Studies of Behaviour, Welfare and Ecology in Captive Animals

To begin at the beginning

Dylan Thomas (1954)

Fig. 1.1  North American porcupine (*Erethizon dorsatum*).
1.1 What Are Captive Animals?

1.1.1 Introduction

For the purposes of this book I have defined captive animals as those that are, or have recently been, under the control of humans. This includes zoo and farm animals, companion animals and free-ranging feral animals, but not animals kept in laboratory conditions. In most cases they are confined in relatively small areas (or volumes) by fences, walls and other barriers, and are unable to escape. In some cases they are free-ranging but still remain closely associated with humans.

1.1.2 A Short and Incomplete History of Captive Animal Studies

Studies of animals kept in captivity have a long history. Over 2300 years ago the Greek philosopher Aristotle wrote his History of Animals (Aristotle, 350 BC; trans. 1910). Alexander the Great captured many exotic animals on his military expeditions and sent them back to Greece where they were kept in menageries. Most of the city states of Greece had such menageries and these would have given Aristotle the opportunity to study animals that he would not have been able to see in the wild. The History of Animals contains descriptions of various aspects of animal behaviour that can only relate to captive animals. For example, he discusses mating in the camel:

The male camel declines intercourse with its mother; if his keeper tries compulsion, he evinces disinclination. On one occasion, when intercourse was being declined by the young male, the keeper covered over the mother and put the young male to her; but, when after the intercourse the wrapping had been removed, though the operation was completed and could not be revoked, still by and by he bit his keeper to death.

Aristotle even refers to the training of elephants:

Of all wild animals the most easily tamed and the gentlest is the elephant. It can be taught a number of tricks, the drift and meaning of which it understands; as, for instance, it can be taught to kneel in presence of the king. It is very sensitive and possessed of an intelligence superior to that of other animals.

The Roman emperors kept many animals in private collections for study and for use in the Roman Games, where they perished in very large numbers. These animals were supplied by the Roman military and acquired from the rulers of the countries where the animals were endemic (Eppllett, 2001). Thousands of wild animals were slaughtered when the Colosseum was inaugurated in AD 80.

The first zoo created for scientific purposes was the Regent’s Park Zoo in London, now known as ZSL London Zoo. It was founded in 1828. Two years earlier in 1826 Stamford Raffles had founded the Zoological Society of London (ZSL). The first scientific meetings of the Society were held in 1830 and in the same year the first Proceedings of the Zoological Society of London were published. Initially the zoo was open only to Fellows of the Zoological Society and others with a written ‘order’ from a Fellow. It was fully opened to the public some 20 years later in 1847.

The scientific interest in zoo animals in Victorian times was largely concerned with anatomy and taxonomy and did not extend to concern for their welfare or any detailed consideration of their behaviour. Early enclosures were barren and many species were held behind iron bars (Fig. 1.2).
Animal welfare legislation is not yet 200 years old. In England in 1882 Richard Martin MP (who earned the nickname ‘Humanity Dick’) was responsible for the passing of An Act to prevent the improper Treatment of Cattle. The Act made it an offence to:

…wantonly and cruelly beat, abuse or ill treat any Horse, Mare, Gelding, Mule, Ass, Ox, Cow, Heifer, Steer, Sheep or other Cattle…

This Act was the first national legislation in the world that punished cruelty to animals.

The Royal Society for the Prevention of Cruelty to Animals (RSPCA) was founded more than half a century earlier, in 1824 in London, as the Society for the Prevention of Cruelty to Animals (SPCA). The ‘R’ was added in 1840 with the permission of Queen Victoria. The Society has been funding animal welfare research for many years and, indeed, funded my own PhD in 1977. It now has a Science Group whose staff study and provide expert advice on welfare issues relating to companion animals, farm animals, research animals and wildlife.

The twentieth century saw the founding of many new organisations concerned with the keeping and welfare of animals, and many of these now undertake and publish research.

The Association of Zoos and Aquariums (AZA) was founded in 1924 – originally as the American Association of Zoological Parks and Aquariums (AAZPA) – and in 1926 Major Charles Hume founded the University of London Animal Welfare Society (ULAWS), which became the Universities Federation for Animal Welfare (UFAW) in 1938. Both organisations publish their own journals.
In a short article entitled ‘Zoo Experiments’ published in 1931, *The Spectator* (Anon., 1931) reported the release of a number of guinea fowl from Whipsnade, proclaiming that:

The new Zoo in Whipsnade has just proved the means of fulfilling the very first and original idea of the Zoological Society. It was to be a garden of acclimatization, designed at least in part to introduce animals to wild life in England. The very first animal selected for experiment was the guinea-fowl.

Serious studies of animals living in zoos and circuses date from the 1950s and were pioneered by the Swiss zoologist Professor Heini Hediger. He is considered to be the ‘father of zoo biology’ and was once the Director of Zurich Zoo. Hediger published a number of early books on captive animals including *Studies of the Psychology and Behaviour of Captive Animals in Zoos and Circuses* (Hediger, 1955), *Wild Animals in Captivity: An Outline of the Biology of Zoological Gardens* (Hediger, 1964) and *Psychology and Behaviour of Animals in Zoos and Circuses* (Hediger, 1969).

Academic journals concerned with animal behaviour appeared in the middle of the last century. The journal *Behaviour* was founded by Niko Tinbergen and W.H. Thorpe in 1948. The first issue carried a paper by Tinbergen and van Iersel (1947) entitled “Displacement reactions” in the three-spined stickleback along with the classic study of wolf social behaviour and communication conducted by Schenkel (1948) in Basle Zoological Gardens (see Fig. 4.12). Over 25 years later, Altmann (1974) published an important and often quoted paper in *Behaviour* in which she described the seven major types of sampling for observational studies of social behaviour that were at that time being used in the literature. The journal *Animal Behaviour* was originally published in 1953 as the *British Journal of Animal Behaviour*, and its first issue included articles on behaviour problems in laboratory rats (Lane-Petter, 1953) and grazing behaviour in dairy cattle (Castle and Halley, 1953).

The Zoological Society of London established a research institute – the Institute of Zoology – in 1960–61 as a result of the efforts of Lord Solly Zuckerman, who was a pioneer in the study of primate behaviour and served as both Secretary and President of the Society. A few years later, the American zoologist Lee S. Crandall published the classic text *The Management of Wild Mammals in Captivity* while working at the Bronx Zoo (Crandall, 1964).

Around the same time, in the UK, there was great concern for the welfare of farm animals. The report of an investigation into farm animal welfare entitled *Report of the Technical Committee to Enquire into the Welfare of Animals kept under Intensive Livestock Husbandry Conditions* (the Brambell Report) was published in 1965 and led to the establishment of the ‘five freedoms’ that are now widely used as the basis for good animal welfare in farms, zoos and other captive environments (HMSO, 1965). In the same year in the USA the Smithsonian’s National Zoo created its zoological research division to study the reproduction, behaviour and ecology of zoo species.

The British and Irish Association of Zoos and Aquariums (BIAZA) was founded in 1966 as the Federation of Zoological Gardens of Great Britain and Ireland. It is the professional organisation that represents the zoo and aquarium community in Britain and Ireland; among other things, it promotes research within its member institutions.

Eight years later, in 1982, the journal *Zoo Biology* was first published. It was the first journal to concern itself exclusively with scientific studies of zoos and zoo animals. Its first editor was Dr Terry Maple, and the very first paper was co-authored by Dr Frans de Waal. It concerned the effects of spatial crowding on social behaviour in a chimpanzee colony at Arnhem Zoo in The Netherlands (Nieuwenhuijzen and de Waal, 1982). The second paper was an account of an enrichment study of otters co-authored by Dr Hal Markowitz, who pioneered the engineering of active environments for animals living in zoos (Foster-Turley and Markowitz, 1982).

In 1986 Donald Broom became the first Professor of Animal Welfare in the world, in the Department of Veterinary Medicine at the University of Cambridge. He has published a number of books including the *Biology of Behaviour* (Broom, 1981), *Farm Animal Behaviour and Welfare* (Fraser and Broom, 1990) and *Domestic Animal Behaviour and Welfare* (Broom and Fraser, 2007). The academic journal *Animal Welfare* was published by UFAW for the first time in 1992. The first volume contained papers describing the use of a puzzle feeder as an enrichment device for gorillas at London Zoo (Gilloux et al., 1992) and the behavioural responses of laying hens to carriage on conveyors (Scott and Moran, 1992). The *Journal of Applied Animal Welfare Science* was first published in 1998 and its first issue included papers on abnormal behaviour in caged birds (van Hoek and Ten Cate, 1998) and the use of toys as enrichment for chimpanzees (Brent and Stone, 1998).

Building on Crandall's earlier work, *Wild Mammals in Captivity: Principles and Techniques* was first published in 1996 (Kleiman et al., 1996) and then revised as *Wild Mammals in Captivity: Principles and Techniques for Zoo Management* (2nd edition), published in 2010 (Kleiman et al., 2010).

Since April 2002 zoos located within the Member States of the European Union have been required by Council Directive 1999/22/EC of 29 March 1999 on the keeping of wild animals in zoos – the Zoos Directive – to have a conservation function. One of the ways in which they may discharge this obligation is to participate in research whose results benefit the preservation of species. Although research is not a mandatory requirement, this legislation has acted as an important incentive for zoos in Europe to undertake their own research and to co-operate with universities and other research organisations.

Scientific interest in the welfare of animals living in zoos has gained increased attention in recent years. The first conference on the welfare of zoo animals (From Good Care to Great Welfare – Advancing Zoo Animal Welfare Science and Policy) was held by the Detroit Zoological Society at Detroit Zoo in August 2011 under the auspices of the zoo’s Center for Zoo Animal Welfare. Papers from the symposium were published in 2013 in a special issue of the *Journal of Applied Animal Welfare Science* (vol. 16, issue 4). In 2013 Terry Maple published a major text entitled *Zoo Animal Welfare* (Maple and Perdue, 2013). In June 2013 the Chicago Zoological Society’s Center for the Science of Animal Welfare (CSAW) organised a second international symposium: Zoo Animal Welfare: Innovations and Future Directions.

Welfare concerns about the keeping of some species in zoos have recently stimulated considerable research effort. The welfare challenges associated with the keeping of elephants in zoos have been of international concern for a number of years, resulting in two major studies in the UK. The first was conducted by Clubb and Mason (2002) and funded by the Royal Society for the Prevention of Cruelty to Animals; the second was conducted by Bristol University (Harris et al., 2008) and was commissioned by the Department for Environment, Food and Rural Affairs (Defra) and also received funding from BIAZA, RSPCA and the International Fund for
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Animal Welfare (IFAW). A review of the latter by the Zoos Forum (now the Zoos Expert Committee) resulted in the formation of an Elephant Welfare Group by BIAZA at the request of the UK government (Zoos Forum, 2010). It was charged with proposing a series of improvements in the welfare and care of elephants in UK zoological collections.

There has been concern for some time about the keeping of a number of other species in captivity – especially chimpanzees, bears and marine mammals – and about the use of animals in circuses. There is also unease about the conditions in which pigs and hens are kept on intensive farms – much of which has been addressed by legislation (e.g. in the European Union, the Pigs Directive and the Welfare of Laying Hens Directive) – and about obesity in some animals kept in zoos and in some companion animals, especially cats and dogs. There is even concern about the amount of space provided by members of the public for their pet rabbits; the Welsh Assembly has issued a Code of Practice for the Welfare of Rabbits (Anon., 2009) under section 14 of the Animal Welfare Act 2006. This increased interest in animal welfare provides many opportunities for scientists to conduct new research that may contribute to the debate about how we should treat animals under human care.

1.2 Types of Studies

Captive animals may be used for a very wide range of scientific studies. However, this book focuses on research that may be undertaken by observation alone and falls into one of three types: behaviour, welfare and ecology.

1.2.1 Behaviour Studies

Studies undertaken with captive animals are often concerned with some aspect of their behaviour. These animals represent an important resource for students and researchers who are unable to study animals in the wild and also because there are certain aspects of behaviour that only occur in captive situations – especially on farms and in zoos – and many of these have welfare implications.

Behaviour may be defined in a number of different ways, for example:

1. The repertoire of responses that an animal may make to changes in its environment.
2. A specific response made by an organism to a specific stimulus.
3. ‘…all those processes by which an animal senses the external world and the internal state of its body, and responds to changes which it perceives’ (Manning, 1972).

One of the main functions of the nervous system is to control the activity of the body – along with hormones – and produce behaviour. We may attempt to explain this behaviour in terms of neurophysiological mechanisms or we may simply study the observed behaviour itself. It is possible to both study and manipulate the behaviour of animals without fully understanding the underlying physiological mechanisms. Indeed, many behaviour studies make little reference to the underlying physiology. This approach treats the animal as a ‘black box’ (i.e. we do not know what is going on inside) and is useful if we are primarily concerned with understanding the causes of behaviour rather than the underlying neural mechanisms (Fig. 1.3).

Keeping animals in captivity inevitably restricts the range of behaviours that they are able to exhibit. However, apart from being of interest for its own sake, knowledge
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of behaviour is important if we are to understand many of the factors that affect animal welfare. For example, poor husbandry may have an adverse effect on the reproduction of animals used in a captive breeding programme in a zoo, or the productivity of animals kept on a farm.

Over 50 years ago, Tinbergen (1963) published an important paper in which he outlined the four major questions in the study of animal behaviour: the ‘four whys’:

1. Causation – What causes an animal to exhibit a particular behaviour? What mechanisms underlie the behaviour? What is its motivation?
2. Development – How did a particular behaviour develop during the lifetime of the animal, i.e. what is the ontogeny of the behaviour?
3. Function (survival value) – Why does an animal exhibit a particular behaviour? How does it help it to survive? What are the consequences for the animal’s fitness?
4. Evolution – How did evolution produce a particular behaviour?

When we undertake a study of a particular behaviour it is important to consider which of the four questions above is being addressed. In a zoo context we would probably be more interested in the causation, development and function of behaviour and less interested in its evolution (Fig. 1.4). For example, understanding the cause of an abnormal behaviour might help a zoo to prevent it, and understanding how a normal behaviour develops might help a zoo to provide appropriate conditions for normal development. Understanding the function of behaviours is important in appreciating the relationship between animals and their environment, and the possible consequences of releasing poorly adjusted animals from captive breeding programmes back into the wild.

Fig. 1.3 The animal as a black box. It is not necessary to understand all of the processes that occur in the nervous system to study behaviour. The nervous system can be treated like a black box, which receives an input of stimuli and causes the generation of a behavioural response. Rockhopper penguin (Eudyptes moseleyi).
Animal welfare is now established as a legitimate discipline of academic study and there has been increasing concern in recent years about the welfare of farm animals, companion animals and animals living in zoos. Most of this concern has been focused on mammals, and, to a lesser extent, birds. However, recently crayfish have been demonstrated to exhibit anxiety-like behaviour following exposure to stress (Fossat et al., 2014); the first time such behaviour has been recorded in an invertebrate.

Animal welfare science is a branch of applied animal behaviour. Welfare studies may be undertaken with captive animals provided that they do not compromise their well-being. They may involve measuring behaviour under various conditions, assessing an animal’s preference when given a choice between different conditions, or assessing its physical condition. Such studies might, for example, involve comparing the behaviours observed when different floor types are available (Meller et al., 2007), assessing the effectiveness of an enrichment device (Jenny and Schmid, 2002) or scoring body condition (Gregory and Robins, 1998).

The relationship between behaviour and welfare is complex. Mason and Mendl (1993) have noted that some responses used to assess animal welfare can be elicited by neutral or even pleasant events as well as by aversive ones; they lack specificity. This often makes behavioural studies very difficult to interpret.

Ecology is the study of the relationship between organisms and each other and organisms and their environment. Although animals living in zoos, and other captive animals, clearly do not have the same ecological relationships that they would have
in their natural habitat, they nevertheless have an ecology and this is worthy of investigation. Many ecological studies involve more than mere observation of the animals. For example, studies of parasites may require the collection of samples of faeces and blood; studies of feeding ecology may require animals to be confined and food intake and faeces production to be carefully measured (e.g. Rees, 1982a, 1983). Such confinement may be problematic in a zoo environment but perfectly normal in a farm environment. However, ecological studies that involve purely observational methods are possible in captive environments. Field studies might, for example, examine habitat selection within an enclosure, and studies of population biology are possible using data from zoo records and studbooks.

Some studies are concerned with the interface between ecology and behaviour. Behavioural ecology is the study of the ecological and evolutionary basis of animal behaviour, and its role in adapting an organism to its environment. Hypotheses in behavioural ecology assume that behaviour is optimised. Captive environments are useful for studying behavioural ecology because the environment can be artificially controlled.

### 1.3 Possible Study Locations

Many students undertake studies of captive animals as part of their studies in zoology, animal behaviour, psychology, animal welfare or some related discipline. Indeed, many research scientists routinely use animals under human control for their work.

Where might we find animals suitable for study (Figs. 1.5 and 1.6)? Traditional zoos such as ZSL London Zoo or San Diego Zoo are obvious places where a wide range of species is potentially available to the researcher. In addition to these large facilities, there are many other smaller zoos that contain interesting species, specialist collections of birds (such as those kept by the Wildfowl and Wetlands Trust in the UK) and aquariums, seal sanctuaries and marine parks, which keep aquatic species. Some zoos and colleges keep animals for teaching and research purposes. Some colleges have a sufficient number and range of exotic species that they are required to have a zoo licence. Others have flocks of sheep, herds of dairy or beef cattle, horses, pigs, goats and other livestock including poultry. Working farms also offer research opportunities.

Companion animals such as dogs and cats make interesting subjects of study, especially where they have established feral populations, as do feral horses, goats and other feral species, along with the deer populations on deer farms and those established in the grounds of many stately homes in the UK.

First-rate opportunities are available for the study of some species that are kept in specialist research facilities such as the Yerkes National Primate Research Center, which is operated by Emory University in Georgia, USA (see Section 2.2.3).

### 1.4 Advantages and Disadvantages of Studying Captive Animals

There are advantages and disadvantages associated with using captive animals in behavioural and ecological studies. Finding animals in the wild is time-consuming, and clearly this is not a problem when captive animals are studied. Often wild subjects have an unknown history whereas the history of farm, zoo or companion animals is likely to be well known and their caretakers (farmers, keepers or owners) are likely to be able to assist with the identification of individual animals. Natural environments
Fig. 1.5  Sources of animals for study. Centre: safari parks – a giraffe (*Giraffa camelopardalis*) at West Midlands Safari Park, UK. Clockwise from top left: feral animals – a herd of British primitive goats (*Capra aegagrus hircus*), Galloway Forest, Scotland; domestic pets – rabbits (*Oryctolagus cuniculus*); free-ranging farm animals – hill sheep (*Ovis aries*); aquariums – Sealife Centre, Blackpool, UK; specialist research centres – giant pandas (*Ailuropoda melanoleuca*) at the Chengdu Panda Breeding Research Centre, China (photograph courtesy of Prof. Geoff Hide, University of Salford. Reproduced with permission); deer parks – fallow deer (*Dama dama*) at Dunham Massey Park, UK; traditional zoos – chimpanzees (*Pan troglodytes*) at Chester Zoo, UK; college farms – a herd of dairy cattle (*Bos taurus*) at Reaseheath College, UK.
are fairly unpredictable and outside of the researcher’s control. In contrast, captive animals often live in controlled conditions, which may be relatively easy to manipulate by, for example, adding an enrichment device, or altering the types of bedding available in a stall on a farm.

However, there are disadvantages inherent in using captive animals as research subjects. If the purpose of the study is to investigate natural behaviour this may be impossible if the animals are not kept in naturalistic environments and normal social groups, or if individuals have developed stereotypic behaviours. The presence of humans may affect behaviour. In zoos, animals are disturbed by keepers (e.g. during feeding and enclosure cleaning) and visitors, and on farms the animals are disturbed by farm workers. Although these interactions may be of interest for some studies, for many others they interfere with data collection.

Access to animals may be restricted due to safety considerations, so that it is not possible to make recordings at certain times of the day or during the night. Researchers working in a zoo may only be allowed on the premises when the zoo is open to the public. A zoo may only be open for 8 hours a day in the summer (e.g. 10:00 to 18:00), and this may be reduced to just 6 hours in winter (e.g. 10:00 to 16:00). The cost of studying captive animals may also be a barrier to data collection. For example, some zoos require students and researchers to purchase a research pass for access to the zoo. In addition, if the researcher does not live near the zoo the cost of travelling (and possibly accommodation) may be prohibitive.

1.5 What Types of Research Have Been Conducted on Animals Living in Zoos?

Captive animals offer opportunities to study a wide range of aspects of their biology, such as behavioural enrichment, social behaviour and dominance hierarchies, parental behaviour, aggression, activity budgets, food selection and feeding strategies, cognition, enclosure use, population biology and interactions between animals and people (Figs. 1.7 and 1.8).

There appears to be no published analysis of the nature of the research conducted on farm or companion animals. However, a number of accounts have been published on the nature of zoo research.

A recent study by Maple and Bashaw (2010) noted that the type of research conducted in zoos is relatively stable, is primarily non-experimental, and consists of studies on the behaviour, nutrition, genetics and reproduction of mammals. Within the Mammalia, primates and carnivores are the most popular taxa. Anderson et al. (2008) found that 35.5% of the 991 articles published in Zoo Biology between 1982 and 2006 were conducted on members of the order Primates, 23.4% on Carnivora, 13.9% on Artiodactyla, 8.8% on Proboscidea and 6.0% on Perissodactyla. Most articles focused on the behaviour and reproduction of animals, and longitudinal trends in the content of the journal included an increase in experimental studies, and studies of diet and nutrition, while studies of behaviour and population biology declined in number.

A similar study was undertaken by Hardy (1996). This study analysed 353 papers published in Zoo Biology between 1982 and 1992 and found that of the 287 papers on mammals, 29.6% were studies of behaviour or behavioural ecology, a further 5.9% involved behavioural/environmental enrichment and 20.2% were studies of reproductive biology. Only 3.8% of papers were concerned with genetics or population
biology, and just 2.3% involved wildlife management. The remainder were concerned with nutrition and diet (3.5%), exhibit design and evaluation (1.2%), veterinary medicine (5.6%), captive management (24%) and morphology and development (5.6%).

I examined 349 papers published in *Zoo Biology* between 1996 and mid-2004 and identified a significant change in emphasis in the research carried out by zoos during this period (Rees, 2005). Reproductive studies replaced behaviour as the largest category (34%), followed by studies of nutrition, growth and development (19%) and behaviour and enrichment (17%). Studies concerned with ecology, field biology, conservation and reintroduction only accounted for some 2% of the total, but there was an increase in papers on taxonomy, genetics and population biology (10%).
Semple (2002) took a different approach and analysed 904 research projects conducted in British and Irish zoos. Studies of behaviour were most popular (40%), followed by environmental enrichment (18%) and reproduction (8%). Fewer than 5% of projects were concerned with ecology, genetics or conservation.

Wiese et al. (1992) analysed 302 research projects carried out on mammals by zoo staff in 40 North American zoos and compared the number of studies conducted with the number published within each subject area. They found that behavioural and behavioural ecology studies made up 22.8% of studies undertaken but only 5.3% of studies published in the same period. Studies of reproductive physiology accounted for only 19.5% of studies undertaken but almost 31% of all published studies, while

![Diagram of abnormal behaviour]

**Fig. 1.7** Types of studies of (a) normal and (b) abnormal behaviour that may be undertaken on captive animals.
studies of natural history or fieldwork represented 23.1% of all published studies but only 16.6% of studies conducted.

Lankard (2001) listed and categorised 957 publications produced in 1999–2000 by the member institutions of the American Zoo and Aquarium Association (now the AZA). The largest research category was ecology/field conservation/reintroduction (27%), followed by veterinary medicine/physiology (15%) and behaviour/ethology (9%). Studies of reproductive physiology/technology amounted to just 7% of the total, and nutrition accounted for only 3%.

Zoo research is heavily biased towards studies of mammals, other taxa being poorly represented. A study of the research activity of North American reptile and amphibian departments concluded that they were not realising their potential to conduct formal research and conservation projects (Card et al., 1998).

**1.6 What Sort of Study Should I Undertake?**

What should you study? As we have seen, a great deal of the research conducted on captive animals is concerned with behaviour and welfare.Behavioural research may take place for a number of reasons (Fig. 1.7). A scientist may wish to study a phenomenon that occurs in the wild but be unable to gain access to a suitable group of wild-living animals, for example tool-use in primates. Although captive animals by definition do not live in a natural environment, it is nevertheless possible to conduct studies of their ecology (Fig. 1.8). A zoo may wish to solve a practical problem relating

![Fig. 1.8 Types of ecological studies that may be undertaken on captive animals.](image-url)
to animal husbandry or welfare, for example determining the effects of visitor presence on the behaviour of a particularly reclusive species; or a student may wish simply to practise the collection and analysis of behavioural data.

Some simple studies may not involve the testing of a hypothesis as such. They may simply set out to answer a fairly straightforward research question such as ‘How do the animals spend their day?’ or ‘Do individuals within the group have particular friendships with other individuals?’ However, the best studies, that is, those that are considered to be most scientific, test one or more hypotheses. The next chapter considers experimental design.