperson towards the animal may affect work motivation, motivation to learn new skills and knowledge about the animal and job satisfaction, which in turn may affect work performance of the stockperson. In many industries outside agriculture, motivating factors which appear to be important determinants of job satisfaction, and thus in turn work motivation, have traditionally been considered to include achievement, recognition, responsibility, the work itself and advancement (Hemsworth and Coleman, 1998). Other factors, often called hygiene factors, which may not actually increase job satisfaction but, when they are at sub-optimal levels, act to depress job satisfaction, include company policy, pay, working conditions and benefits. Therefore, if the stockperson's attitude towards interacting with his or her animals, the subjects of the stockperson's tasks, is poor and, in conjunction with the consequent effects that this may create such as animal handling, production and welfare difficulties, the stockperson's job satisfaction is likely to deteriorate with adverse consequences on work motivation. Furthermore, if the stockperson's attitude towards the animals is poor, their commitment to the surveillance of and the attendance to production and welfare problems facing the animal is likely to deteriorate. Thus, the attitudinal and behavioural profiles of the stockperson may have marked effects on animal productivity and welfare both via fear of humans by the animal and via work performance of the stockperson.

In fact, some recent research in the Australian pig industry (Coleman et al., 1998) has indicated relationships between the stockperson's attitudes and a number of job-related variables. It was found that some measures of work motivation of stockpeople were correlated with attitudes towards pigs and towards most aspects of working with pigs. Job enjoyment and opinions about working conditions showed similar relationships with attitudes. Thus, the stockperson's attitudes may be related to aspects of work apart from handling of animals.

9.5 Opportunities to Improve Human–Animal Interactions in the Poultry Industries Through Training Stockpeople

Significant relationships have been found between stockperson attitudes and behaviour and animal fear (behaviour) and productivity in the dairy and pig industries (Coleman et al., 1998; Hemsworth et al., 1981b, 1989, 2000; Breuer et al., 2000). For instance, positive attitudes to the use of petting and the use of verbal and physical effort to handle cows and pigs were negatively correlated with the use of negative tactile interactions such as slaps, pushes and hits, which in turn were positively associated with fear of humans and negatively associated with the productivity of the animals. As a consequence of such research, the model shown in Fig. 9.1 has been proposed by Hemsworth and Coleman (1998) to describe the influence of human–animal interactions on the productivity and welfare of intensively-managed farm animals.

These sequential human–animal relationships indicate opportunities to improve animal behaviour, productivity and welfare by improving the attitudes and behaviour of stockpeople. Indeed, studies in the dairy and pig industries have shown that it is possible to firstly, improve the attitudinal and behavioural profiles of stockpeople and secondly, reduce level of fear and improve productivity of their farm animals (Coleman et al., 1999; Hemsworth et al., 1994a, 2002). This approach in

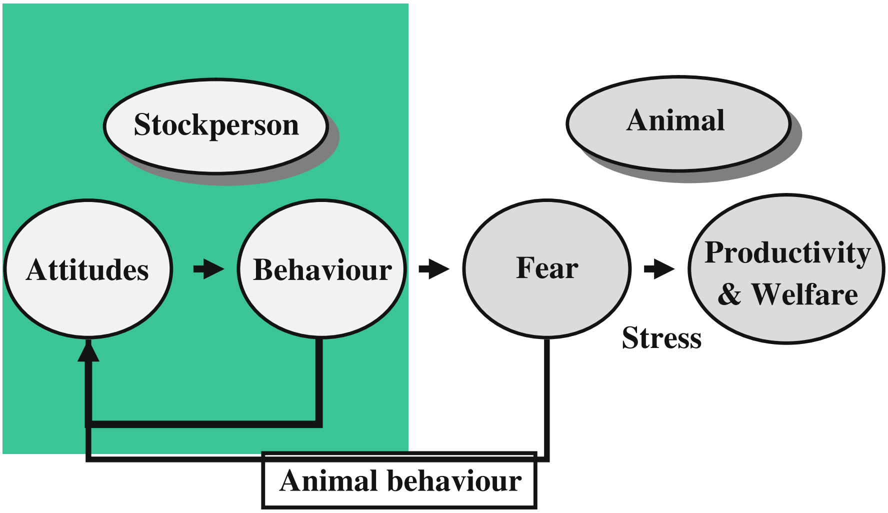

Fig. 9.1 Model of human–animal interactions

improving the attitudes and behaviour of stockpeople has been described in detail by Hemsworth and Coleman (1998). Basically, cognitive-behavioural modification techniques involve retraining people in terms of their behaviour while at the same time changing their attitudes and beliefs. This process of inducing behavioural change is really a comprehensive procedure in which all of the personal and external factors that are relevant to the behavioural situation are explicitly targeted. For instance, recognition of the sensitivity of farm animals to human behaviour, the subtle behavioural patterns of stockpeople that affect the animal, the consequences of poor handling on both the stockperson and the animal, the situations in which behavioural change is most difficult to achieve and maintain and maintaining behavioural change, need to be addressed.

In an attempt to identify human factors affecting fear in commercial meat chickens, Hemsworth et al. (1996b) and Cransberg et al. (2000) studied the relationships between the attitudes of stockpeople towards interacting with their birds, the behaviour of the stockpeople towards their birds and fear of humans by birds. While there was a significant relationship between the behaviour of the stockperson and the behavioural responses of birds to humans, there was no evidence of a relationship between stockperson attitude and behaviour. This is in contrast to the results of studies in the dairy and pig industries. In retrospect, it appears that the wrong attitudinal variables may have been targeted in the questionnaire used to assess attitudes. The most pertinent attitudes in predicting behaviour are those that specifically assess attitudes towards relevant behaviour (Hemsworth and Coleman, 1998) and the most important behaviour exhibited by the stockperson that was found to be associated with fear responses by birds to humans was speed of movement, a behaviour pattern that was not specifically addressed in the attitude questionnaire in this study. Clearly understanding relevant stockperson behaviour appears to be the key to changing stockperson attitudes to manipulate these human–animal interactions to improve poultry welfare.

9.6 Opportunities to Improve Human–Animal Interactions in the Poultry Industries Through Selecting Desirable Stockpeople

Research by Coleman et al. (1999) has shown that in the pig industry, not only is there a direct relationship between stockperson attitudes and behaviour and pig productivity, but also that there is relatively high staff turnover with 48% of stockpeople exiting within 6 months of recruitment. Anecdotal reports suggest that most managers of Australian pig farms tend to select staff based on intuitive and subjective measures. These usually take the form of personal recommendations, interviews (sometimes by telephone due to long distances) and *curriculum vitae* (CV). In particularly remote parts of Australia, employment may be given to itinerant workers with no formal CV, relevant experience or referees. In this situation the piggery manager has little to base his or her judgment on except "gut feelings" and hunches. A similar situation appears to exist in the poultry industries.

The potential value of selecting stockpeople using screening aids in the poultry industries is illustrated by a recent study in the Australian pig industry. One hundred and forty-four inexperienced stockpeople completed a series of computerised job-related questionnaires (Coleman, 2001, Carless et al, 2007). Inexperienced stockpeople were those who had been recruited to the piggery within the previous 4 weeks. After 6 months of employment, stockpeople were re-assessed by the supervisor and by an independent observer. A positive attitude towards the characteristics of pigs was a significant predictor of positive behaviour towards pigs and technical skills and knowledge, but not of work motivation and commitment. This suggests that attitude towards pigs is a good predictor of performance relating specifically to working with pigs, but not to general work motivation and commitment. This is an important result because our previous work (Hemsworth and Coleman, 1998) showed that only attitudes towards interacting with pigs are good predictors of behaviour. When the definition of behaviour is broadened, as in this more recent study, more general attitudes appear to be better predictors. Another significant finding was that a pre-employment measure of potential performance called the PDI-Performance measure was found to be a good predictor of all measures of actual observed performance. A person scoring high on this measure is likely to adhere to rules, show stability of behaviour, take care while performing tasks and take responsibility. The results from this study suggest that this measure may be a useful tool to help select stockpeople who will perform well in the ways studied here. The other main finding was that women appear to perform better on the basis of observations than do males. While this is a consistent result for these data, care needs to be taken that there are not other confounding factors. Females represented only 19% of the stockpeople in both the experienced and inexperienced groups. They may, therefore, have been a self-selected group, that is, a group who actively chose to enter the industry rather than doing so out of necessity. However the evidence obtained here is the first empirical support for the intuitively plausible assumption that women may be more nurturing and conscientious and therefore perform better in a commercial piggery.

It is reasonable to expect that similar predictors of stockperson performance would be obtained in other livestock industries including the poultry industries. There is considerable generality in the attitude–behaviour relationships observed in the dairy, pig and poultry industries, so it might be expected that similar generalities may apply for stockperson selection and training. Selection procedures do provide an opportunity not only to select stockpeople but to provide targeted training for both experienced and inexperienced stockpeople using selection tools as screening aids.

9.7 Conclusion

Human–animal interactions has been the topic of this chapter because there is an increasing body of evidence, currently not recognised widely in agriculture, that suggests that these interactions may result in profound behavioural and physiological changes in the animal, with consequences for the animal's welfare. Our understanding of human–animal interactions in the poultry industries is relatively poor, however limited research on poultry together with studies in other livestock industries demonstrate the implications of human–animal interactions for poultry welfare. Research on the interactions between humans and farm animals has shown interrelationships between the stockperson's attitudes and behaviour and fear, productivity and welfare of farm animals. The mechanism whereby fear affects welfare (and productivity) appears to be through a stress response. The risk to welfare also arises in situations in which the attitude and behaviour of the stockperson towards the animals are negative because the stockperson's commitment to the surveillance of, and the attendance to, welfare issues is most likely highly questionable. Furthermore, these interactions may also influence the stockperson to the extent that job-related characteristics, such as job satisfaction, motivation and commitment, may be affected, with implications for the job performance and career prospects of the stockperson.

The sequential relationships between human and animal variables indicate that there is an opportunity to target stockperson attitudes and behaviour in order to improve poultry welfare. Stockperson selection and training programs addressing these key attitudinal and behavioural profiles appear to offer the poultry industries potential to improve poultry welfare. Understanding stockperson behaviour appears to be the key to manipulating these human–animal interactions to improve poultry welfare. Research is clearly required along these lines if the poultry industries are to minimise the limitations that human–animal interactions impose on poultry welfare.

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Chapter 10
The Welfare and Ethical Assessment of Housing for Egg Production

Chris M. Sherwin

10.1 Introduction

Modern-day egg production is an ethical irony. Eggs have the potential to be one of the most ethically acceptable forms of food production in which humans could be involved, but instead, it is arguably the most human-biased of all food-animal industries. It is easy to imagine a scenario in which small groups of hens co-exist with humans in a symbiotic relationship that is almost devoid of negative ethical concerns. Hens will spontaneously produce eggs on a regular basis with little human intervention. These eggs could be gathered with minimal influence on the hens that laid them, and no loss of life because the eggs are unfertilised. The human caretakers could provide supplementary food and appropriate housing for the hens, and the hens in return could provide food for the humans in a way that involves no obvious welfare concern. But, this is an idyllic concept; it would be impossible to meet the present demand for eggs by producing them in this way. During recent decades, there has been a massive increase in the consumption of eggs. Satisfying this consumer trend obviously requires some intensification of the production systems, which has resulted in many different types of poultry housing. These take various factors into account, and it will become apparent in this chapter that different housing systems give very different weightings to these factors. This means that housing designs range from something approaching a semi-intensive version of the idyllic concept described above, whereas others have welfare issues associated with them that are so overwhelming they are perhaps the most contentious food-animal production system in existence. This chapter explores the ethical issues relating to why some of these housing systems have developed in the way they have, and how and why we would find some of them acceptable but others not.

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10.2 The Ethical Arguments

Broadly, there are three viewpoints on the ethics of animal agriculture that relate to egg production. Two of these are rather extreme and have limited relevance to this book. However, the third, which is a compromise, arguably represents the views of the majority.

The first extreme viewpoint is that animals have rights. These include not being held in captivity or being reared solely for the purposes of human consumption, a viewpoint that is perhaps most frequently associated in modern times with Tom Regan (e.g. Regan, 1983). Followed to its logical conclusion, this argument precludes any form of holding animals on farms, including hens for egg production. The content of this book, *The Welfare of Domestic Fowl and other Captive Birds,* is partly to consider welfare and ethics in poultry production systems. It therefore accepts at the outset that it is sometimes justifiable to keep hens for egg production. This means the animal rights viewpoint has little relevance for the present discussion.

The second extreme viewpoint is that animals have no feelings or do not experience suffering of any kind. Taken to its logical conclusion, this viewpoint would suggest that it is acceptable to house animals in whatever type of housing we choose because there can be no negative effects on the animal. This viewpoint is held by relatively few people. Rather, there is an immense literature and diversity of highly popular animal welfare organisations which indicate that many people believe animals, including hens, can suffer, and that housing can have a significant impact on their welfare. Again therefore, this extreme viewpoint has little relevance for the present discussion.

The content of this book contains two premises. First, it suggests that keeping hens for egg production is overall, morally defensible – it is not arguing for a ban or elimination of egg production. But second, the appearance of the word "welfare" in the title suggests that egg production can, under some circumstances, cause concern about the welfare of the hens. These are the two fundamental issues of the third ethical viewpoint, utilitarianism, which indicates that it is acceptable for humans to "use" hens to produce eggs, but, the welfare of the hens must also be considered and not overly compromised.

This third viewpoint, a utilitarian perspective, would generally indicate that for a housing system to be ethically acceptable, some form of cost-benefit analysis should be performed. The costs and the benefits of the system are identified, considered, and for a system to be ethically acceptable, the costs incurred should be outweighed by the benefits. Such an analysis can be difficult for animal production systems because the costs and benefits to the stakeholders (animals and humans) are like the proverbial chalk and cheese. The costs of a production system to humans are generally economic (e.g. the costs of feeding the animals, building infrastructure, labour) whereas the costs to an animal are generally welfare compromises (e.g. severe spatial and behavioural restriction, routine mutilation). The benefits of a production system to humans might be the abundant supply of a good quality, highly nutritious food source, whereas for an animal, the benefits of a system might be the provision of a suitable rest area, being housed with conspecifics, appropriate space allowance, etc. It is relevant that the economic benefits of different systems to humans will vary considerably depending on a wide range of factors including individual circumstances, cultural beliefs and the countries legislative procedures. In contrast, welfare costs to the hens are more absolute. A hen forced to spend her life in a cage that provides her with so little space that she is unable to fully preen is likely to suffer the same amount whether she is in a developing nation or an affluent country, or whether she is a pet or part of a massive agricultural system. The variability of the costs and benefits of poultry housing systems mean that it is sometimes necessary to make rather generalised statements. In this chapter, these comments are generally from the viewpoint of humans in an affluent society with a wide range of alternative food sources available. This does not diminish the reality that in other situations, eggs as a food source might be considered more necessary, perhaps even essential, to human life. It is also assumed that the costs and benefits in human terms are most likely to be reflected in the costs and benefits to the egg producer. In this chapter, the costs and benefits of a range of housing systems are identified and discussed to try to produce an ethical assessment of each. Prior to this, there are sections describing the major housing systems used for egg production and the capacity of hens to experience suffering.

10.3 Housing Systems for Egg Production

Many types of housing systems are used for laying hens. Their diversity is so great that entire books have been written on the subject and it is impossible within this one chapter to comprehensively describe and assess all systems. Therefore, only the most widely used systems are considered and those with common characteristics are grouped together. Small-scale systems such as farmyard egg production are not considered because these usually produce a negligible amount of eggs in terms of national or global consumption, however, it is noted that these systems tend to have associated with them high levels of hen welfare.

10.3.1 Conventional Cages

The housing system most widely used for laying hens is cages. Conventional (battery) cages are made with a wire-mesh floor, front, back and sides, although the sides are sometimes made of solid metal. Food is provided by a trough at the front of the cage replenished by an automatic delivery system, and water from overhead nipples. The floor of the cage is sloped so that when eggs are laid, they roll to the front of the cage to be automatically collected (this avoids losing eggs due to trampling and being eaten by the birds). The cages are usually arranged in several tiers with faeces removed by a belt between the tiers. Conventional cages typically house 3–6 hens and provide upwards of 300 cm^2 per bird; a cage that provides 600 cm^2

per bird equates to 16.7 hens per m^2. It is common to have tens of thousands of hens in a single house, sometimes hundreds of thousands. This system of housing was developed relatively recently, but has spread rapidly. For example, conventional cages were introduced into the UK from the USA during the 1920s in response to economic pressure and a trend towards intensification of all production systems (Harrision, 1964). In the UK in 1965 only 9% of egg-laying birds were housed in cages, by 1978 this had risen to 57% and by 1994 to 85% (Gatward, 2001 p. 17). Appleby et al. (1992) reported that in most countries, conventional cages house over 90% of hens used for egg production, although this proportion has decreased to approximatelyl 70% in recent years, at least in the UK. Directive 1999/74/EC of the European Commission sets out minimum standards for the protection of laying hens in the EU. This states that all conventional cages in the EU must now provide a minimum of $550cm^2$ per hen and be fitted with suitable claw shorteners. Moreever, by 2012, conventional cages will no longer be permitted in the EU.

10.3.2 Furnished and Get-Away Cages

In recent years, some cage systems have been purpose-designed to incorporate features to improve the hens' welfare (i.e. additional space, nest, dust-bath, perch and scratching strip) but also to minimise the extra economic cost of enrichment (Reed and Nicol, 1992; Duncan, 1992; Sherwin, 1994; Appleby, 1998; Appleby et al., 2002). Food and water are generally provided as in conventional cages. Furnished cages provide greater space allowance (typically between 500 and 1,250 cm^2 per hen) than conventional cages and some house small groups of hens (4–8 hens) whereas others house larger colonies of 60–80 hens (Wegner, 1990).

10.3.3 "Barn" Systems (Perchery and Aviary)

In barn systems, layer hens are kept as a single flock in a large house. A typical design would have nest boxes arranged down the centre of the shed on an area of plastic or mesh slats, leading down to litter areas at the periphery of the house. They may contain extensive perches or shelves, thus utilising the available vertical height of the house. Percheries usually provide less floor space but compensate for this by having a considerably larger numbers of perches arranged on frames so that the hens can move up and down between perch levels. Aviaries are essentially a floor system but with tiers of wooden slats, or, wire or plastic mesh at different levels. Group sizes in these systems vary enormously; in the UK, a barn flock would typically be 15,000 hens. The maximum EU stocking density is 25 hens per m^2. In systems providing litter, the hen defecates in the litter which is broken down by microbial action aided by the hens pecking and scratching behaviour. If the litter becomes too wet because of water spillage or high stocking density, it can pack down and become solid, thereby reducing the microbial action. This inhibits pecking and scratching, thus rapidly exacerbating the problem. Wet litter is corrosive and can cause foot problems. Litter must be provided in sufficient quantity to be attractive to hens, otherwise this reduces their use of the substrate and increases crowding in other areas of the housing system.

10.3.4 Tiered Wire Floor

This system is similar to the aviary in that it uses tiers to increase vertical use of the house space. There are narrow rows of tiers with passages between, and manure belts underneath each tier. Nest boxes are provided, although the tiers are sloped to collect any eggs that are laid on them. Perches are provided and there is litter on the floor. Typical stocking densities of this system are 20 hens per m^2.

10.3.5 Deep-Litter and Strawyard

Both these systems are litter-based, although as the names suggest, strawyards use straw whereas deep-litter systems usually use a wood-shavings litter. Strawyards are generally smaller systems holding 400–600 hens, and are often converted buildings with natural ventilation and light. Deep-litter systems (e.g. Appleby et al., 1988) are usually purpose-designed houses that are fully enclosed to allow lighting manipulations and have powered ventilation for temperature control. The floor is usually only partly covered with litter, the remainder (up to two thirds) is generally wooden slats to allow droppings collection. Maximum EU stocking density in these systems is 7 hens per m^2.

10.3.6 Free Range

Free range systems vary considerably in their design and management but, all allow hens access to an open-air run that is usually covered with vegetation. The system is based around one or several houses. A typical house design would have nest boxes arranged down the centre on an area of plastic or metal mesh or slats. Litter areas are often provided between the slatted area and the "pop-holes" or doors leading to the outdoors environment. The houses generally contain perches, drinkers and feeders – in some countries, it is against codes of recommendations to provide feeders or drinkers outdoors as this represents a health risk due to disease transfer by wild birds. Overhead shelters are often provided in the outdoors area to reduce the hens' fear of aerial attack and thus encourage greater utilisation of the run. Some legislation stipulates the hens should be given continuous daytime access, whereas in others, access can be restricted. Usually, hens are locked indoors at night to reduce predation. Free range houses are sometimes mobile or semi-fixed so they can be moved on a regular basis to reduce the build-up of pathogens in the house itself or in the heavily used areas of the run immediately outside of the house. As a consequence, these are sometimes temporary and built of materials such as straw-bales. Alternatively, the hens are sometimes given access to different areas of the pasture in a rotation system. Pasture management is required and this can be achieved by moving the houses, changing stocking density, or sowing the ground with appropriate seed mixture. Typical flock sizes (in the UK) are 7,000–8,000 hens, but some systems are as large as 15,000 hens. Maximum permissible external stocking density in the EU is 2,500 hens per hectare, (0.25 hens per m^2) although obviously much higher densities occur when many hens are in the house, e.g. 9 hens per m^2. Semi-intensive systems also exist which are similar to free range, although hens are kept at higher stocking densities of 4,000 hens per hectare (0.4 hens per m^2) .

10.4 The Capacity of Hens to Experience Suffering

As indicated above, an ethical assessment of poultry housing systems requires a cost-benefit analysis. The ethical costs of poultry housing systems to layer hens are generally compromises to welfare, therefore, it is necessary to understand the capacity of hens to experience suffering to appreciate these costs.

It is common for people to believe that hens are less able to experience suffering than other vertebrate species. This belief is influenced by several factors. For instance, there are a number of phrases (at least in the English language) which place poultry in a very negative perspective, e.g. “turkey” is used to describe an item of machinery that malfunctions, and “chicken” is used as an expression of cowardice. Our perception of an animal’s capacity to experience suffering is also influenced by our ability to empathise with the animal. Unfortunately, birds perhaps more than many other production animals, do not often behave in ways that we can empathise with and they often do not respond positively to our presence (they don’t purr or wag their tails to greet us). This tends to make us believe they are less sentient than other animals that behave positively or in ways with which we can empathise. It is also common for humans who see a large flock or group of similar-looking animals, as in modern poultry systems, to overlook the capacity of an individual animal to experience suffering (polyism). But, animal welfare should be considered at the level of the individual, not the group – it is the individual hen that experiences the negative mental state, not the flock.

Many researchers in animal welfare would now argue that hens are capable of a variety of types of suffering (e.g. Dawkins, 1993; Webster, 1994; Appleby and Hughes, 1997; Fraser and Broom, 1997; Duncan and Mench, 2000). The most basic of these is pain, but, there is now considerable evidence that hens respond both behaviourally and physiologically in ways that are analogous to other vertebrates when placed in circumstances that might cause negative mental states such as fear, frustration and perhaps even depression or boredom. Therefore, the following sections examine ethical concerns of poultry housing with the acceptance that hens are capable of experiencing a range of types of suffering, to a greater or lesser degree.

10.5 Ethical Costs to Hens Common to Housing Systems

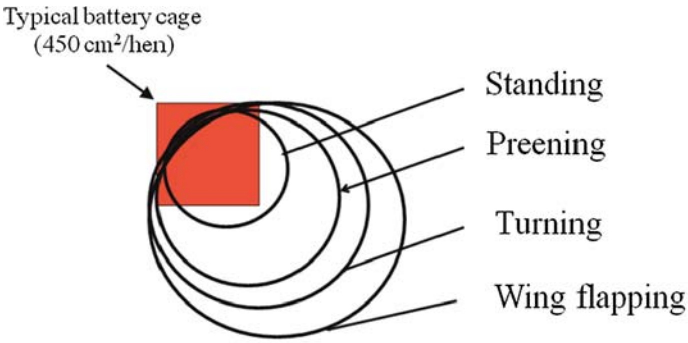
Some ethical costs of housing for layer hens relate to particular systems, however, others are common to several or all. The following section discusses welfare concerns that are common to several housing systems. A later section, "Ethical assessment of housing for layer hens", discusses other issues specific to particular systems and includes these in an overall assessment of the system.

10.5.1 Life Prior to Egg Production

Most chicks bred for egg laying begin life in a similar way, regardless of the housing system for which they are destined. On the day of hatching, chicks are sexed and the males euthanized, generally by maceration. The females are vaccinated, beak-trimmed, and then transported to the rearing unit. Rearing can take place either in cages or on deep-litter. This may be a single stage process where the chicks are kept on the same unit until they reach maturity at approximately 16 weeks of age, at which time they are transferred to the layer unit. Alternatively, in a multi-stage system, the chicks are moved between environments according to the developmental stage they are at. Various aspects of the environment may change between these stages to suit the growing chicks' needs. So, temperature may be reduced, grid flooring may increase in size to suit the chicks' feet and the height at which food and water is provided may be increased. It is believed that moving the birds less frequently reduces stress, although if the chicks do not experience the appropriate environment during these early stages of life (e.g. access to perches), they might not be adequately prepared for the housing system in which they are about to be placed.

10.5.2 Spatial and Behavioural Restriction

Several housing systems, most notably cages, provide hens with very limited space. For example, many conventional cages provide only 450 cm^2 per bird, which equates to each hen having to live for 56 weeks or more in an area approximately the size of a sheet of A4 size paper. Dawkins and Hardie (1989) determined the amounts of space that hens require for a range of behaviour (Fig. 10.1). When these are compared with the space provided in housing systems, it is obvious that several systems totally prevent some behaviour and considerably restrict other behaviour. Some of the restricted behaviour (e.g. wing stretching, wing flapping, preening) is comfort behaviour associated with grooming or maintenance of the musculo-skeletal system. If the hen is prevented from performing these behaviour patterns, it appears that the motivation to perform them continues to escalate and the behaviour is eventually performed at a heightened intensity if the bird is ever given the opportunity to do so. The hen behaves as if she is trying to compensate for the previous inability to perform the behaviour (the rebound effect). It has been argued that this indicates she was likely to have become frustrated when performance was prevented



Behaviour	Area Required(cm^2)
Standing	475
Preening	1,150
Turning	1,271
Wing flapping	1,876
Ground scratching	856
Feather ruffling	873
Wing stretching	893

Fig. 10.1 The amount of space required by hens to perform a range of behaviours (*circles*) compared to the amount of space typically provided by a conventional cage (*square*) (after Dawkins and Hardie, 1989)

(Nicol, 1987). Hens demonstrably prefer more space than is provided by conventional cages (Dawkins, 1978) and the spatial restriction forces hens to share space for many behaviour patterns, e.g. turning. Although hens are gregarious animals and will often choose to be in close association with each other, to be forced into permanent close contact that prevents unrestricted performance of these behaviours almost certainly causes some degree of frustration (Keeling and Duncan, 1989).

The environment of some housing systems for layer hens is greatly impoverished. These can either prevent hens from performing some behaviour, or do not provide the appropriate stimuli to elicit other behaviour. This means that hens in these systems exhibit a behavioural repertoire that is reduced or distorted compared to that of feral hens or those in more extensive production systems. The non-expression of some of this behaviour is probably trivial to the hen, or perhaps even a positive aspect of the housing system (e.g. the absence of predator avoidance), however, prevention of other behaviour is widely believed to compromise welfare. Some behaviour, e.g. ground-pecking or scratching, is performed at a high rate in extensive systems, but is considerably reduced in more restrictive housing. It has been argued that to ensure good welfare, animals should be provided with environments that allow them to express a full repertoire of behaviour. Similarly, it has been shown that the hen is highly motivated to show some behaviour, e.g. nesting, perching and dust bathing, at least at certain times of the day. These activities are totally prevented in some housing systems and it has been argued widely that this leads to frustration in hens (e.g. Duncan, 1970, 2001; Dawkins, 1988a, b; Baxter, 1994; Cooper and

Appleby, 1996; Friere et al., 1997; Olsson and Keeling, 2000, 2002; Widowski and Duncan, 2000).

10.5.3 Injurious, Non-aggressive Pecking (Feather and Vent Pecking)

Feather pecking is the pecking at, or plucking, feathers from other hens. The severity of this pecking varies, but sometimes causes obvious pain to the bird being pecked and can lead to bleeding and cannibalism. It has been argued that feather pecking is redirected foraging behaviour (e.g. Blokhuis, 1986) or is related to dustbathing (Vestergaard and Lisborg, 1993). Whichever, it would appear that many poultry housing systems are inadequate for the pecking needs of hens, so this activity is re-directed to the feathers of group-mates. Vent pecking is characterised by a hen causing damage to the cloaca and the surrounding skin of another hen. This is believed to arise from the exposure of the cloacal mucosa immediately after egg laying, which appears attractive for pecking by other hens. Therefore, housing systems, particularly the nest boxes and perches, should be designed to reduce the prevalence of cloaca presentation and reduce the incidence of this behaviour.

Both feather pecking and vent pecking occur in conventional cages (Allen and Perry, 1975) as well as alternative systems, but are less controllable and spread more easily in the large flock sizes of alternative systems, sometimes increasing mortality rates (Hughes and Gentle, 1995; McAdie and Keeling, 2000). In a survey of free range, barn and perchery systems, 51% of farmers reported feather pecking in the last depopulated flock while 37% reported vent pecking (Green et al., 2000; Potzsch et al., 2001). In the affected flocks of this study, feather pecking was more prevalent (30% of birds) than vent pecking (3.5% of birds), although 1.3% of vent-pecked birds died as a result of their injuries compared to less than 1% mortality due to feather pecking. Due to the prevalence and severity of injuries caused by these behaviour patterns, feather and vent pecking are arguably the greatest welfare concerns of egg production. As a consequence, there has been much research on methods of preventing or alleviating the consequences. Some of these are management controls such as reduced stocking density, access to an outdoor area, or, provision of perches at an early age. Two other methods, beak-trimming and reduced light intensity, are widely used but cause other welfare concerns and are therefore discussed in more detail below.

10.5.4 Beak-Trimming

Beak-trimming (perhaps more accurately described as “partial beak-amputation”) is performed on almost all egg-layer chicks when they are routinely sexed at about one day of age. It is performed to reduce feather pecking and vent pecking later in life. It involves removing the distal third or two thirds of the chick’s beak by either a blade or infra-red beam. Beak-trimming causes welfare concerns because the beak contains highly innervated tissue – it is only the surface and extreme tip of the beak that is keratinised dead tissue. During beak trimming, this highly innervated area is transected and it has been shown that neuromas (abnormal nerve regeneration) form in the beak stump. The afferent fibres running from the stump in the intamandibular nerve have abnormal spontaneous activity (Breward and Gentle, 1985) which is remarkably similar to the discharges originating from stump neuromas in human amputees and implicated in phantom limb pain syndromes (Gentle, 1986). Beak-trimming also leads to changes in behaviour that indicate substantial acute and chronic pain (Duncan et al., 1989), and the beak may re-grow abnormally causing feeding problems for the hen or requiring the beak to be trimmed again. However, modern, infra-red trimming of chicks' beaks seems to result in much less pain (Gentle and McKeegan, 2007).

Beak-trimming is performed routinely on the vast majority of chicks shortly after hatching, although the legislation of many countries indicates this procedure should only be performed as a last resort once feather pecking has become prevalent. While there is no doubt that feather pecking and vent pecking are considerable welfare concerns, beak-trimming does not necessarily eliminate these. In a survey of free range, barn and perchery systems, 96% of the flocks were beak-trimmed, yet feather pecking occurred in 51% of these and vent pecking in 37% (Green et al., 2000; Potzsch et al., 2001). In contrast, in a semi-commercial trial of furnished and conventional cages using non-beak-trimmed hens, feather damage was generally less in the furnished cages and mortality was relatively low overall (Appleby et al., 2002). The authors suggested that beak-trimming for hens in some cage systems is becoming increasingly questionable, especially given the recommendation by legislative bodies that this procedure should be performed only as a last resort.

The routine beak-trimming of chicks is partly a consequence of the current scale of egg production and housing designs. It is argued that beak-trimming must be performed routinely on almost all chicks at an early age because large flock sizes and methods of catching adult hens, which are dictated by housing design, mean this is impractical or too expensive when the birds are older. Ideally, smaller systems, better designed to reduce feather pecking, would reduce the need for beak-trimming and allow this to be performed on a smaller number of animals as a response to an outbreak of feather pecking rather than a prophylactic measure performed on a large proportion of hens. This could also be combined with using strains that have been genetically selected for showing less feather pecking activity (Hughes and Duncan, 1972; Kjær and Sørensen, 1997; Jones and Hocking, 1999).

10.5.5 Light Intensity Reduction

A widely used method of reducing feather pecking is to reduce light intensity (Kjaer and Vestergaard, 1999) but because a minimum of 5 lux is necessary to maintain egg laying (Appleby et al., 1992, p. 50), intensities of 10 lux or more are recommended. At these low intensities it becomes difficult for humans to detect blood or inspect the hens properly, especially in the more densely populated housing systems. Low light intensites may be associated with more direct welfare costs to the hens. Prescott and Wathes (2002) showed that hens prefer to eat in brightly lit environments rather than dim, and Davis et al. (1999) showed that older hens prefer brightly lit areas for active behaviour but dim areas (<10 lux) for inactive behaviour. Potzsch et al. (2001) showed that the use of high light intensities over nest boxes to attract hens was associated with increased vent pecking – possibly due to the contrast with low light intensity prevalent in other areas of the housing system. Dimming the lights can also cause problems when the intensity is then abruptly increased temporarily to inspect the hens; this has been associated as a risk factor of increased feather pecking (Green et al., 2000) and the birds can become frightened resulting in panic-type reactions which increase the risk of injury. In turkeys, low light intensities (perhaps in combination with long light phases) can cause retinal detachment and buphthalmia, a distortion of the eye morphology that can lead to blindness (Harrison et al., 1968; Siopes et al., 1984). This does not appear to have been investigated for layer hens under modern lighting patterns. Gradual changes in light intensity at the beginning and end of the light phase enable birds to feed in anticipation of the dark period and to move safely between roosts rather than moving in the dark and risking injury, which is possibly more important in furnished systems.

10.5.6 Photoperiod

Egg production can be manipulated by the duration of the light phase and/or bursts of light. The use of light to improve or enhance egg production has resulted in the development of many varied lighting programmes. Some of these appear rather excessive from a human perspective, for example, the light period may be suddenly interrupted by several relatively brief periods (e.g. 1–2 h) of dark (this saves energy but appears to have no effect on production). Savory and Duncan (1982) showed that hens will work for light, although the welfare implications of intermittent lighting are difficult to judge.

10.5.7 Fluorescent and Incandescent Lighting

Two types of lighting are used widely in poultry housing, i.e. incandescent and fluorescent. Incandescent lighting is considered to be more expensive, but it does have some advantages such as being easy to dim with relatively non-specialised equipment should feather pecking occur. Fluorescent lighting is cheaper to run but is not easy to dim requiring specialised dimmers. The spectral characteristics of these two light sources vary considerably, although this might not be readily evident to human eyes (see also Chapter 6 by Tina Widowski, this volume). Fluorescent lamps also flicker on and off at a rate which, although not perceived by humans, may be perceived by hens. Despite this, preference tests indicate that if hens are sensitive to this flicker frequency, they do not find it aversive, but may actually prefer fluorescent lighting compared to incandescent (Widowski et al., 1992).

Both incandescent and fluorescent artificial lighting emit little or no ultraviolet radiation (UV). Humans are insensitive to UV and therefore do not detect this absence. However, sunlight contains considerable amounts of UV to which hens are sensitive and which influences their behaviour (Jones et al., 2001). Sherwin and Devereux (1999) have suggested that the absence of UV from artificial light sources may have a role in the causation of feather pecking in turkeys. The extent to which the absence of UV from artificial lights compromises welfare is not yet known. Other poultry species prefer areas illuminated with additional UV (Moinard and Sherwin, 1999), but poultry reared without UV show little indication of being stressed (Maddocks et al., 2001).

10.5.8 Bone Weakness

The spatial and behavioural restriction of some housing systems means that hens in these systems move less frequently and with less vigour than in other systems. This reduces physical stressors on the skeletal system which are vital to bone growth and maintenance. As a result, hens from more restrictive systems have weaker bones or lower overall skeletal condition (Fleming et al., 2004), compounded by nutritional requirements for calcification of the eggs being produced by the hen (Whitehead and Fleming, 2000). Hens from less restrictive systems with various types of furniture (perches, building struts, etc.) are more likely to suffer fractures during the egg laying period as they "fly" about the house, Hens are also at considerable risk of bone breakage during depopulation which can be markedly influenced by the housing system. Gregory and Wilkins (1989) reported that up to 30% of hens from conventional cages suffered broken bones during catching and transportation, whereas there were about half as many similar breakages from hens in free range or percheries (Gregory et al., 1990). Tibia strength is increased by up to 41% and humerus strength by up to 85% in percheries and deep-litter systems compared to conventional cages (Appleby et al., 1992, p. 194). Leyendecker et al. (2002) reported that bone strength was consistently higher for hens kept in aviaries compared to furnished and conventional cages, and that the humerus strength was higher for hens in furnished cages compared to conventional cages, although there were no differences in tibia strength. In cages, bone strength can be increased simply by adding a perch (Duncan et al., 1992), or increasing the height of cages (Moinard et al., 1998) although bones are still likely to be weaker than in non-cage systems (Hughes and Appleby, 1989).

10.5.9 Gases and Air Quality

Problems with air quality are more common in floor systems than cages. For example, in one study of a deep-litter house stocked at a low density, average airborne dust was 30 mg per m^3 and average ammonia was 23 ppm; the birds were exposed to these levels over long periods. The recommended maxima for short-term exposure in humans are 10 mg per m^3 for dust and 35 ppm for ammonia (Appleby et al., 1992 p. 46). If a litter-based system is not functioning properly (i.e. if microbial breakdown of faeces is not occurring rapidly enough), ammonia can build up. This can lead to respiratory problems, although the prevalence and welfare impact of this is not well understood for layer hens.

10.5.10 Forced Moulting

In some countries, layer hens are slaughtered at approximately 72 weeks of age because there is a gradual decrease in egg production and quality with time, and this represents the age when the costs of egg production outweigh the monetary gains to the producer. However, in some other countries, the birds are force-moulted to reduce excess body fat and allow the reproductive tract to recover for a second laying cycle. This is usually achieved by a combination of short day-length with food restriction and sometimes water restriction. The objective is not the moulting itself, but the termination of egg laying. After this period of non-laying, the hen can then be induced to lay again at a greater rate than previously. Webster (2000) stated that under commercial conditions, food is withdrawn to induce a loss of 35% of body weight; in his study this required food to be removed for 21 days. This duration of food deprivation is likely to be extremely stressful (Duncan and Wood-Gush, 1971; Duncan and Mench, 2000).

10.5.11 Scale of Production

Modern egg production operations can be enormous in size. Large egg farms might have tens of houses each containing hundreds of thousands of hens. Economies of scale in large-scale production systems benefit the farmer in terms of reduced costs of land, buildings, infrastructure, etc. giving an increased profit per hen. There is no inherent reason why large scale production systems should necessarily adversely influence hen welfare, however, when combined with the overwhelming global drive to increase cost-efficiency, welfare compromises almost certainly do occur as a consequence of large-scale production. First, in large scale systems it is more likely that polyism will occur, but, we should remind ourselves that welfare must be considered at the level of the individual; if a wire-mesh floor causes abrasions to the feet of a hen, it is the individual hen that experiences discomfort, and this may be multiplied up many thousands of times for a flock of laying hens. Perhaps the greatest danger of large scale systems is the inability to monitor hen welfare so that minimum standards are at least maintained. Adequate daily monitoring of the hens is a legal requirement in some countries, but in a house of 60,000 hens, it would take one stock person 33.3 h to examine every hen if each was looked at for only 2 s. Considering that many poultry units are designed to be operated by a small number of staff, adequate monitoring of the hens is highly unlikely, if not impossible. It appears then, that the scale of production or, more precisely, the labour input per bird is a factor that should be taken into consideration in the ethical assessment of housing systems.

10.5.12 Fit to Travel?

At the end of their egg production life, hens are usually removed from their housing, placed into crates and transported to a slaughterhouse. As a consequence of the restricted space of some housing systems and nutritional requirements, the musculoskeletal system of hens is often considerably weakened by the end of their egg laying life and the birds' bones are frequently broken during the depopulation process (*see* "Bone weakness"). This obviously represents a considerable welfare problem, but might also indicate a legal issue. It is a legal requirement in some countries that animals should not be transported if they are weak or injured. It could be argued that a housing system which renders animals physically weakened and highly prone to bone fractures is one that produces animals which are unfit to travel.

10.6 Ethical Costs to a Producer Common to Housing Systems

The costs of a housing system to a producer can vary considerably. Factors that must be considered include the skill required to operate the system, the labour required (e.g. depopulating conventional cages is much easier and quicker than aviary systems where the birds can run away to escape), health and safety issues (e.g. litter-based systems often generate air quality problems), and the ease with which eggs can be collected (e.g. eggs laid on the floor are difficult to detect and require manual collection). But, most of these problems can be integrated into one factor – the economic cost of the system. So, if a system requires particularly skilled staff, these can be obtained, albeit at a higher price than other systems. Similarly, health and safety issues can be overcome by, for example, buying respirators. Therefore, the costs to the producer can really be summarised as one variable, i.e. how much money the housing system costs to set up and maintain, and the costs of egg production within that system.

10.7 Ethical Assessment of Housing Systems for Layer Hens

10.7.1 Conventional Cages

10.7.1.1 Costs and Benefits to the Hen

Conventional cages impose considerable costs on hens. Hens in these systems are exposed to some extent to all the common welfare costs discussed above. The lack of quantity and quality of space means that hens in conventional cages experience the greatest degree of spatial and behavioural restriction of all the housing systems. The limited space means it is impossible for hens in conventional cages to perform behaviour such as wing-flapping or the short-distance "flying" which hens often perform if they have adequate space. Conventional cages provide no pre-formed nest or material from which she can build a nest, causing intense frustration evident by stereotyped pacing and vocalisations. The wire floor prevents ground-scratching and dust-bathing. When hens are prevented from dust-bathing, they show anomalous behaviour such as attempting to dust-bathe in the feed and performing dust-bathing movements on the wire mesh floor. Conventional cages also deprive the hens of any foraging material, which often results in re-directed pecking that is sometimes injurious to cage-mates. There is usually no perch in conventional cages which can lead to foot problems that are exacerbated if the slope of the cage floor is great. Growth of beaks and claws can become abnormal due to the lack of surfaces to wear them down. The levels of osteomalacia and osteoporosis are considerably higher in caged hens than in group-housed or free range, and there may be more muscle-weakness in caged birds (Loliger et al., 1981).

Despite the almost exclusively anthropocentric development of conventional cages, there are some benefits to the hens from being housed in this system. The hens are protected from predators and they are kept warm, clean and away from their faeces thus avoiding pathogen ingestion and the spread of disease. They are housed in small groups, which also helps reduce the impact of any disease or injurious pecking, and they also generally have access to ad libitum food and water (but see "Forced Moulting").

10.7.1.2 Costs and Benefits to the Producer

The benefits of conventional cages to humans are manifold – which is, of course, why the system has been so enthusiastically and widely adopted throughout the world. Conventional cages allow hens to be kept at very great densities on small amounts of floor-space. This means that the costs of the infrastructure and labour can be minimised. In economic terms, the conventional cage is the least expensive method of keeping large numbers of hens for eggs (Elson, 1985). Eggs can be collected automatically, food and water distributed with great ease either manually or mechanically, medication given simply by treating the common water or food source, production levels can be optimised by artificial light manipulations, and food and/or water can be easily withdrawn for several days to force moult the hens to rejuvenate egg production (in those countries where this is legal). Compared to many other systems it is relatively easy to inspect each bird (although see "Scale of Production Systems"). Because there is no litter in conventional cages, air quality in these systems is often better than in others.

10.7.2 Furnished Cages, Get-Away Cages and Tiered Wire Floor

10.7.2.1 Costs and Benefits to the Hen

Compared to conventional cages, these systems offer benefits to the hen by providing a nesting area, a perch, dust-bath, scratching strip and additional space. The presence of a nesting area is almost certainly a great welfare improvement, although the absence of nesting material may possibly be a cost to the hens (Duncan and

Kite, 1989; Hughes et al., 1989). When a dust bath is provided, this is not always used for dust-bathing and hens will sometimes continue to dust-bath on the wire mesh floor, indicating design improvements may still be required. The dust-bath is often used by the hens as a pecking and scratching (foraging) substrate that could help reduce feather pecking in these systems. Furnished and get-away cages provide more space than conventional cages, but still prevent some behaviours (e.g. vigorous wing-flapping, flying, nest building) and inhibit others (comfort behaviours), determined partly by the number of hens in the cage system. The birds are not separated from their faeces as completely as in conventional cages, and the hens are therefore presumably at a greater risk of disease. Appleby et al. (2002) compared behaviour and production of hens in a variety of cage systems. They reported that feather and foot damage were generally less in furnished than conventional cages, and that comfort behaviour was more frequent in furnished than conventional cages, although still not frequent.

10.7.2.2 Costs and Benefits to the Producer

Furnished and get-away cages are relatively new housing systems and as a consequence, there are still some practical problems with them. In some designs the hens have to be prevented from entering the dust-bath during the morning because there is a tendency for the hens to lay eggs in the substrate. The substrate is also distributed widely by the hens during vigorous dust bathing, which means it must be replaced, and it can be abrasive on machinery. Depopulation can be problematic in these systems as the birds are able to move quite freely. Perhaps the worst cost of furnished cages to the producer is the down-grading of eggs. Because faeces can collect in various areas including the nest, eggs can become dirty. They are also sometimes cracked due to being trampled or laid from the perch (Appleby et al., 2002).

10.7.3 "Barn", Perchery, Aviary, Deep-Litter and Strawyard

10.7.3.1 Costs and Benefits to the Hen

These systems provide hens with sufficient space and furniture to express an almost complete range of behaviour that would be observed in free range or feral hens, although some designs seem to be prone to high levels of aggression and increased mortality (Nicol et al., 2006). As with all the more extensive systems, contact with faeces can occur, and so the risk of coccidiosis is higher. Some barn systems have associated with them a higher frequency of bone breakages. Presumably, this occurs because the infrastructure is more complex and the hens can crash into objects such as perches, perhaps especially when trying to find a roost if the lights have suddenly been turned off. It is sometimes observed that hens do not always use perches when these are provided. This can be remedied by giving the hens access to perches when they are young chicks (Appleby and Duncan, 1989).

10.7.3.2 Costs and Benefits to the Producer

Some of these "Barn" system designs are complex and have electrically operated covers that allow the hens access to sand only during certain parts of the day. These complexities are expensive to build and also add maintenance costs to the systems. For example, they may require regular servicing from an outside engineer. Hens in deep-litter systems often lay floor eggs, which means these must be manually collected – a time consuming operation. Floor eggs are commonly dirtier than nest-box eggs which means they have to be cleaned which adds to the costs. Any litter-based system requires skilled maintenance and is still prone to problems that are very difficult to control or remedy (e.g. wet litter, compaction of the litter, high dust levels, etc.).

10.7.4 Free Range

10.7.4.1 Costs and Benefits to the Hen

The outside area of free range systems generally offers hens a considerably greater amount of space and a more diverse environment than is provided by other systems. The hens have access to natural and varying foraging substrate, natural dust-baths, nesting material, space in which to move about vigorously and, as a consequence, exhibit a more diverse and complete ethogram. The amount of space provided in the house may be rather more restrictive, with stocking densities similar to those of perchery or barn systems. However, the hens are usually only restricted to the house at night or in poor weather, and it should be remembered that hens naturally choose to roost in close proximity, presumably as a thermoregulatory and anti-predator strategy.

Free range systems can have welfare costs for hens. The hens are able to forage on a wide range of substrates, some of which will contain pathogens or their own faeces thereby exposing them to an increased risk of disease.; it has been reported that hens on a well-run free range system have worm infestation and coccidiosis levels that are 10 times greater than in conventional cages (Loliger et al., 1981, cited by Fraser and Broom, 1997, p. 371). Hens on free range systems are vulnerable to predation by animals such as foxes. Poorly designed systems provide inadequate overhead cover resulting in the hens being fearful of fully utilising the space available outside, and dominant hens may sometimes stand near the pop-holes of the house and inhibit other birds from entering and exiting the house. Webster (1994) argues that the social behaviour of hens means they are unsuited for the large group sizes usually kept on free range systems. He also comments that due to repeated incidences of fear outside the house and the mad rush of all the birds to get outside when the pop-holes are opened, more than half the hens elect, sooner or later, not to go out of doors at all. Certainly, the number of hens outdoors is often lower than might be expected (e.g. Bubier and Bradshaw, 1998). The outside area is obviously open to the elements and in poor weather, hens may be reluctant to go outside meaning the house design has to cope with the high stocking densities and concomitant problems of aggression and feather pecking. In addition, if the land is not well maintained, it can become sodden, increasing disease risk or making it unattractive for the hens to use.

10.7.4.2 Costs and Benefits to the Producer

Free range systems are likely to be the most expensive to run. This is partly because more land has to be purchased or rented, and the producers have to find more highly skilled staff than for other systems, therefore salaries are higher. Weather conditions can sometimes be so extreme that production levels become rather variable, and overall production rates can be lower than other systems, possibly as a result of floor-eggs and eggs being laid in the outside area. In terms of benefits to producers, there is a strong public perception that free range systems are better for the hens' welfare and that eggs from these systems are healthier and taste better than eggs from other systems. Whether these beliefs are well founded or not, they allow producers to charge the highest premiums of all the housing systems.

10.8 Conclusions and Final Remarks

Ethical assessment of animal production systems can be difficult because the costs and benefits are so very disparate for the parties involved. For example, it might mean nothing to a hen that a 10% premium is charged for her eggs simply because she is provided with a few centimetres more of space, but this surcharge could be the difference between whether a producer can afford to feed his family. Alternatively, giving hens a nest box could improve welfare considerably, but this is unlikely to benefit the producer in any way unless this is reflected in increased productivity or premiums. It is perhaps worth remembering in this respect that humans usually have control of their choices whereas the hens have none. Hens might be placed into a housing system that causes them a great degree of pain, suffering and distress, and sometimes they pay the ultimate cost – yet they are unable to do anything to change this. On the other hand, producers and consumers usually do have a choice – we, at least in more affluent societies, can choose to have housing systems which are more welfare oriented, and ultimately, could choose not to eat eggs at all.

A decision on the ethical acceptability of conventional cages would appear to be perhaps the easiest to make of all egg production housing systems. Conventional cages offer considerable benefits and economic advantages to the producer, but they also cause great costs to the hens in terms of animal welfare compromises. Although a decision on the acceptability of conventional cages may appear relatively easy, this is because we tend to think in polarised terms of whether it is animal welfare or economic benefit that should be given the highest priority. There seems to be little room for compromise: although conventional cages offer some benefits to the hens, many believe that the behavioural and spatial restrictions are so severe that this system is ethically unacceptable. Furnished and get-away cages also restrict hens spatially, but these systems have been deliberately designed to offer facilities that allow the hens to perform highly motivated behaviour. They also offer similar productivity to conventional cages, but at a slightly higher cost of operation. This suggests that these systems are more ethically acceptable relative to conventional cages, but the absolute acceptability in terms of welfare is perhaps less clear. "Barn" systems, deep-litter and strawyards generally provide the same facilities as do furnished cages, but in addition, offer a greater space allowance and a litter substrate and nesting material. These systems are again more costly, and with increased aggression and mortality in barn system, these may be less ethically acceptable than the cage systems. In many respects, free range systems are the antithesis of conventional cages: they offer the greatest benefits to the hens, but have the highest costs for the producer. There are still welfare issues associated with free range systems, even when they are skilfully managed, but overall, free range systems appear to be the most ethically acceptable of all the systems discussed here. Notwithstanding this, some would still argue that the remaining welfare issues are great enough to indicate this is still not a totally acceptable method for egg production. Perhaps this exemplifies the divergent viewpoints stimulated by modern animal production systems. This polarisation of views, especially with respect to the more intensive systems, has prevailed for a considerable period of time. In 1970, the Farm Animal Welfare Advisory Committee was established to report on animal welfare matters to the UK Ministry of Agriculture. They were asked to publish a report on the working of the Codes of Recommendation for the Welfare of Livestock. It appears the Committee was unable to reach a consensus because they published a two-part report divided into the "ethical" and the "scientific" approach. Those supporting the ethical approach concluded: "The crucial point relates to the limit which man, in a civilised society, is willing to take his exploitation of the animals he uses for food. Too much has been left in doubt and welfare needs have been placed second to considerations of productivity". However, the scientific approach concluded that many of the recommendations in the codes were more generous to the animal than was justifiable scientifically (Appleby et al., 1992, p. 90). In the years since this report was published, animal welfare science has addressed many of the "doubts" to which the ethical viewpoint referred. Several of these have been resolved, usually in a manner which indicates that welfare considerations were second to productivity, perhaps a considerably more distant second than thought at the time of the report's publication. Modern systems have tried to counter this and to some extent have been successful. However, it appears that for some egg production systems at least, animal welfare continues to be placed a second priority to productivity.

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Chapter 11
Stunning and Slaughter

Mohan Raj

11.1 Introduction

In most of the developed countries, excluding the United States of America, it is a statutory requirement that all animals including poultry slaughtered for human consumption are rendered immediately unconscious (stunning) and they remain so until death supervenes through blood loss (slaughter). The duration of unconsciousness induced by a stunning procedure must be longer than the sum of time that lapses between the end of stun and neck cutting and the time to onset of death following neck cutting. Since the effect of a stunning method is momentary, the onus of preventing resumption of consciousness thereafter relies on the efficiency of slaughter procedure (bleeding out); i.e. the prompt and accurate severance of blood vessels (neck cutting) supplying oxygenated blood to the brain. Some stunning procedures are therefore purposefully applied to induce humane death (e.g. killing with argon or nitrogen-induced anoxia), rather than mere unconsciousness, and other methods lead to death due to structural damage to the brain (e.g. penetrating captive bolts).

In view of the globalisation of trade, it is not surprising that poultry produced in Brazil and Thailand is consumed in the UK and Europe. However, this tremendous achievement of export potential and the associated economic prosperity to local communities should not be jeopardised owing to the lack of understanding of welfare issues and/or appropriate legislation required to ensure the welfare of poultry during stunning and slaughter. The consumers of economically affluent societies are becoming increasingly concerned with what they eat, the country of origin of their food and standards applied during production and processing. Therefore, improving welfare standards at an affordable price is probably the best thing one could do to sustain prosperity. In this regard, the World Organisation for Animal Health (known as the OIE) has taken a leading role in terms of developing and adopting science based standards of animal welfare, especially

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during transport (by air, sea and land), humane slaughter and killing for disease control purposes. The OIE is also providing help and guidance to 172 (and increasing) member states to enable them draft national animal welfare legislations. The Food and Agricultural Organisation (FAO), European Commission and non-governmental organisations (NGOs) are working together and have a more comprehensive animal welfare initiative for the developing countries (for details visit, http://www.fao.org/ag/againfo/programmes/animal-welfare/en/).

The purpose of this article is to highlight some of the welfare concerns associated with the major stunning methods and the need for standardisation of procedures. Poultry stunning methods have been previously reviewed in detail with regard to commercial developments and requirements to ensuring bird welfare (Bilgili, 1999; Raj and Tserveni-Gousi, 2000; Raj, 2003; Raj, 2006). A more comprehensive scientific report on the stunning and slaughter of animals has also been published by the European Food Safety Authority (EFSA scientific report and opinion of the Animal Health and Anima Welfare Panel can be accessed at http://www.efsa.europa.eu/EFSA/efsa_locale-1178620753812_1178620775454.htm). The Farm Animal Welfare Council (FAWC) in the UK also published its own recommendations on stunning and slaughter of poultry (report can be accessed at http://www.fawc.org.uk/reports.htm).

11.2 Distinction Between Mammals and Birds

In most existing animal welfare legislation, “poultry” are included in the definition of “animal”. This is legitimate, because advancement in science has revealed that the functional anatomy essential to support life is very similar in birds and mammals and they are, by the virtue of being sentient, equally susceptible to suffer pain and distress (Gentle, 1992; Gentle and Tilston, 2000). In general, since the number of birds slaughtered each year for human consumption exceeds mammals by billions, any compromises in welfare of poultry at slaughter represents a huge amount of suffering.

However, the existing legislation in some countries would appear to be contradictory and illogical to purists concerned with the welfare of poultry. For example, it is generally an offence to hang live and conscious mammals (e.g. cattle, sheep, goat, pigs or rabbits) up-side-down prior to stunning, whereas, it can be done legitimately to poultry. Secondly, any mammal found to have broken bone(s) or dislocated joint(s) at the time of arrival in the slaughterhouse must be humanely killed before their carcasses are moved, where as, any poultry affected by similar conditions are permitted to be uncrated (including tipping), shackled and prone to further pain and suffering associated with the pre-slaughter processes. Thirdly, when an electric current is used for stunning mammals, it can be applied either across the head (spanning the brain) or head-to-body (spanning the brain and the heart). Ironically, the head-to-body stunning (also known as electrocution) must always lead to cardiac arrest and death in mammals, whereas, it is not a pre-requisite in poultry species.

These contradictions in legislation suggest that the distinction between mammals and birds is not based on moral or ethical grounds. Therefore, purists could argue that real improvements to bird welfare at slaughter cannot be assured until these contradictions are resolved. Poultry should also be stunned prior to shackling, birds suffering from broken bone(s) and/or dislocated joint(s) must be humanely killed before shackling and electrocution must always induce death via cardiac arrest in poultry species also.

Nevertheless, electrocution (water bath stunning) and exposure to gas mixtures are the two major methods of stunning/killing poultry under commercial conditions. Head-only electrical stunning is used to stun small number of birds on the farm and in small abattoirs, at least in the UK.

11.3 Electrocution or Electrical Water Bath Stunning

Multiple bird electrical water bath stunning is the most common and cheapest method of rendering poultry unconscious prior to slaughter under commercial conditions, where high throughput rates are required. Under this system, conscious birds are hung by the legs upside-down on a moving metal shackle line and their heads passed through an electrified water bath, such that the current flows through the whole body towards the shackle, the earth. There are many welfare problems associated with commercial electrical water bath stunning systems, which raise the concern whether it will ever be possible to achieve humane stunning without causing avoidable pain and/or suffering to conscious poultry.

11.3.1 Pain and Suffering Associated with Uncrating

Three types of crates (containers) are used for transporting chickens to processing plants with high rates of throughput. From bird welfare and meat quality points of views, the type of crate with drawers that open is considered to be better than the old fashioned loose crate (which involves removing birds through a hole of about A4 size paper) and modules (which involve tipping birds on to conveyor belts from a height of more than 2 m.). The pain and suffering associated with the uncrating would be worse in birds with broken bone(s) and/or dislocated joint(s) that had occurred as a result of rough handling on the farm or during loading.

11.3.2 Pain and Suffering Associated with Shackling

The legs of birds are compressed during shackling and the degree of compression can be as high as 20% (Sparrey, 1994). Based on the presence of nociceptors in the shank skin of poultry and the close similarities between birds and mammals in nociception and pain, it has been concluded that shackling is a painful procedure (Gentle, 1992; Gentle and Tilston, 2000). This pain and suffering is likely to be worse in birds suffering from painful lameness due to diseases or abnormalities of leg joint/bone (Butterworth, 1999; Danbury et al., 2000). In this regard, the prevalence of extreme lameness in broiler chickens has been reported to be up to 15% in Denmark and about 1% in the UK (Berg and Sanotra, 2001; Sanotra et al., 2001; Butterworth, 1999). In a recent survey of 176 broiler flocks in the UK, it was found that 27.6% of birds had lameness causing poor locomotion and 3.3% were almost unable to walk (Knowles et al., 2008). This pain is also likely to be significant in birds suffering from dislocation of joints and/or fracture of bones induced by rough handling during catching, crating and uncrating. In light of this knowledge, the maximum time for which birds may be suspended from shackle lines before water bath stunning has been reduced recently in UK legislation from previously accepted maximum times of 6 and 3 min to 3 and 2 min, for turkeys and broilers respectively. This change is probably due to the improved scientific knowledge and understanding of the pathogenesis of lameness and associated pain, and a sustained campaign by the animal welfare organisations (e.g. Royal Society for the Prevention of Cruelty to Animals (RSPCA) in the UK). In view of the fact that broilers of similar genetic makeup are reared under intensive husbandry systems, the potential welfare problem associated with lameness could be a universal welfare issue. Therefore, global consensus needs to be reached on the duration of conscious birds being suspended up side down on moving metal shackles and the OIE standards should be amended. Birds suffering from broken bone(s) and/or dislocated joint(s) should be humanely killed prior to shackling. Live bird shackling of poultry should be eliminated in the long term as methods of stunning poultry in transport crates using gas mixtures prior to shackling are available (see, gas or controlled atmosphere stunning).

11.3.3 Pain and Suffering Associated with Pre-stun Electric Shocks

The severity of pain associated with an electric shock needs no explanation. The complexity of commercial water bath stunning systems and the physical contact between birds on the shackle line make it difficult, if not impossible, to control the current pathway and eliminate this potential problem.

11.3.4 Delivery of Sufficient Current to Render Each Bird Unconscious

The commercial electrical water bath stunner may contain many birds (e.g. up to 20) at any one moment and, as birds enter a stunner supplied with a constant voltage, they form a continuously changing parallel electrical circuit (Sparrey et al., 1993). Under this situation, according to Ohm's law, each bird will receive a current inversely proportional to the electrical resistance or impedance in the pathway.

The effective electrical impedance can vary between birds, usually between 1,000 and 2,600 Ω in broilers and 1,900 and 7,000 Ω in layer hens (Schutt-Abraham et al., 1987; Schutt-Abraham and Wormuth, 1991). Ironically, most of the electrical impedance in the pathway between the electrified water bath and the earth is attributed to the poor contact between the legs and metal shackle. The implication of this is that tighter shackle-leg fitting will reduce the electrical impedance, but this, of course, will have the negative effect of increased suffering due to pain. However, owing to the variable electrical impedance, it will be impossible to deliver to each bird in a water bath stunner a pre-set minimum current necessary to achieve humane stunning (Sparrey et al., 1992). On the other hand, it has been suggested that installation of constant current stunners under commercial conditions would ensure delivery of a pre-set current to each of the birds in a water bath (Sparrey et al., 1993). During stunning with a variable voltage/constant current stunner, each bird is electrically isolated and the stunner modulates the voltage required to deliver a pre-set current by continuously monitoring the impedance in the pathway. However, considering that the birds are suspended on shackles 15 cm apart and the processing line is operating at a speed of up to 220 birds per minute, it has been argued that it will be extremely difficult to isolate each bird long enough to measure its resistance or impedance in the pathway and deliver the pre-set current (Bilgili, 1999). In other words, high throughput rates are not conducive to the efficient functioning of constant current stunners. However, owing to the differences in the electrical resistance of various tissues in the pathway, it has been reported that only a small proportion of current (10–28%) applied in a water bath may flow through the brain and the majority may flow through the carcass (Wooley et al., 1986a, b), which seems to question the humanitarian advantages of a constant current water bath stunning system.

11.3.5 Determination of Unconsciousness and Insensibility Following Electrical Stunning

In general, the neurophysiological basis of electrical stunning is that, when an electrical current of sufficient magnitude is applied to the brain, it induces *grand mal* epilepsy. In human beings, *grand mal* epilepsy is always associated with unconsciousness and insensibility, and therefore, the induction of *grand mal* epilepsy has been universally accepted as a requirement for effective electrical stunning in mammals. For example, a minimum current of 1.3 Amp has been used for stunning pigs, head-only or head-to-body (Hoenderken, 1978; Lambooy, 1981).

However, in contrast with the mammalian species, electrical stunning (head-only or water bath) of chickens seldom produces a *grand mal* epilepsy in the brain. Instead, only a small proportion of them develop "epileptiform" activity in the EEG following electrical stunning (Gregory and Wotton, 1987) and about 90% of birds that develop "epileptiform" activity show low frequency (<3 Hz) polyspike or spike and wave activity (Gregory 1987). This observation may be disconcerting from a welfare point of view because literature concerning epilepsy in humans suggests that the manifestation of spike-wave discharges or generalised spikes of 3–4 Hz in the EEG is not associated with unconsciousness (Hawken, 1979; Dreifuss and Ogunyemi, 1992).

On the other hand, Rhody and Kuenzel (1981) found that corneal electrical stimulation (electrical stimulation of the brain through the eyes) in paroxysmal (px) chicks, in which genetically inherited neuronal lesions lead to spontaneous epilepsy and seizure, results in spike and wave activity in the EEG. In comparison with normal siblings, px chicks have been found to suffer from dysfunction of gamma amino butyric acid (GABA), an inhibitory amino acid neurotransmitter (IAA), in pathways in the brain (Firman and Beck, 1984; Lewis et al., 1994). Together, these reports lead to speculation that a low frequency polyspike pattern, induced by electrical stunning, may be associated with unconsciousness in chickens, provided that modern commercial strains of chickens are also assumed to be suffering from GABA dysfunction.

It has also been reported that, in contrast with the low frequency polyspike activity in the EEG of px chicks induced by electrical stimulation, corneal electrical stimulation in normal siblings resulted in a profoundly suppressed EEG (Rhody and Kuenzel, 1981). Therefore, it is not surprising to find that the pioneering studies into refining electrical stunning of chickens have also used the occurrence of a profoundly suppressed EEG as a criterion to determine its effectiveness (Richards and Sykes, 1967; Kuenzel and Walther, 1978). Indeed, the low frequency polyspike activity occurring in electrically-stunned modern commercial chickens also leads to a suppressed EEG, provided that the stunning current applied is in excess of 100 mA per bird in a water bath stunner (Gregory, 1987). Therefore, the occurrence of low frequency polyspike activity immediately followed by a profoundly suppressed EEG after electrical stunning in chickens could be considered as indicators of effective stunning and that these manifestations are the net result of dominant IAA neurotransmitter/neuromodulator mechanisms in this species.

Nevertheless, from a bird welfare point of view, the duration of unconsciousness induced by electrical stunning must last longer than the time to onset of brain death through blood loss. In other words, the profoundly suppressed EEG induced by electrical stunning should lead to an isoelectric EEG during bleeding. Therefore, Schutt-Abraham et al. (1983) evaluated electrical stunning of broiler chickens using the criteria listed below and concluded that a minimum of 120 mA per bird in a water bath will be necessary to achieve humane stunning whilst using a 50 Hz sine wave alternating current (AC).

Adequately stunned: The EEG showed a pattern of polyspike burst followed by a flat or "isoelectric" line as characteristic for a complete epileptic fit. This pattern had to last for at least 30 s after the onset of current flow to ensure that the birds do not regain consciousness during bleeding.

Inadequately stunned: The EEG pattern was similar to above but either lasted for less than 30 s or lacked the flat or "isoelectric" line, the latter pattern being looked upon as incomplete epileptic fit.

Not stunned at all: The EEG pattern remained similar to the pre-stunning one; no epilepsy occurred.

Research, carried out during the 1980s, showed that a minimum current of 120 mA per chicken in a water bath, delivered using either a 50 Hz sine wave AC or 350 Hz a pulsed direct current (DC), will be necessary to abolish somatosensory evoked potentials (SEPs are evoked electrical activity in the brain occurring in response to painful stimuli such as electrical stimulation of a peripheral nerve) following stunning (Gregory and Wotton, 1989; 1990a and 1991). These results and those of Scutt-Abraham et al. (1983) suggest that in a water bath a minimum of 120 mA per chicken will be necessary to achieve effective stunning and that the occurrence of a profoundly suppressed EEG and abolition of SEPs are intrinsically linked. However, since application of dopamine has been reported to attenuate neuronal excitation occurring during somatosensory stimulation in behaving monkeys (Rolls et al., 1984), abolition of SEPs alone may not be used as a reliable predictor of the effective electrical stunning in chickens. In this regard, the inevitable pre-slaughter handling stress (manual catching and shackling) associated with the electrical water bath stunning is very likely to elevate chicken brain dopamine levels (Gruss and Braun, 1997), which could suppress the SEPs.

It has been reported that a current level of 120 mA delivered using a 50 Hz sine wave AC will induce cardiac arrest in 95% of chickens (Gregory and Wotton, 1990a). However, a high current such as this was also found to be detrimental to carcass and meat quality (Gregory and Wilkins, 1989; Wilkins et al., 1998). Therefore, a lower current of 105 mA per chicken in a water bath stunner has been recommended in the UK and this amount of current when delivered using a 50 Hz sine wave AC will induce cardiac arrest in 90% of birds (Gregory and Wotton, 1990a). In the same study, based on the time to return of normal neck muscle tone in birds that did not suffer cardiac arrest at stunning, it was suggested that 105 mA per bird in a water bath stunner will induce 52 s of apparent unconsciousness. This interpretation may be considered valid in this context because a current of greater than 100 mA has been known to induce a suppressed EEG, and hence, unconsciousness (Gregory, 1987). The Farm Animal Welfare Council (FAWC, 2009) favours the use of stun-to-kill electrical systems, "which deliver certainty that a bird's welfare cannot be compromised once the stun has been administered".

Subsequent studies carried out during the 1990s into evaluating the effectiveness of electrical water bath stunning seem to have unwittingly ignored the importance of neurophysiological evidence and, instead, have relied entirely on the induction of seizures or loss of muscle tone as criteria for determining effective stunning and, the time to recovery of neck muscle tension as an indicator of recovery of consciousness following electrical water bath stunning (Rawles et al., 1995; Wilkins et al., 1999; Wotton and Wilkins, 1999). By contrast, scientific literature suggests that these cannot be true predictors of the state of consciousness following electrical water bath stunning. For example, effective electrical water bath stunning-induced release of neurotransmitter/neuromodulator (e.g. nor-adrenaline) in the chicken brain could play an important role in the induction and maintenance of unconsciousness and, its release in the spinal cord could provide analgesia. Indeed, many modern sedatives, anaesthetics and analgesics have been developed on the basis of interfering with these brain mechanisms. However, from an electrical stunning point of view, this combination of central and peripheral effects of water bath stunning on neurotransmitters can be evidenced from the fact that it leads to tonic convulsions, whereas, head-only electrical stunning, in which only the effect on the brain will be manifested, induces clonic convulsions (wing flapping). In addition, it has been estimated that, under water bath electrical stunning situations, only a small proportion of applied current (10–28% of applied current) may flow through the brain and the majority of current may flow through the carcass (Wooley et al., 1986a, b), which includes the peripheral nervous system and neuro-muscular junctions. This implies that the neurotransmitter-mediated responses following electrical water bath stunning could vary according to the amount of current flowing through different tissues. More importantly, if the amount of current flowing through the peripheral nervous system is greater than the amount of current flowing through the brain, the resumption of normal brain function is likely to precede that of the peripheral nervous system, including neuro-muscular junction.

It has been reported that the greater the volume of skeletal muscle, the greater the proportion of current flowing through it during water bath electrical stunning (Mouchoniere et al., 1999). This finding is further supported by another study in which it was found that, at a given current level, broilers weighing >2.70 kg took longer to regain neck muscle tension than those weighing <1.68 kg (Wilkins et al., 1998). Further evidence against the use of muscle tone to determine the state of unconscious following water bath stunning emerges from the reports that water bath stunning of chickens with 105 mA per bird for 3 s induced 52 s of apparent insensibility, where as, head-only electrical stunning of chickens with 336 mA for 7 s induced 26 s of insensibility (Gregory and Wotton, 1990a, b). Clearly, the time to return of neck muscle tone under the water bath electrical stunning system is twice as long when compared with the head-only electrical stunning (which does not involve the peripheral effects of the stunning current). Therefore, it will be unwise to determine the effectiveness of electrical water bath stunning based on loss of muscle tone and estimate the duration of unconsciousness using the time to return of neck muscle tone.

The problem with the electrical water bath stunning system is further confounded by the apparent conflict between bird welfare and meat quality (Gregory and Wilkins, 1989). Therefore, high frequency (>300 Hz) stunning delivered using different wave forms of currents, which do not adversely affect the carcass and meat quality, has become more prevalent under commercial conditions (Wilkins et al., 1998). In this regard, a chicken water bath stunner involving ultrabrief pulsed DC has been introduced purely on the grounds that it is not detrimental to carcass and meat quality (Wotton and Wilkins, 1999). While using this stunner, a current of 15 mA or less per bird in the water bath stunners has been justified purely on the basis of induction of seizure and the time to return of neck muscle tone. A prolonged application of such a low current delivered with this waveform and frequency may eventually lead to immobilisation, rather than epileptiform activity in the brain, which could be misinterpreted as effective electrical stunning. Another disconcerting fact is that a two-stage electrical water bath stunning system, involving application of a “relaxation” current in the first phase and a “stunning” current in the second phase, has been introduced under commercial conditions. Although the electrical parameters involved in this stunner are not known, this kind of water bath stunning system is not only lacking scientific rationale but also seriously infringes any legal welfare requirement to immediately render the birds unconscious. Therefore, the use of such systems should be actively discouraged.

Evidently, the amount of current necessary to induce seizure (muscle tremors resembling epileptic fits) is less than that is necessary to induce epileptiform activity in the EEGs. In this regard, both effectively and ineffectively stunned birds show seizures and therefore induction of seizure cannot be used to monitor the effectiveness of stunning. It is worth noting that spontaneous breathing, blinking of eyes and response to touching the eyes would be absent during the period of occurrence of seizures, which makes the distinction between immobilisation and effective stunning more difficult. In order to overcome this practical problem, electrical water bath stunning has been described in the proposed European Regulations (which can be accessed at http://ec.europa.eu/food/animal/welfare/slaughter/proposal_en.pdf) as "Exposure of the entire body through a water bath to a current generating a generalised epileptic form on the EEG (stunning) and possibly the fibrillation or the stopping of the heart (killing)". Additionally, equipment used for stunning animals should be evaluated by independent laboratory, licensed and accompany standard operating procedures.

Nevertheless, literature concerning direct stimulation of neurones in the brain indicate that (a) symmetrical biphasic electrical stimuli activated fibres of passage, axon terminals and local cells around the electrode at similar thresholds, (b) a predominantly anodic or positive electrical pulse selectively activated local cells, (c) a predominantly cathodic or negative electrical pulse selectively activated fibres of passage, (d) in all the electrical stimulation waveforms, the threshold for activation of axon terminals was lower than the threshold for direct activation of cells, and (e) the output from stimulated cells, which affected other cells, was dependent on electrical stimulation frequency (see, McIntyre and Grill, 2002). This implies that the electrical waveforms used for stunning would have a significant impact on the welfare of birds at slaughter. In this sense, alternating current (AC) induced electrical fields would affect cell axis both parallel and perpendicular to the field, whereas, direct current (DC) fields affect only cell axis parallel to the electrical field. Research has shown that prevalence of epileptiform activity in the EEG and the magnitude and duration of EEG suppression occurring following head-only or water bath electrical stunning of chickens are dependent on the waveform (biphasic/alternating current or monophasic/pulsed direct current), frequency (Hz) and amount (mA) of the current applied to individual bird (Mouchoniere et al., 2000; Raj and O'Callaghan, 2004a, b).

In a recent study, broilers were stunned individually in a water bath stunner by delivering a constant current of 100, 150 or 200 mA for one second using 200, 400, 600, 800, 1,000, 1,200 or 1,400 Hz sine wave AC and the birds were slaughtered manually using a unilateral or ventral neck cutting procedure (Raj et al., 2006a). The results of this study showed that the probability of inducing epileptiform activity in most of the broilers was dependant on the electrical stunning current and frequency.

In this regard, effective water bath stunning of broilers would be achieved with a minimum current of 100, 150 and 200 mA delivered using frequencies of up to 200, 600 and 800 Hz, respectively. It is likely that electrical frequency greater than 800 Hz would have required a minimum current of more than 200 mA, to induce epileptiform activity in the EEGs of majority of the broilers. Based on these results it was suggested that effective water bath stunning of broilers with a minimum current of 100, 150 and 200 mA could be achieved with electrical frequencies of up to 200, 600 and 800 Hz, respectively.

In another study, broilers were stunned individually for 1 s with a constant average current of 100, 150 or 200 mA delivered using either 200, 800 or 1,400 Hz pulsed DC (unipolar square wave) (Raj et al., 2006b). In this study, the probability of occurrence of epileptiform EEG decreased as frequency increased at each of the average current levels tested. The probability of inducing epileptiform activity, and hence effective stunning, in high proportion (80%) of broilers was limited to 200 mA average current delivered using 200 Hz pulsed DC. Based on the results, it was recommended that a minimum of 200 mA average (400 mA peak) current per bird should be delivered using 200 Hz pulsed DC with a mark:space ratio of 1:1 to achieve effective water bath stunning in 80% of broilers. However, electrical water bath stunning of broilers with 200 mA average current of 200 Hz resulted in cardiac arrest in some birds without epileptiform EEGs indicative of effective stunning. Owing to the prevalence of cardiac arrest in conscious broilers, the use of pulsed DC for water bath stunning of broilers could be questioned on ethical and bird welfare grounds.

Another study evaluated the affect of the pulse width of a direct current (DC) on the effectiveness of electrical water bath stunning, and slaughter, in broilers (Raj et al., 2006c). In this study, broilers were stunned individually in a water bath stunner for 1 s with a constant peak current of 400 mA of a 200 Hz pulsed DC. The pulse width of the 200 Hz DC was set at 0.5, 1.5 or 2.5 msec (10, 30 or 50% of 5 msec current cycle for 200 Hz). At this peak current level, reducing the pulse width would lead to proportional reduction in the amount of average current. Therefore, the average currents delivered to broilers were calculated to be 40 ($0.5/5 \times 400$), 120 ($1.5/5 \times 400$) and 200 ($2.5/5 \times 400$) mA. Broilers were slaughtered using either a unilateral or a ventral neck cutting procedure. The results of this study showed that the pulse width had a significant effect on the incidence of epileptiform activity in the EEGs. In this regard, pulse widths of 10, 30 and 50% of current cycle induced epileptiform activity in 13, 73 and 80% of broilers, respectively. Based on the results, it was recommended that a pulse width of at least 30% of current cycle would be necessary to induce epileptiform EEGs in the majority of birds.

11.3.6 Effect of Neck Cutting Procedures

It has been known that the time to onset of brain death in chicken is quicker with the induction of cardiac arrest at stunning, decapitation and severance of the two carotid arteries supplying oxygenated blood to the brain, than other neck cutting procedures

(Gregory and Wotton, 1986). Recent studies have shown that ventral neck cutting procedure severing two carotid arteries and two jugular veins prevented resumption of consciousness, where as, unilateral neck cutting severing one carotid and one jugular vein resulted in recovery of consciousness in broilers stunned with high frequency currents (Raj et al., 2006a, b and c). In spite of these reports, the poultry industry in many countries continues to severe one jugular vein or a small vein at the back of the neck of poultry that were stunned, rather than killed. These inappropriate neck cutting procedures, if implemented following stunning with high frequencies and/or low currents, could lead to recovery of consciousness during bleeding and, inevitably, live birds entering scald tanks (Raj, 2006).

11.3.7 Live Birds Entering Scald Tanks

Live birds can enter scald tanks under two scenarios. Firstly, inadequately stunned birds and those that have missed the stunner, due to wing flapping or being runts, are very likely to miss the neck cutter by holding their heads up. Occasionally, effectively stunned birds also miss the neck cutting machine due to the fact that they miss the rails that guide the neck towards the blade(s). Hence, if these birds are not slaughtered manually, they will enter the scald tank live and conscious. Secondly, adequately stunned birds could have a poor neck cut and hence enter the scald tank alive but unconscious. Although legislation requires that a manual back-up should be present to cut necks of birds that missed the neck cutter, owing to fast throughput rates, manual back-up alone is not sufficient to prevent this potential welfare problem.

The potential welfare problem of live birds entering scald tanks, recognized by the occurrence of "red-skin" carcasses, was reported to be the result of poor slaughter procedures (Harris and Carter, 1977). In the 1980s, it was reported that almost one third of the birds processed under commercial conditions may be entering scald tanks alive (Heath et al., 1981; Griffiths and Purcell, 1984). Heath et al., (1983) suggested that red-skin carcasses are produced from poultry that are alive when they entered the scald tanks and this was later confirmed experimentally by Griffiths (1985) to be the consequence of an acute inflammatory reaction. In recent years, the potential for this problem to occur has increased due to the use of high frequency currents (which do not induce cardiac arrest) in the water bath and significant increases in throughput rates.

11.4 Electrical Stun/Kill Method

Head-only electrical stunning is commonly used to manually stun small numbers of poultry on farms. Accurately administered head-only electrical stunning is probably the quickest method of stunning poultry, and certainly, better than water bath stunning. However, there are at least two practical problems associated with the head-only electrical stunning of poultry. Firstly, head-only electrical stunning devices are restricted, by operator health and safety laws in some countries, to use a maximum of 110 V, and this low voltage may not be adequate to stun poultry immediately (e.g. within a second), especially waterfowl. Ironically, such restrictions do not seem to apply to devices used for manual electrical stunning of pigs. Secondly, the conventional stunning electrodes, which consist of a few pins as electrical contact points, have a very small surface area that is in contact with the head and this is not conducive to delivering sufficient current to induce immediate loss of consciousness, in particular, when using low voltages.

Ideally, electrodes should be conformable to the shape of the head such that the contact area is relatively large and the electrode material should have low electrical impedance. For example, electrodes made of steel wire mesh (one square millimetre) filled with fine steel wire not only conforms to the shape of the head but also has a relatively lower electrical impedance than steel plates or pins (personal observation). A recent study in which broilers were stunned head-only, using conformable electrodes, showed that a current of 100 mA is sufficient (Raj and O'Callaghan, 2004a). This amount of current is significantly less than 240 mA recommended as the minimum current for stunning chickens, using the conventional tongs (Gregory and Wotton, 1990b).

On the other hand, head-only electrical stunning also results in severe wing flapping, which is not conducive for prompt and accurate cutting of carotid arteries in the neck or maintaining good carcass and meat quality. Therefore, birds will have to be appropriately restrained and promptly bled out. Alternatively, poultry can be firstly stunned head-only using a pair of hand-held tongs and then killed immediately by passing an electric current either from head to body or across the chest such that the electrical field spans the heart. In general, induction of cardiac arrest at stunning has been known to eliminate convulsions and recovery of consciousness following stunning.

This electrical stun/kill method appears to be more humane than the induction of cardiac arrest in a water bath stunner. Firstly, the stunning current is applied focally to the head in order to span the brain, prior to the induction of cardiac arrest. This will enable the application of any amount of current, that is found to be adequate for any one species of bird on welfare grounds, without compromising carcass and meat quality which would otherwise occur under the water bath system (Raj et al., 2001). Secondly, it is envisaged that the alternative stun/kill method will be applied to birds which are restrained in a sitting posture using a pair of conveyors which will enable shackling to be performed, either manually or automatically, on freshly killed carcasses. This will certainly eliminate the stress and pain associated with the shackling of conscious birds under the water bath system. The Silsoe Engineering Research Institute in the UK has developed a prototype electrical stun/kill system, which should help the small poultry processors achieve greater standards. Such a system aimed at improving bird welfare at slaughter has also been found to provide an incentive to the industry through improved carcass and meat quality (Raj et al., 2001).

In addition, birds killed using the electrical stun/kill technique remain in a tonic state (rigidly extended legs) for a period of about 20 s post-kill and this may provide opportunity for automatic shackling of freshly killed poultry (personal observation). In this regard, it is worth mentioning that automatic shackling and, hence, reducing labour cost has been the aspiration of equipment manufacturers and poultry processors alike for many years.

However, the potential for large scale application of this technique remains to be seen, because, the welfare problems associated with the methods of uncrating and orientating live birds, restraint and application of electrodes in the correct position, and the consistency of achieving humane death have not been fully evaluated.

11.5 Gas or Controlled Atmosphere Stunning/Killing of Poultry

Based on the welfare concern associated with electrical water bath stunning, it was suggested by the Farm Animal Welfare Council in the UK that research should be carried out to test the suitability of using carbon dioxide for stunning, while the birds were still in their transport containers (FAWC, 1982). Gentle and Tilston (2000) reiterated that the pain associated with shackling of poultry can be severe, and therefore, recommended killing poultry in transport containers using gas mixtures. Although many would agree with this recommendation, the opinion regarding what gas mixture should be used for killing poultry seems to be divided.

It is known that poultry can be killed by exposing them to either an anoxic atmosphere created with nitrogen or argon, or a minimum of 45% by volume of carbon dioxide in air (Raj et al., 1992). However, since the induction of unconsciousness with gas mixtures is a gradual process (not immediate), people concerned with bird welfare argue that the gas mixture should be non-aversive and the induction of unconsciousness should not be distressing to the birds. This argument is based on the real concern that the inherent problems with the electrical water bath stunning should not be replaced with a new set of problems, such as, stressful induction of unconsciousness. This view is supported by the fact that chickens and turkeys, given a free choice, refused to enter a feeding chamber containing high concentrations of carbon dioxide (Raj, 1996; McKeegan et al., 2003; Sandilands et al., 2006). In this study, the aversive effects of carbon dioxide were found to be stronger than the motivation to feed after overnight fasting. This is hardly surprising (to those who have inhaled this gas!) because carbon dioxide is an acidic gas and is pungent to inhale. It is also a potent respiratory stimulant (increases rate and depth of breathing), and induces respiratory distress during the induction of unconsciousness (Gregory et al., 1990). For example, the head shaking and gasping behaviour that occur during exposure to gas mixtures containing carbon dioxide very much resemble those described in veterinary text books as "respiratory distress" occurring during respiratory diseases. In addition, sneezing and/or vocalisation occur in disease as well as during exposure to carbon dioxide gas. Based on this similarity, it is reasonable to assume that inhalation of carbon dioxide gas is distressing.

By contrast, it can also be argued that the unpleasantness associated with the induction of unconsciousness with a high concentration of carbon dioxide for a brief period, for example 30 s, may be less than the cumulative pain and suffering associated with the electrical water bath stunning. In addition, using carbon dioxide for stunning pigs is an approved method in many countries. However, it has been shown that inhalation of 80% carbon dioxide is aversive to pigs, induces severe respiratory distress and that the induction of unconsciousness can take up to 45 s (Cantieni, 1976; Hoenderken et al., 1979; Raj and Gregory, 1995 and 1996; Raj, 1999). However, people wanting to use carbon dioxide stunning of poultry would argue that it is illogical to allow the stunning of pigs with carbon dioxide and disallow stunning of poultry with this gas, in which there is a significant welfare advantage when compared with the electrical water bath stunning systems. On this basis, different types of carbon dioxide stunning systems have been developed around the world and, the worst one (on bird welfare grounds) involves shackling of live poultry prior to exposure to this gas. Evidently, this carbon dioxide stunning system is operating in countries where there is no legal requirement for humane stunning of poultry. Other carbon dioxide stunning systems involve tipping of live birds from transport modules on to conveyors and passing them through a tunnel containing high concentrations of, or gradients of, carbon dioxide gas. There are also two-phase stunning systems operating in Europe. One involves stunning poultry with exposure to a mixture of 40% carbon dioxide and 30% oxygen and then killing them with an exposure to 80% carbon dioxide in air (Coenen et al., 2000). Another system involves stunning of poultry with exposure to 30% carbon dioxide and then killing them with exposure to 60% carbon dioxide. However, control of temperature and humidity of carbon dioxide gas mixtures in the stunning atmosphere could improve the welfare of birds. For example, in humans, nasal breathing of air increases the respiratory system's ability to warm and humidify the inspired air compared to oral breathing. By contrast, oral breathing, in particular, during exercise-induced hyperventilation results in the drying and cooling of upper respiratory tract, and this is one of the causes of exercise-induced asthma or bronchoconstriction. Under these circumstances, inhalation of warm and humidified air helps to alleviate distress and this concept is widely used in human artificial respirators. Since chickens exposed to carbon dioxide gas also show gasping (oral breathing), it is thought that administration of warm and humidified gas mixture will help to reduce the severity of distress occurring during gasping.

On the other hand, it was thought that the argument based on carbon dioxide stunning of pigs does not help to alleviate suffering in either of the species concerned. Therefore, the Ministry of Agriculture, Fisheries and Food (MAFF) (currently known as the Department of Environment, Food and Rural Affairs, DEFRA) in the UK opted to develop potential alternatives. In this regard, anoxia, induced with argon or nitrogen, is known to render animals and birds unconscious. Nitrogen occurs in abundance (about 79%) and argon occurs in minute quantities (<1%) in the atmospheric air and they can be contained in a suitable stunning/killing apparatus. Indeed, exposure to anoxia has been described as the "euphoric way of losing consciousness" in humans (Ernsting, 1965). Research has clearly shown that chickens and turkeys do not show any aversion to the initial exposure to, or inhalation of 90% argon in air with less than 2% residual oxygen (Raj, 1996; Sandilands et al., 2006). Webster and Fletcher (2001) have shown that the behaviour of birds during exposure to argon was very similar to those exposed to atmospheric air, until the birds in argon lost consciousness. Clearly, the induction of unconsciousness in chickens with anoxia is non-aversive and almost stress free.

It has been reported that exposure of chickens to 2% oxygen in argon results in loss of brain responsiveness to a painful stimulus (SEPs) in 29 s, and therefore, it is safe to assume that the birds are rendered unconscious within this period (Raj et al., 1991). However, anoxic convulsions (wing flapping) occurring after the loss of consciousness can be aesthetically unpleasant to some people. In this regard, Ernsting (1965) reported that, under anoxic conditions, depression of activity in the mammalian brain extends progressively from the telencephalon to the diencephalon and then to the mesencephalon. Anoxic convulsions result from the release of the caudal reticular formation from the suppression by higher centres, particularly the cerebral cortex and rostral reticular formation (Dell et al., 1961; Ernsting, 1965). The implication of this is that the onset of anoxic convulsions themselves can be used as an indicator of the loss of consciousness. This interpretation is supported by the fact that captive bolt stunning, in which there is a profound brain damage, leads to severe wing flapping in poultry (Raj and O'Callaghan, 2001). Similarly, decapitation and neck dislocation also induce wing flapping. However, McKeegan et al. (2007) suggested that, on the basis of EEGs recorded during exposure of chickens to anoxia, the EEG suppression occurring at the start of anoxic convulsions is not profound enough to rule out the presence of consciousness. In contrast, Raj et al. (2008) have stated that the EEG changes occurring in chickens during anoxic convulsions are incompatible with the persistence of consciousness and sensibility.

However, the duration of unconsciousness provided by the anoxia may not always be long enough to allow uncrating, shackling and bleeding while the birds remain unconscious. For example, anoxia-stunned chickens regain consciousness as soon as 15 s after returning to atmospheric air (Raj and Gregory, 1990). Thus, it was concluded that the birds should be killed with the gas rather than stunned (Raj and Gregory, 1990; HMSO, 1995).

Since the cost of argon is prohibitive and since it is not readily available in some countries, the use of nitrogen has been suggested as an alternative (Poole and Fletcher, 1995). It is also worth mentioning that the gas stunning/killing installations operating in Europe are using a gas mixture consisting of predominantly (80% by volume) nitrogen and a low proportion (20% by volume) of argon to kill poultry in transport containers. The improved carcass and meat quality achieved with this method and relatively low cost of nitrogen should be attractive to poultry processors wanting to improve welfare of poultry.

It is apparent that, owing to the conflict between bird welfare and meat quality, the potential welfare problems associated with the electrical water bath stunning cannot be eliminated. On the other hand, alternatives such as the use of nitrogen-induced anoxia for killing chickens, while they are in transport containers, would appear to be the most humane option. Although carbon dioxide is aversive to poultry, the welfare problems associated with the live bird handling and electrical water bath stunning systems per se could be used to defend this gas for stunning poultry. On the other hand, it is comforting to learn that gas or controlled atmosphere stunning systems for poultry have been certified for producing Halal meat in Sweden, Denmark, France and Germany (FAWC, 2009). The legislative and poultry processing community should be proactive in implementing welfare-friendly stunning methods.

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Chapter 12
The Future of Poultry Welfare

Suzanne T. Millman, Joy A. Mench, and Anne E. Malleau

12.1 Introduction

In contemplating the future of poultry welfare, one must be aware of the current situation in the context of how this issue has evolved. From this perspective, one may project forward to identify opportunities for continued advancements and barriers that must be negotiated. In this chapter, we will explore the development of poultry welfare as a topic of public concern and of academic inquiry. We will then describe different mechanisms through which improvements in poultry welfare have been achieved. In conclusion, we will analyse the strengths and weaknesses of the existing framework in terms of addressing contemporary poultry welfare issues, and will identify problem areas where further interventions may be necessary to address societal concerns.

12.2 A Description of the Poultry Industry

Chickens were domesticated for ornamentation and cockfighting (Smith and Daniel, 2000). Although small numbers are still kept for these purposes, most chickens today are raised for production of meat (broiler chickens) or eggs (laying hens). Based on the vast numbers of chickens, ducks, geese and turkeys kept worldwide (Fig. 12.1), poultry welfare deserves particular attention. Tremendous increases in chicken inventories since the 1960s occurred in response to consumer demands for poultry meat (Fig. 12.2) and eggs (Fig. 12.3). Since its inception as a commercial enterprise in the 1940s, the poultry industry has grown steadily and become increasingly concentrated, both geographically and in terms of its structure. There has been a progressive reduction in the number of poultry producers and an increase in the size of production units in all developed countries. In the US, for example,

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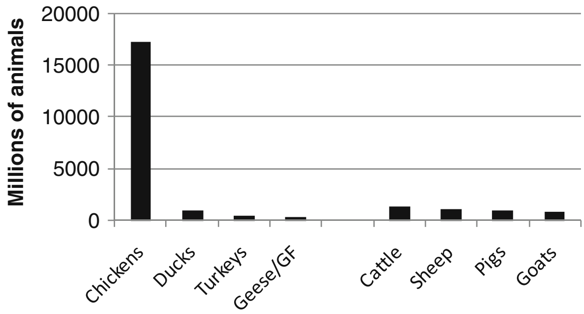

Fig. 12.1 World inventory of (live) food producing animals, based on 2007 data (Food and Agriculture Organization of the United Nations, 2008) GF = Guineafowl

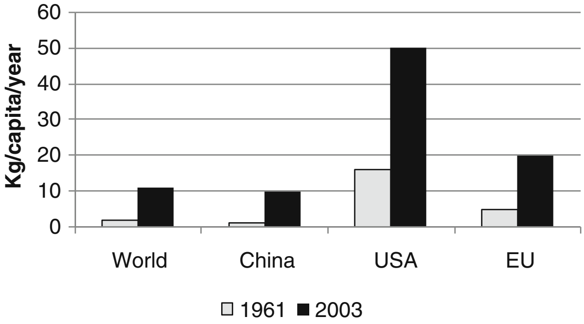

Fig. 12.2 Changes in consumption of poultry meat in selected countries based on data from 1961 to 2003 (Food and Agriculture Organization of the United Nations, 2008)

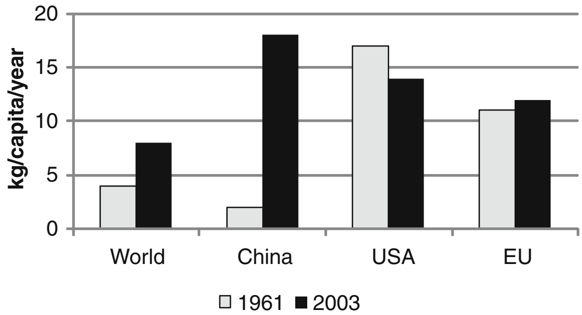

Fig. 12.3 Changes in consumption of eggs in selected countries based on data from 1961 to 2003 (Food and Agriculture Organization of the United Nations, 2008)

there used to be hundreds of companies producing broilers, whereas there are now only about 50, and the top five companies account for nearly 60% of all production (Thornton, 2003). Similarly, around 60 companies own nearly 80% of the laying hens in the US, and modern hen complexes can contain as many as four million birds (Bell, 2002).

In terms of international production of poultry products, China is the largest producer of chickens, ducks and geese, and the United States is the largest producer

Table 12.1 Top poultry producing countries, based on 2007 live animal inventory (Food and Agriculture Organization of the United Nations, 2008)

Top countries	Chickens	Ducks	Turkeys	Geese/Guineafowl
1	China (4,512 million)	China (737.2 million)	USA (271.7 million)	China (293.2 million)
2	USA 2,050 million)	Viet Nam (62.8 million)	France (28.1 million)	Egypt (9.2 million)
3	Indonesia (1,345 million)	India (35.0 million)	Chile (28.0 million)	Ukraine (8.9 million)
4	Brazil (999 million)	Indonesia (34.1 million)	Italy (25.0 million)	Romania (4.5 million)

Inventory is presented in parentheses.

of turkeys (Table 12.1). Even within the US, broiler and turkey meat production is primarily concentrated in only one region, the south-eastern part of the country, and is a significant economic force in this region. However, it is important to recognize that many poultry production companies have become large multinational enterprises, often with a vertically integrated structure in which the activities of a single company may range from growing of grains and feedstuff formulation, through hatching and rearing of chicks, housing of laying flocks or production of broilers, to processing and marketing of eggs or finished meat products. Vertical integration is the most cost-effective model of poultry production; it is estimated that to reach the "break point" for economic efficiency on a commercial broiler farm in the US, a company must now process 65 million birds per year (Aho, 2002).

Genetic selection has made a major contribution to the economic success and development of modern poultry production, and the breeding of poultry has become a large global industry in its own right. Worldwide, there are now fewer than two dozen companies that maintain the foundation and grandparent stocks of layers and broilers, referred to as primary breeder companies. These companies are responsible for the development and implementation of genetic selection programs to produce desirable phenotypes. Progeny of the grandparent stocks are then supplied to poultry companies to be reared as parent stock for the production of broilers and laying hens.

12.3 The Emergence of Public Concern About Poultry Production Practices

One consequence of concentration of the poultry industry, and of housing flocks in restricted-entry facilities, is that average citizens have lost their connection with how birds are raised for the production of poultry meat and eggs. In recognition of this, British writer Ruth Harrison detailed her concerns about the welfare of animals raised in commercial production systems in the influential book, *Animal Machines*

(Harrison, 1964). As a non-scientist and someone not involved with agriculture, Harrison described husbandry practices used in the meat, egg and dairy industries in lay language that resonated with the general public, and she articulated many of the welfare concerns that are still being debated today. Approximately one-third of her book was devoted to laying hens and broilers, with concerns raised about pain associated with elective surgeries, such as beak trimming, deficiencies in battery cage design for housing laying hens, and problems, such as lameness, that are associated with fast growth in broilers. Public outcry prompted the British government to commission an investigation of these claims, and the resulting Brambell Report (Command Paper 2836, 1965) articulated many of the same concerns raised by Harrison.

Opinion surveys indicate that concerns about animal welfare resonate with the general public. In 2005, the European Commission's Health and Consumer Protection Directorate General commissioned a comprehensive survey of public attitudes towards animal welfare, involving 24,708 citizens in 25 Member States of the European Union (Eurobarometer, 2005). Only 32% of respondents had a positive view about the welfare of laying hens and 22% had a very negative view of their welfare. More than 40% of respondents chose laying hens and broilers among the top three species needing improvements in their welfare. However, there are regional differences in the level of concern for animal welfare, and only 52% of respondents reported that they consider animal welfare when they are making their food purchases. Similarly, in an American Farm Bureau sponsored survey, >60% of respondents felt that the government should take an active role in promoting farm animal welfare, and 69–88% of respondents agreed with the statement "I would vote for a law in my state that would require farmers to treat their animals more humanely" (Lusk and Norwood, 2008). Fifty-six percent of respondents in this study felt that decisions about animal welfare should be made by the "experts" rather than the public. Interestingly, a survey of animal science faculty at US universities revealed support for general principles of animal welfare, and greatest concerns were directed at the welfare of poultry relative to other food producing species (Heleski et al., 2004).

Public awareness of animal welfare has been driven by high profile campaigns and activism about certain issues. For example, Compassion in World Farming placed celebrities in a large-scale cage to draw the attention of the British public to battery cages used in egg production. Similarly, in North America, welfare concerns relating to broiler chickens have been popularized through a campaign organized by People for the Ethical Treatment of Animals (PETA), with actress Pamela Anderson as spokesperson. The increased availability of video technology has also led to filmed evidence of poor housing or inhumane handling of poultry on some farms being broadcast on television news programs and on the internet. Furthermore, depiction of poultry as sentient beings in documentary films, such as *Chickens are People, Too* by J. Kastner (2000), and anthropomorphism in mainstream movies, such as *Chicken Run* by Lord and Park (2000), are increasingly stimulating questions about whether commercial production practices are morally acceptable.

12.4 Academic Interest in the Issue of Animal Welfare

Integral factors necessary for understanding and resolving contentious societal issues are precise terminology and frames of reference from which dialogue can proceed. The emergence of animal ethics and animal welfare science as academic disciplines has provided tools for discourse. In his book, *Animal Liberation*, philosopher Peter Singer (1975) popularized ethical questions about the treatment of animals. Basing his argument on utilitarian ethical principles, Singer proposed that emerging scientific evidence supports the capacity for sentience in some species, meaning that at least some animals can experience feelings of pleasure and pain that may be analogous to feelings experienced by human beings. Consequently, the interests of these animals should be factored into decision-making when weighing costs and benefits associated with a particular course of action. Singer used the example of behavioural deprivation of laying hens housed in battery cages to support his arguments, claiming that the costs to the hens in terms of frustration, pain and fear were greater than the marginal economic benefits obtained by the consumers that bought eggs from these farming systems. Other philosophers have considered treatment of animals in terms of their inherent value and their basic rights as moral agents with independent interests (Regan, 1983), or their rights according to the animal's inherent nature or "telos" (Rollin, 1995). However, the utilitarian framework for animal welfare remains the predominant position referred to in discussions between policymakers, scientists and producers, with costs and benefits weighed according to values placed on impacts to an animal's biological function, its feelings and its inherent nature (Fraser, 1999).

In addition to ethical components of animal welfare, there is a need for factual information about sentience, about the factors that cause suffering and pleasure, and how these concepts may be applied to production environments. Scientific interest in poultry welfare has varied over the decades. In the peer-reviewed *Poultry Science* journal, there has been interest in poultry welfare as far back as 1921 (Fig. 12.4), and increased interest in poultry welfare during the 1950s and 1960s, a period of industrialization with the advent of battery cage systems for laying hens and genetic selection for growth and feed efficiency in broilers and turkeys (Smith and Daniel, 2000). Conversely, scientific articles that cite "welfare" as a subject keyword were notably reduced during the 1970s, when public interest in animal welfare was rapidly increasing. One constraint on publication in peer-reviewed journals is the availability of qualified academic reviewers, and this was a particular problem for the new disciplines of applied ethology and animal welfare science (Millman et al., 2004). In recognition of the increasing importance of behaviour and welfare in contemporary poultry production, *Poultry Science* launched a new journal section in 2005, "Environment, Well-being and Behavior", which has facilitated publication of welfare-related manuscripts. However, the number of poultry welfare manuscripts published is currently small when compared with those in traditional disciplines of economic importance, such as nutrition and genetics.

Exploring animal welfare as a scientific concept became a key focus for many researchers, particularly in the relatively young discipline of applied ethology.

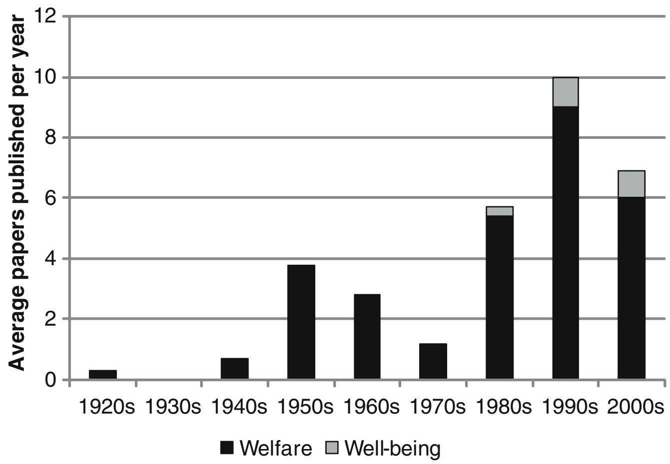

Fig. 12.4 Trends in papers published by *Poultry Science* journal that refer to poultry welfare or well-being in the title and/or abstract. Data for 2000s was based on papers published during January 2000 to December 2007 inclusive

The journal *Applied Animal Ethology* (now *Applied Animal Behaviour Science*) launched its inaugural issue in 1974, and scientific papers were specifically solicited for "Welfare and relationships" as one of three topic areas. In the first issue, one-half of the papers published related to poultry. Research on animal cognition, consciousness and sentience has been an active area of study involving poultry (Duncan and Wood-Gush, 1971; Dawkins, 1976, 1977; Siegel et al., 1978; Duncan, 2002). This may have been facilitated by their small size and rapid growth, relative to other livestock species; poultry are easy to handle and to manage in typical laboratory environments, expediting collection of experimental data. Based on this growing background of fundamental research, there is a better understanding of the cognitive abilities of poultry (Rogers, 1995; Forkman, 2000; Davis and Taylor, 2001; Nicol, 2004), of how they communicate feelings of frustration (Duncan, 1970), fear (Jones, 1989), hunger (Savory et al., 1993) and pain (Gentle et al., 1990; Danbury et al., 2000), as well as relationships between behaviour, stress and poultry health (Zulkifli and Siegel, 1995).

Researchers have applied this fundamental knowledge to address commercial production practices of public concern (Appleby et al., 2004). Novel techniques have been developed to determine preferences of hens for certain resources in their environments and to assess strength of motivation to perform certain behaviour (Hughes, 1976; Dawkins, 1983; Duncan, 1992). This knowledge has been used to improve the design of cages for laying hens (Appleby et al., 2004). Interdisciplinary research teams have also produced refinements in handling (Hemsworth and Coleman, 2004), transportation (Mitchell and Kettlewell, 1998) and stunning of poultry at slaughter (Raj and O'Callaghan, 2004). Similarly, alternative solutions to beak-trimming have been developed using genetic selection on the basis of bird temperament (Craig and Muir, 1993). Most recently, epidemiological techniques are being used to assess welfare in "real life" commercial environments, and to identify associated risk factors (Huber-Eicher and Sebo, 2001; Algers and Berg, 2001; Nicol et al., 2003; Pagazaurtundua and Warriss, 2006; Weitzenburger et al., 2006). These techniques are particularly valuable for validating on-farm intervention strategies intended to improve welfare (Dawkins et al., 2004; Weeks and Butterworth, 2004).

In the absence of clear solutions to public concerns, scientists have been able to clarify the grounds upon which concerns about poultry welfare may be justified. For example, the practice of induced moulting to improve egg production performance is common in layer flocks in the United States. The traditional method involved depriving laying hens of food for 5–14 days until they lost 20–30% of their body weight, shed their feathers and ceased producing eggs, after which a second egg-laying cycle was stimulated through changes in diet and photoperiod (Bell, 2002). Conversely, a natural moult is a gradual process that results from physiological changes associated with decreasing day-length during the autumn, and although feed consumption is reduced at this time, hens never cease eating completely nor do they become denuded of feathers. Furthermore, behavioural and physiological changes that result from feed deprivation during an induced moult are consistent with feelings of hunger and distress, at least during the initial stages (Webster, 2003a). Articulation by scientists of the specific welfare issues associated with feed deprivation (Bell et al., 2004) facilitated industry-sponsored research into alternative moulting methods that may be more acceptable on welfare grounds (Biggs et al., 2003), and indeed led to a major change in this practice in the US (see below). Furthermore, once the specific concerns associated with practices like these have been delineated, ethical discussions may ensue based on value judgements used when weighing costs to the individual hens that arise from different practices, benefits of eggs as an inexpensive source of dietary protein for consumers, and the environmental and animal welfare benefits that arise when, for example, the use of a second egg-laying cycle results in fewer hens being raised to meet the demand for eggs.

It has been suggested that many of the changes to animal welfare policy have been made based on "collective and individual decisions, rather than on scientific assessment" (Bennett, 1997). Philosopher Paul Thompson (2003) argues that standard scientific methods are inadequate for addressing animal welfare concerns; integrative research is needed that explores animal welfare science while being sensitive to competing public values in terms of risks to environmental quality and food safety. Similarly, scientist Jeffrey Rushen (2003) suggests that researchers have used concepts of animal welfare that are too limited in the interest of scientific rigour, and consequently, are unable to address the multidimensional nature of animal welfare concerns as expressed by the public. He suggests that greater use of epidemiology and other research techniques that account for variability and interactions between husbandry factors may yield more useful information for identifying the main threats to animal welfare in commercial situations. In some countries, animal welfare research has also been limited because it is not well funded compared to other scientific areas.

Support for poultry welfare research has traditionally been strongest in Europe. In 1981, the first European symposium dedicated to poultry welfare was held in Køge, Denmark (Sørensen, 1981), with the objectives of increasing awareness of poultry welfare issues, disseminating knowledge of research results and identifying gaps in knowledge for further investigation. Subsequently, European Symposia on Poultry Welfare have been held every four years, organized by the World's Poultry Science Association. The First North American Poultry Welfare Symposium was held in 1995 in Edmonton, Canada (Mench and Duncan, 1998), and increasingly these scientific meetings are being sponsored by the poultry meat and egg industries worldwide. Involvement of the poultry industry in organizing and attending animal welfare conferences, and in funding and participating in welfare-related research projects, is a promising development for transfer of welfare knowledge to commercial applications.

12.5 Addressing Poultry Welfare Concerns Through Legislation

While expressing concern about the treatment of birds in commercial egg and meat production, many citizens probably assume that poultry welfare is protected under animal protection laws. However, there is considerable variation in the levels of protection conferred to animals in both developed and lesser-developed countries (Wilkins et al., 2005). Significant differences exist between European and North American countries, and this is particularly evident in terms of the laws that govern the treatment of poultry (see below).

In the UK, one outcome of the Brambell Report (Command Paper 2836, 1965) was a vision of morally acceptable animal production that granted certain rights or freedoms to animals. In addition, a Farm Animal Welfare Council (FAWC) was formed to advise policymakers on animal welfare issues, composed of individuals from a variety of backgrounds including animal scientists, veterinarians, farmers and animal protection, all with an interest in improving animal welfare. The vision of animal care was further refined by FAWC into the "Five Freedoms for Farm Animal Welfare" (FAWC, 1993):

1. Freedom from hunger, thirst and malnutrition
2. Freedom from pain injury and disease
3. Freedom from discomfort
4. Freedom to express natural behaviour
5. Freedom from fear and distress

These Five Freedoms have provided a framework for development of government policy, research priorities and husbandry guidelines, particularly in Europe. Similarly, animal welfare advisory groups composed of different stakeholders developed recommended codes of practice for livestock and for poultry in Canada, New Zealand and Australia. The development and review of these codes has been a consultative process, and they were often largely based on current industry "best practice". Since the codes are strictly voluntary, there are no mechanisms to determine how closely they are followed, or even if producers are aware of them.

In Europe, animal welfare policy has continued to steadily evolve (Table 12.2). A Convention on the Protection of Animals Kept for Farming Purposes was developed,

Table 12.2 Select European poultry welfare legislation (European Commission, 2008)

Year	Description
1974	Council Directive 74/577/EEC: Requires stunning of animals before slaughter
1978	Council Decision 78/923/EEC: Approves the European Convention for the protection of animals kept for farming purposes. Provides general rules for the protection of all species of animals kept for food, wool, skin, fibre, fur or other farming purposes based on ethological and physiological needs
1988	Council Directive 88/166/EEC: Providing minimum standards for protecting the welfare of laying hens housed in battery cages, including cage design, prohibits forced moulting through feed restriction, alarm system, culling protocol
1991	Council Directive 91/628/EEC: Protecting animals during transport. Amends 90/425/EEC and 91/496/EEC. Requires provisions for feed and watering needs of poultry greater than 72 h of age for journeys greater than 12 h
1993	Council Decision 93/119/EC: Protecting animals at the time of slaughter or killing. Requires stunning prior to slaughter or killing, or instantaneous killing, with exemption for ritual slaughter. Acceptable stunning methods include captive bolt pistol, concussion, electronarcosis, exposure to carbon dioxide. Killing methods may include free bullet pistol or rifle, electrocution, exposure to carbon dioxide gas. Decapitation, cervical dislocation and vacuum chambers may be used for poultry if carried out by competent staff. Also requirements for animals killed for disease control and for killing of surplus chicks
1993	Commission Regulation 93/1274/EEC defines labelling standards for table eggs marketed as "Free-Range", "Semi-Intensive", "Deep Litter", "Perchery" housing systems
1997	Treaty of Amsterdam: Grants special consideration of animals under the law as "sentient beings"
1998	Council Directive 98/58/EC concerning the protection of animals kept for farming purposes. Strengthens inspection and enforcement requirements, including records of mortality and medicinal treatments for three years, housing requirements, breeding requirement – "no animal shall be kept for farming purposes unless it can reasonably be expected, on the basis of genotype or phenotype, that it can be kept without detrimental effect on its health or welfare"
1999	Council Directive 1999/74/EC: laying down minimum standards for the protection of laying hens. Indicates minimum husbandry standards for caged and non-caged hens, including stocking density, feeder space, etc. Non-cage and enriched cage systems must provide 750 cm^2 space/hen, a nest, perching space of 15 cm/hen, litter for pecking and scratching, 15 cm/hen perch space and unrestricted access to 12 cm/hen of feed trough space. Non-enriched cages must provide 550 cm^2 space/hen, and are prohibited after 2012
2007	Council Directive 2007/43/CE: laying down minimum standards for the protection of chickens kept for meat production. Indicates lighting, litter, feeding and ventilation requirements, and maximum stocking density of 33 kg/m^2 space per bird, or 39 kg/m^2 space per bird if more stringent animal welfare standards are met

and was passed by the Council of Europe in 1976. Poultry welfare was one of the first issues to be addressed, specifically in regard to housing of laying hens (for a more thorough review, see Appleby, 2003). In 1979, European governments agreed to provide funding for scientific research on poultry welfare, to be reviewed by the Scientific Veterinary Committee (SVC). As a consequence, a Council Directive was passed in 1986, regulating minimum standards for hens in battery cages. The legislation was further amended and strengthened, so that European Directive 88/166/EEC set down a minimum space allowance of 450 sq cm per bird, as well as minimum requirements for cage height, floor slope and feed trough space. Furthermore, the Commission was required to report back on scientific developments regarding the welfare of hens under different management systems. In 1996, a second review by the SVC proposed that there were inherent problems associated with battery cages, because of insufficiency in the design to accommodate the strong motivation of hens to build nests, to dustbathe, to perch and to forage in litter. These recommendations by the SVC led to Directive 1999/74/EC, requiring a phase out of standard battery cage housing for laying hens by 2012. However, cages that are furnished with a perch and a nest box will be permitted. A similar process involving scientific review and phasing in of recommended legislation is currently underway for broilers and turkeys. Despite these tremendous changes in laying hen housing, some animal protection groups remain critical of the European legislation, particularly in regard to the failure to require cages that incorporate litter for dustbathing and foraging (Wilkins, 2004).

A particularly significant development for animal protection in Europe was the Treaty of Amsterdam, which came into effect in 1999. The Treaty requires Member States to pay "full regard to the welfare requirements of animals", granting animals special status as "sentient beings". Conversely, animal protection laws of most countries have been traditionally based on the value of animals as property, and hence the intent of these laws has been to protect animal owners against losses, rather than protecting animals from suffering per see (Wise, 2003). Animal cruelty is discussed in the property section of the Canadian Criminal Code, and states "(i) Every one commits an offence who (a) wilfully causes or, being the owner, wilfully permits to be caused unnecessary pain, suffering or injury to an animal or by wilful neglect, cause damage or injury to an animal or bird". The offence is classified as a misdemeanour or lesser crime, and is often difficult to enforce since there is a burden of proof placed on the prosecutor to demonstrate that the accused *intended* to harm the animal, rather than on the *impacts* of these actions on the animal. Similarly, common husbandry practices, such as surgical amputations without analgesia (beak-trimming, toe-trimming, dubbing combs), are exempt in practice due to challenges in demonstrating that any pain experienced is *unnecessary*. In Canada, efforts to strengthen this century-old law, by making cruelty a felony and by moving it out of the property section of the Criminal Code, have been debated since 1999, generating more letters of support than any other issue. A significant obstacle has been lobbying of government officials by commodity groups, because of concerns about "nuisance lawsuits" that contest standard husbandry practices rather than address overt animal abuse. Changes were eventually made to the animal welfare section of the Canadian Criminal Code in 2008, but these only amounted to increasing the penalties for breaking the Code; the wording describing offences was left intact.

In the United States, where individual states have a great deal of legislative autonomy, all states have legislation covering aspects of animal treatment, generally referred to as anti-cruelty laws. The Massachusetts Bay Colony enacted the first anti-cruelty legislation in 1641, stating "no man shall exercise any tyranny or cruelty toward any bruit creatures which are usually kept for the use of man" (as cited in Unti, 2002, p. 16). There is considerable variability between states in terms of what practices are considered acceptable. In many states, anti-cruelty legislation provides exemptions for all or some common agricultural practices, with many of these exemptions enacted since 1990 (Wise, 2003). Furthermore, poultry species are specifically exempt from anti-cruelty laws in some states (Wolfson, 1999). Cockfighting is banned in all states, although the final ban, in Louisiana, did not take effect until August, 2008 (in 2007, the US Congress also passed a federal law providing felony penalties for interstate commerce, import and export related to animal fighting activities, including cockfighting).

There are two federal laws in the US that pertain to the welfare of commercially farmed animals (Wolfson, 1999). The Twenty-Eight Hour Law was established in 1873 to protect livestock during transport to slaughter. The law states that after 28 h of travel, livestock must be provided with the opportunity to rest, feed and drink. The law was intended for animals being transported by sea or rail, and was not applicable to poultry since birds are not transported by these means. The law was amended in 1994 to include transportation by trucks and other vessels, although this is not yet enforced by the USDA. Whether this revised law applies to transportation of poultry has yet to be determined. In 1958, the Humane Methods of Livestock Slaughter Act was established, which requires that livestock be rendered unconscious in a humane manner prior to slaughter. Surprisingly, poultry are exempt from this law in the US, although analogous legislation in Canada enacted during approximately the same period includes poultry slaughter.

Whereas husbandry practices in animal production are increasingly regulated in Europe, there has been a reluctance to introduce new federal legislation in the US and Canada for protection of farmed animals. However, there have been recent attempts (some successful) to prohibit particular poultry husbandry practices, such as induced molting, *foie gras* production, or housing hens in conventional cages, through US state legislation or ballot initiatives (Mench, 2008). Six states regulate transportation of poultry, but address only the most extreme situations. For example, Pennsylvania prohibits transporting more than 15 pounds of live birds per square foot (Wolfson, 1999), equivalent to three market weight broiler chickens per cubic foot – a feat that is probably physically impossible. Furthermore, maximum fines range from \$50 to \$100 (US), and hence are unlikely to act as deterrents.

12.6 Using Market Forces to Address Poultry Welfare Concerns

Economic models are useful for identifying the value that society places on particular goods and services, while allowing freedom of choice. It is interesting that there has been only a limited amount of research exploring the economic aspects of animal welfare. Two researchers in particular have provided much of the conceptual framework surrounding this topic (McInerney, 1996, 2004; Bennett, 1995, 1996, 1997). Examining animal welfare from an economic perspective is not as straightforward as it might seem, due to the contributions of both human and animal factors, interactions between these factors, and challenges in assessing the economic "value" to what may be regarded as a "public good". In economic terms, farm animals can be categorized as a resource, either as working capital (e.g. laying hens), goods in progress (e.g. broilers), or investment capital (e.g. breeding stock) (McInerney, 2004). However, many would argue that their value and importance are greater than what can be derived from their productivity; there are moral and ethical components that need to be accounted for.

McInerney (1996) identified two ways in which the economics of animal welfare have been interpreted. The first interpretation relates to commercial implications of welfare improvements, including financial costs and benefits associated with change. This interpretation proposes a fairly narrow view since it identifies the issue as a problem only for producers, rather than for the food chain as a whole. Hence, this interpretation fails to look at how resources are used and allocated, in favour of an accounting perspective resulting in a view that simply measures the gains and losses to one group in a food chain, when quite clearly there are many affected players in the system. Alternatively, the second interpretation takes a broader perspective that includes how resources are used in agriculture, impacts on the real costs of food and the extent to which the outcome meets societal preferences (McInerney, 1996). This second interpretation accounts for an industry with many interrelated sectors.

One of the methods economists employ to analyze and assess the advantages and disadvantages of a proposed policy is Cost-Benefit Analysis. Benefits to society that are associated with a proposed policy are weighed against the associated costs to determine whether the policy appears worthwhile or not. Simply put, benefits include aspects that we want or like from a policy, whereas costs include those we do not. More specifically, "costs" include such things as financial effects on producers, impacts on international trade and consumer prices, as well as any additional costs to the government or to taxpayers. More specific "benefits" include the extent to which consumers, including those who do not purchase animal products, desire change, and the individual benefits they derive from change (Bennett, 1996). Unfortunately, since defining and measuring costs and benefits can involve a degree of subjectivity, disagreements often arise. The existing level of demand for a good and its market price are frequently used to estimate the value of a good, but this is not always indicative of the true value (Bennett, 1997).

Animal welfare is difficult to classify as a "good", because physical differences generally cannot be used to discriminate between products from birds raised in different production systems (Blandford and Fulponi, 1999). For example, eggs produced by laying hens kept in battery cages look identical to those from hens raised in free-range systems. This being the case, there is little incentive to provide higher-cost goods, since the difference is discernable by few, if any, consumers. Labeling has frequently been used as a way to deal with different properties or methods to facilitate consumer choice. To ensure validity of label claims, government intervention may be necessary to instill consumer confidence. For example, as of 2004, table eggs sold in the European Union were marked with a code to indicate the production method used, and the terms "free-range", "barn or perchery" and "cage" production systems were assigned legal definitions (Table 12.2).

This approach is dependent on two assumptions: (1) consumers possess the necessary information to make informed judgements about production practices that affect poultry welfare, and (2) consumers are willing to pay for improvements to poultry welfare. There are various qualitative methods utilized to investigate consumer perceptions, purchasing patterns and behaviour. Willingness to pay is a technique used to measure the value of a product by asking people what the product is worth to them using contingent valuation. In this sophisticated survey technique, respondents are presented with hypothetical, but realistic scenarios, and their answers reflect their willingness to pay for the product. In essence, an individual's willingness to pay for something is used as a measure of the utility that is derived from the good, and therefore a measure of the benefit and value to the individual (Bennett and Larson, 1996). For example, eggs produced by hens housed in non-cage systems have higher monetary value than eggs produced in battery cage systems on the basis that someone is willing and able to pay for them. Moreover, consumers feel that these eggs are worth the higher price. A key criticism to the willingness to pay measure is that while consumers are provided with realistic scenarios or choices, they are still only hypothetical choices that may not necessarily reflect behaviour when consumers are faced with these decisions at the supermarket (Bennett et al., 2002). For this reason, estimates of willingness to pay should be treated with caution, and values obtained are likely to be more useful for comparative purposes, rather than as definitive estimates of the societal benefits associated with animal welfare policy (Bennett, 1996). It should also be noted that contingent valuation measures preference at a particular point in time based upon information that the respondent has at hand.

Despite the challenges associated with using consumer choice, these techniques have provided insights into the strengths of concern about poultry welfare. Two of the most common research methods for assessing willingness to pay are surveys and focus groups. Surveys conducted by animal protection organizations, university researchers and animal industry groups all indicate that people are willing to pay for animal welfare if they can be assured that the husbandry methods are indeed more humane (respectively: Caravan Opinion Research, 1995; Bennett, 1996; Animal Industry Foundation, 1989; Eurobarometer, 2005). However, there is variability in the amounts that consumers are willing to pay, as well as contradictory responses that have been uncovered with more comprehensive analysis. Using focus groups in the UK, Bennett and colleagues found that 76% of respondents expressed concern about farm animal welfare, but only 34% of them avoided certain food products based on their concerns (Bennett et al., 2002). Eggs from hens housed in battery cages were the most common food item avoided. Harper and Henson (2001) examined consumer concerns about animal welfare in a telephone survey of 500 consumers in the UK, whereby they tested a series of hypotheses generated from focus group results. The interviews were conducted by a professional market research agency using a technique called "laddering", consisting of an analysis of hierarchies of attributes, consequences and values. This technique allows investigation into relationships between product characteristics and consumer values, and how these relationships affect purchasing behaviour. Consumer consumption patterns were found to have shifted from red to white meat. However, these changes were largely driven by health concerns rather than by animal welfare issues. Significantly, although consumers did not spontaneously identify animal welfare as a factor, they considered welfare to be implicit in their decisions. For example, there was an assumption that better tasting, healthier, and safer products would necessarily come from chickens that were raised in production systems that conferred higher levels of animal welfare, despite the absence of supporting evidence.

In recognition of consumer support for "welfare friendly" husbandry standards, food assurance schemes have been created in several countries with the mandate of improving conditions under which farm animals are kept, and of making these products readily available to consumers. In 1994, the Royal Society for the Prevention of Cruelty to Animals (RSPCA), the UK's principal animal welfare group, commissioned a survey to gauge consumer attitudes towards animal welfare issues. Results from this survey prompted the organization to create "Freedom Food", a labelling programme that involves comprehensive husbandry standards developed by a scientific advisory committee on the basis of the "Five Freedoms". The program involves third-party certification in that the RSPCA does not directly market Freedom Food products, but poultry meat and eggs that meet or exceed Freedom Food standards are eligible to be labelled "Freedom Food, RSPCA Monitored". Mandatory annual inspections, in addition to unannounced visits by the RSPCA, are used to ensure that the standards are being met. Freedom Food has been largely successful in securing consumer support, and the scheme is credited with the rise in popularity of free range and barn eggs in the UK, where 38.2% of total egg production came from non-cage systems in 2007 compared to just 15% in the 1994 (DEFRA UK Egg Survey Data, 2008). The Freedom Foods program has been used as a model for similar animal welfare certification programs in Canada (British Columbia SPCA certified), and in the US (Certified Humane).

12.7 Actions by the Poultry Industry to Address Poultry Welfare Concerns

Responses by the agricultural industries to animal welfare concerns have often been ambivalent, with producers viewing animal welfare as an issue that could have negative impacts on their lives and livelihood. This concern probably has its foundation in a disparity between producers and the public in their attitudes towards animals. For example, Te Velde et al. (2002) conducted interviews of farmers and consumers in The Netherlands to assess their perceptions of farm animal welfare. They found that farmers believed that they treated their animals well, but that they largely viewed animal welfare as relating to animal health and provision of food, water, shelter, hygienic conditions and gentle handling. Consumers, on the other hand, felt that the welfare of farm animals was not good, not because of poor health but because the animals lacked freedom to move and carry out their normal behaviour. The increasing emphasis on animal welfare and environmental regulations made the farmers feel unappreciated and unwanted. They feared that working conditions would worsen if they were forced to farm in more traditional ways to assuage these public concerns. Similar attitudes are expressed in many articles about animal welfare in industry publications.

Regardless, the poultry industry took a proactive stance in addressing animal welfare issues by developing or helping to develop husbandry guidelines. In some cases these guidelines have served as adjuncts to legislation or Codes of Practice. In Australia, for example, the chicken meat industry collaborated in developing a Quality Assurance program that also includes a set of auditing criteria; the requirements of the program were based upon the Australian Codes of Practice (RIRDC, 2001). In the UK and other countries, codes have been based on EU and UK legislation, and have been developed jointly by the industry and government agencies (e.g. DEFRA, 2002a, b). However, the effectiveness of safeguarding poultry welfare through voluntary codes of practice is questionable. For example, despite the efforts invested in developing codes of practice in Canada, most producers were unaware of them, and there has been difficulty in modifying guidelines to accommodate advances in scientific information. The guidelines were not revised for a twenty year period, primarily due to funding constraints (Mayer, 2002).

In the US, in the face of pressure to critically examine current practices, one of the major poultry commodity groups, United Egg Producers (UEP), took the unusual step of assembling a committee of independent experts, including animal welfare scientists and a representative from an animal protection group, in 1998. The committee reviewed the scientific literature with respect to the welfare of caged laying hens and made recommendations that could be formulated by producers into a set of UEP guidelines. Several of the more controversial issues were addressed, including cage space, air quality, beak trimming, induced moulting, handling and euthanasia (Bell et al., 2004). The resulting guidelines called for an increase in space allowance in existing houses to 67–87 in.^{2} per hen from the current industry standard of 48–54 in.^{2} per hen to be phased in over six years. Improved air quality and hen handling standards were developed, and the use of genetic strains that do not require beak trimming was recommended. These guidelines are reviewed and updated annually as new scientific information becomes available (http://www.unitedegg.org). In addition, UEP supported research for the development of alternative moulting techniques that would not require feed restriction. The success of this research led the UEP in 2006 to add a provision to their standards that feed withdrawal moulting methods could no longer be used. UEP also established a third-party audit, and producers who pass this annual audit can display a "UEP Certified" logo on their egg cartons. More than 80% of UEP producers are now certified, representing a striking industry commitment to adoption of a poultry welfare standard in the absence of any regulation. The UEP process served as a model for other commodity groups in North America to develop science-based animal welfare standards for all livestock and poultry species for use by retailers (see below).

Breeding companies have a key role to play in improving poultry welfare, since some significant welfare problems have arisen due to genetic selection for high rates of production, or as related aspects of such selection. These include skeletal problems in broiler chickens (Mench, 2004) and osteoporosis in laying hens (Whitehead, 2004), hunger in broiler breeders due to the necessity for feed restriction (Mench, 2002), aggressive mating behaviour in broiler breeder males resulting in injuries to hens and reduced fertility (Millman et al., 2000), and a number of behavioural problems (Kjaer and Mench, 2003). Selection programs for poultry have been driven almost solely by production considerations. Egg-laying lines have been selected for traits such as egg number, egg size, shell strength, shell colour and low mortality. Meat lines have been selected for growth rate, meat yield, ratio of white to dark meat, feed efficiency, and rapid feathering. The breeding companies have also directed some attention recently toward reducing skeletal problems in meat birds by selecting for a low incidence of tibial dyschondroplasia lesions and good walking ability (Kestin et al., 1999), and towards reducing feather pecking and cannibalistic behaviour so that the need for beak-trimming can be eliminated. Although there are other aspects of behaviour and welfare that could be improved by selection (Kjaer and Mench, 2003), there is likely to be little incentive for breeding companies to exercise such selection unless there are also positive economic consequences for the producers. And as long as pressure for increasing economic efficiency is the primary driver for breeding companies, it is likely that problems related to selection of birds for high production will continue.

12.8 Responses of Multinational Retailers to Poultry Welfare Concerns

National and multinational retailers are playing an increasingly critical role in the development and implementation of animal welfare standards. In the UK, Tesco supermarket helped to guarantee the success of the RSPCA Freedom Food programme by initially pricing Freedom Food products competitively despite their higher production costs. Producers are typically paid only about 55% of the retail price (Bell, 2002), so retailers have pricing flexibility to promote particular product lines.

In the US, there has been increasing pressure for retailers to deal with farm animal welfare issues (Mench, 2003). This is part of a growing trend of social-cause activists using the market to accomplish political ends. This has been brought about by frustration over the congestion of traditional legislative channels and facilitated by fragmentation of agricultural interest groups, consumer affluence, and the concentration of food markets into just a handful of firms (Scheweikhardt and Browne, 2001). It was the fast-food retailers in the US that initially spearheaded the establishment of animal welfare standards. McDonald's began to audit packing plants to ensure that the cattle supplied to them were handled and killed humanely, a programme that led to marked improvements in techniques and practices for moving and stunning livestock in those plants. McDonald's then appointed an animal welfare committee of outside experts, and established minimum standards and an auditing programme for their shell egg suppliers. These standards closely paralleled the guidelines adopted by UEP, but with an immediate phase-in of space requirements and elimination of induced moulting by means of feed withdrawal. Other fast-food retailers, then supermarkets, quickly followed suit. In 2000, the trade associations of the supermarkets and the fast-food industry, the Food Marketing Institute (FMI) and the National Council of Chain Restaurants (NCCR), joined together and consolidated their animal welfare advisory committees to provide a coordinated retail response to animal welfare issues (Brown, 2004). The FMI-NCCR committee worked with the various commodity groups, like the UEP and the National Chicken Council, to assist them in developing scientifically sound and consultative guidelines. In December 2003, Whole Foods Market, the largest natural and organic retailer in the world, began developing "Animal Compassionate Standards". In January 2005, this company also launched the Animal Compassion Foundation, a separate and independent non-profit educational organization created to provide producers and researchers with the opportunity to learn, share ideas and collaborate on projects.

Ultimately, the effectiveness of retailers in ensuring standards will depend upon the establishment of auditing systems that ensure best practices and set goals for improvement. The FMI-NCCR established an independent auditing system that was intended to apply industry-wide, but the utilization of this programme by the individual retailers was limited, and the programme has been discontinued. Instead, many of the retailers have developed their own audits, often based on the commodity group standards developed as part of the FMI-NCCR process. Because large-scale auditing systems are still in the developmental stage, it is too early to predict how they will be structured or how effective they will be. There are also significant challenges in arriving at reasonable auditing standards that can be easily and reliably evaluated by farm inspectors (Webster, 2003b).

12.9 Discussion

Clearly there has been progress in identifying and addressing poultry welfare issues, with the increased understanding about sentience, factors affecting welfare and innovations in husbandry practices and in technology. The development of assessment protocols is significant, since these allow collection of data about prevalence of problems in current systems, to gauge improvements and to determine the effectiveness of interventions. Despite these advancements, further scientific inquiry is needed to address unresolved issues. Relationships between animal welfare standards and risks associated with poultry diseases, food safety and environmental problems are complex and have significant impacts for societal interests. For example, alternative housing systems for laying hens can result in an increase in floor eggs, which is positively associated with bacterial contamination (De Reu et al., 2006). Some practices of concern, such as induced moulting of laying hens using feed deprivation, are associated with shedding of *Salmonella enteritidis* (Holt and Porter, 1993), and hence, pose increased risks to public health.

There are various mechanisms by which poultry welfare issues may be addressed, and these are likely to be utilized differently according to cultural influences, financial infrastructure requirements and the nature of the welfare issue at hand. The two main mechanisms are legislation and the marketplace (i.e. retailer and/or industry led initiatives). Although retailers have an enormous ability to influence animal welfare standards and their actions have led to demonstrable improvements in animal welfare, there are some limitations to retail-driven standards. The first is the potential for conflict between producers and retailers with regard to the costs associated with animal welfare improvements and auditing programs. While some improvements in animal welfare are cost neutral or even reduce production costs, others clearly lead to increases in production costs, and there are also costs associated with auditing programmes themselves. Increased production and compliance costs can disproportionately affect small producers who lack the infrastructure, funding for capital improvements, or secondary markets (for example, to sell parts of products, such as broiler thighs that may be less desirable to a particular retailer). Conversely, problems may arise with retailers being “enforcers” of animal welfare standards when they and their suppliers have such closely aligned economic interests.

Because retailers are also in competition with one another for consumer dollars, a retailer-driven program could result in a patchwork of standards, with some retailers preferring to purchase less expensive products produced using minimal standards while others adopt more stringent standards. Unless products are labelled or identified in some way, this could lead to confusion among consumers about the different standards, and ultimately affect consumer confidence in the retail programme. For these reasons, retail-driven standards are less likely to create a “level playing field” for producers and consumers than is legislation, since retailers are interested in differentiating themselves to consumers. Conversely, retail driven standards are likely to be more flexible than legislation, allowing them to be changed or reinterpreted when new scientific information about poultry welfare becomes available.

Even given uniform action among chain restaurants and supermarkets, there will be limitations to the application of any standards. For example, an increasing proportion of eggs are sold, not as shell eggs, but as liquid eggs that are dried or frozen and used in further processed foods (Bell, 2002; Eurogroup/RSPCA, 2002). It seems unlikely that most supermarkets will “trace back” animal ingredients in further processed foods to their sources of origin. It also seems unlikely that retail auditing programs or guidelines will be extended to primary breeding companies, which means that the onus will be on producers to resolve problems even if the origin of those problems is primarily genetic. How retail standards will play out in the international arena, where more stringent legislative standards that lead to increased production costs may exist, such as those requiring poultry to be provided with additional space or furnished cages, is an unresolved issue (Eurogroup/RSPCA, 2002).

Legislation has been a key ingredient for animal welfare changes in the EU. However, this approach has been criticized on the basis that "The use of legislation raises issues such as whose preferences the legislation reflects and whether the preferences of some people in society should constrain the food consumption choice of others" (Bennett, 1997). It is important to ensure that drafting of policy involves a variety of stakeholders including animal behavioural scientists, animal production scientists, veterinarians, individuals from the food and agribusiness industries, and consumers in addition to government officials. In the absence of adequate stakeholder involvement in the process, efforts to draft legislation run the risks of addressing a few high-profile welfare issues with overly simplistic solutions that can produce new, and sometimes more significant, welfare problems. Furthermore, if provisions are not included to ensure that legislation is being enforced, animal protection laws are rendered meaningless. Clearly the poultry industry is a sizable industry, and therefore requires a well-constructed policy framework that is set up to accommodate change over time.

In addition to legislation, policymakers have the opportunity to guide the poultry industry towards production practices that improve animal welfare through financial incentives. Producers who do not meet specified animal welfare standards could be taxed, or subsidies could be provided as incentives to those producers who produce goods at or above specified animal welfare standards (Bennett, 1995). An example of this approach has been adopted for broilers in Sweden, where an on-farm animal welfare protocol is used to collect bird-related outcomes, such as mortality data, culls because of leg deformities and footpad dermatitis (Berg and Algers, 2004). Incentives to improving housing and management are provided by correlating the maximum stocking density allowed at the time of slaughter in each broiler house to the total animal welfare score received. Similar monetary incentives to improve broiler and turkey welfare could also be a practical and effective tool for retailers, particularly in countries such as the United States, where there is less government regulation of production practices.

With an increasingly global economy, it is impossible to contemplate the future of poultry welfare without taking into account the issues of trade in animal products. For countries with more stringent or extensive animal welfare standards, and hence higher costs of production, domestic industries are vulnerable to exports from countries with fewer regulations. For example, the US and China both are net exporters of liquid eggs (Fig. 12.5). Conversely, the United Kingdom, a country with some of the most stringent animal welfare legislation, is a net importer. Currently, the World Trade Organization (WTO) does not allow countries to differentiate between products on the basis of husbandry practices, and the issue of whether or not animal welfare concerns can be accommodated through trade agreements continues to be debated. An important development has been the recent interest in animal welfare by

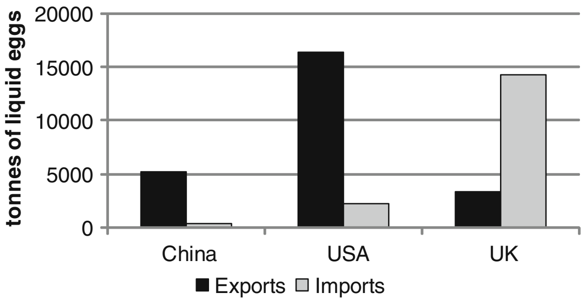

Fig. 12.5 International trade of liquid eggs for select countries, in tonnes (Food and Agriculture Organization of the United Nations, 2008)

the World Animal Health Organization (Office des International Epizooties, 2004), since this organization moderates trade issues involving animals for the WTO.

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