A review of the welfare of wild animals in circuses

Stephen Harris, Graziella Iossa & Carl D. Soulsbury
School of Biological Sciences, Woodland Rd, University of Bristol, Bristol, BS8 1UG

1 Summary 1
2 Introduction 3
2.1 Circuses in context 4
3 Have animals in circuses been domesticated? 6
3.1 Summary 7
4 Animals in captivity 7
4.1 Summary 10
5 The health of captive animals 10
5.1 Summary 11
6 Captivity related stress 11
6.1 Reproduction in captivity 13
6.1.1 The effects of captivity-related stress on reproduction 13
6.1.2 Elephant reproduction 14
6.1.3 Carnivore reproduction 14
6.1.4 Primate reproduction 14
6.1.5 Ungulate reproduction 15
6.2 Summary 15
7 The effect of travel on animal welfare 15
7.1 The transport of reptiles 16
7.2 Do animals habituate to travelling? 16
7.3 Summary 17
8 The behaviour of captive wild animals 17
8.1 Time budgets 17
8.2 Stereotypies 18
8.3 Summary 21
9 Training and performance 21
9.1 Summary 22
10 How many wild animals are there in European circuses? 22
10.1 Summary 23
11 The origin of captive wild animals in circuses 23
11.1 Summary 23
12 Which species of animal are suitable for life in circuses? 23
13 Conclusions 23
14 References 24
15 Appendix I 33
16 Appendix II 34

1 Summary

- We reviewed the peer-reviewed scientific literature to assess the welfare of wild animals in circuses.

- Domestication usually occurs over thousands of years and involves selecting fearless and tame animals. A low number of generations of wild animals have been bred in circuses. Even if there had been selection for tameness in circuses – and there is no

evidence that there has – not enough has occurred for any wild circus animal to be considered domesticated.

- Almost all captive animals are restricted in their ranging movements, their ability to socialise and pair as they would choose, and in the way they find and select food. In zoos more complex captive environments (naturalistic displays with appropriate substrates, plants, hiding places, perches, etc.) may be employed to mitigate behavioural problems stemming from captivity, and provide the animal with a diverse array of stimuli. Neither natural environments nor many highly motivated natural behaviours can be recreated in circuses.

- Complex environments cannot be set up in circuses because of frequent travelling and extremely small accommodation and exercise areas. Circus animals' lives are inevitably impoverished.

- The captive environment and performance can have adverse effects on an animal's health ranging from teeth abnormalities to problems with ligaments and unusual diseases. Animal health in circuses is likely to be poor.

- The lack of appropriate social interaction, reduction in time spent foraging and the restricted freedom to perform many highly motivated behaviours represent stressors for captive animals. Stress can have short-term as well as chronic long-term behavioural and physiological effects. Through time this can induce poor welfare by compromising health, altering brain function, reducing breeding potential and lowering life expectancy.

- The effects of husbandry-related stress on an individual's reproduction can be severe and include: reduced or no reproductive life span; infanticide or abandonment related to social disruption or hand-rearing; high infant mortality; and reduced life expectancy. All of these problems are particularly severe for hand-reared animals; hand-rearing is likely to be common in circuses.

- Circus animals travel frequently. Many features of travel, such as forced movement, human handling, noise, trailer movement and confinement constitute sources of stress to captive animals. There is no conclusive evidence on whether animals habituate to frequent travel. There is, however, evidence that travel is stressful for captive animals and it may have adverse effects on reproduction.

- Circus animals spend the majority of the day confined in the "beast wagon", about 1% of the day performing and the remaining time in exercise pens. They usually feed and move considerably less than free-living animals and spend a lot more time inactive or performing stereotypies.

- Most species stereotype more in circuses than in zoos. As stereotypies generally indicate sub-optimal environments, a higher degree of stereotyping in circuses may be considered indicative of poorer welfare.

- There has been no scientific evaluation of how much training is carried out in circuses, or the methods used, or whether the time spent training and the associated stimulation are effective substitutes for involvement in more natural activities. Whilst training

based on positive reinforcement has the potential to alleviate some of the negative aspects of a circus life, poor training has the potential to negatively affect both short- and long-term welfare.

- Behavioural and physiological parameters indicate that human audiences have stressful effects on captive wild animals, and that this can have severe consequences for welfare.

- Hand-rearing, training and performance do not compensate for the unavoidable negative effects of a circus life. To the contrary: the evidence suggests that both hand-rearing and performing have deleterious effects on an animal's subsequent reproductive ability and health.

- There are less than thirty wild animals in British circuses. There are between 2,400 and 5,900 wild and domestic animals in circuses in Europe. In 1990 up to 40% of carnivores and 14% of ungulates in British circuses were unwanted zoo animals.

- The majority of European circuses are small and financial difficulties seem to be widespread, with an attendant risk of poor husbandry and veterinary care for the animals.

- Current scientific knowledge suggests that animals suitable for circus life should exhibit low space requirements, simple social structures, low cognitive function, non-specialist ecological requirements and an ability to be transported without adverse welfare effects. None of the wild species exhibited by circuses currently or in the past is close to meeting these criteria.

- We conclude that all species of wild mammals, birds and large reptiles should be subject to a test of suitability for a life in circuses.

2 Introduction

Wild animals are kept in captivity for conservation, education and research purposes in zoos, research in laboratories, fur farming and for entertainment in circuses and other establishments that provide animals for other entertainment industries such as television, films, advertisements and music videos.

In captivity animals are not free to perform many behaviours to the same extent as they would in the wild. Captivity restrains an animal's natural movements, foraging, feeding, hiding, escaping and mating behaviours, and restricts appropriate, or allows inappropriate, social interactions, both intraspecific and interspecific [1]. This is increasingly being recognised as being deleterious for a captive animal's cognitive development, normal social development and, later in life, reproduction and health [2-4].

Despite having bred for tens of generations in captivity, animals suffer if they are prevented from performing highly motivated behaviours [e.g. 5]. In other words, animals bred for generations in captivity show extremely high motivation to perform certain activities seen in their wild counterparts.

However, it may be hypothesised that circus animals do not give particular cause for welfare concern for two reasons. Firstly, it may be claimed that circus animals are indeed different

from zoo or free-living animals. Second, any reduction in the stimulation provided by the environment in which circus animals are kept relative to, for example, zoo animals, is compensated for by upbringing (specifically hand-rearing), training and performance.

Here we present evidence from mainly peer-reviewed literature to test these and other hypotheses. We examine:

i) whether captive animals are different from their wild counterparts;
ii) the living and travelling conditions of animals in circuses;
iii) the behaviour and health of animals in circuses;
iv) welfare related to training and performance;
v) the number and origin of animals involved in the circus industry;
vi) the suitability of species for circus life.

2.1 Circuses in context

Circuses with animal acts such as are known today first appeared in Britain at the end of the 18^{th} century as shows with horse riders, clowns and rope walkers [6]. Throughout this document we use the word circus to refer to a travelling group of entertainers and animals; we only consider wild, i.e. non-domesticated, animals. These animals are confined in beast wagons when travelling and for a certain period of time after arriving at a location. Beast wagons are typically small enough to be carried on a long trailer. Alternatively animals are held in exercise pens on site (larger cages connected to the beast wagon) when they are not performing. When not on tour they are held at one location, such as winter quarters, but very little is known about these facilities. Here we discuss the conditions experienced by wild animals on tour.

Until very recent times, the public knew exotic animals only through zoos and circuses. Nowadays, people have access to wild animals through easy travel, television, the Internet and other media, and those exhibiting captive wildlife are under considerable scrutiny as public awareness of animal welfare increases.

Exhibitors must increasingly justify why they keep wild animals, and long ago zoos in particular recognised that entertainment was inadequate as a sole or primary reason for keeping and exhibiting animals. Conservation is now purported to be the main purpose of zoos, with awareness raising through education being the primary means of achieving this aim [7-9], but the same cannot be said of circuses

Zoos to an extent justify any negative effects of captivity through the benefits they claim to bring, and have taken steps to review whether such benefits actually accrue[i]. There is an acceptance at UK government[ii], EU [10] and United Nations[iii] levels that zoos serve as conservation facilities.

---

[i] Zoological Society of London Symposium "Catalysts for Conservation: A Direction for Zoos in the 21st Century" (February 2004 - proceedings are currently being compiled).
[ii] News Release, Education programmes required in zoos: http://www.defra.gov.uk/news/2004/040913c.htm
[iii] For example, most or all Parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) recognise that zoos are a bona fide destination for Appendix 1 (the most strictly regulated category) species.

The World Association of Zoos and Aquariums (WAZA[iv]), of which the British and Irish Association of Zoos and Aquariums (BIAZA) is an Association Member, has a Code of Ethics[v], reproduced by BIAZA [11] as an instruction to its members. This code details the circumstances under which it is acceptable to exhibit animals, including as part of shows. For instance, WAZA states that where wild animal are used in presentations, such shows "must: (a) deliver a sound conservation message, or be of other educational value, (b) focus on natural behaviour, (c) not demean or trivialise the animal in any way."

WAZA also states that "All exhibits must be of such size and volume as to allow the animal to express its natural behaviours". WAZA is against the "keeping and transporting of animals under inadequate conditions, e.g., the keeping of bears in … circuses…"

BIAZA requires that its member organisations must not "…send animals to institutions other than zoos which would not normally be considered suitable outlets, which may include circuses…"

In this context we examine the welfare that animals experience in circuses and to what extent their lives differ from other captive animals.

Animal welfare may simply be defined as an animal's ability to cope with its environment [12]. It is a different concept to physical health. Assessing animal welfare involves measuring particular behavioural and physiological indicators, i.e. loss of appetite, signs of frustration, breeding rates, immunity, life expectancy, etc. These measures can then be used to give a relative assessment of the welfare of animals living in different situations.

We have limited our review as much as possible to the peer-reviewed scientific literature. Such studies on circus animals are scarce, but we have taken as our mandate the statement of the Rt. Hon. Lord Rooker[vi], which expanded on the statement of Parliamentary Under-Secretary of State Ben Bradshaw MP[vii]. Where the evidence was lacking for some measures we have reviewed the evidence available from studies of animals in other captive situations such as zoos and, secondarily, laboratories and farms. Of necessity, some of this literature includes domesticated animals.

We believe this comparison to be valid for two reasons. Firstly, zoos keep all of the animals commonly used in circuses[viii] and, second, in both cases the history of the animals (captive-bred or wild-caught, owned by one or several institutions) is comparable. With regard to farm and laboratory animals, most species kept are domesticated and therefore adapted to living with humans. However, they are still liable to experience negative welfare whenever the ability to perform highly motivated behaviours, inherited from their wild ancestors, is thwarted e.g. [13-15]. For these reasons we think it reasonable to assume that any shortfalls in

---

[iv] "As of September 1, 2005, the worldwide membership of WAZA includes 217 leading zoological institutions in 46 countries or territories, 22 regional, subregional or national zoo and aquarium associations on all continents, representing another 1000 zoos and aquariums, and 11 affiliated organisations whose combined reach includes most of the publicly-owned as well as some private zoological parks and aquariums of the world". (http://www.waza.org/about/index.php?main=about&view=members)

[v] WAZA Code of Ethics: http://www.waza.org/ethics/index.php?main=ethics&view=ethics

[vi] Hansard, 23th May 2006, GC Col 177, and see Appendix II

[vii] Hansard, 14th March 2006, GC Col 1404, 1405

[viii] By such terms as "commonly used in circuses" we mean those species currently kept in European and North American circuses, and those used in the past or potentially used in the future.

the level of welfare of zoo, laboratory or farm animals is equally, or more likely, to apply to other captive wild animals in similar situations.

It could conceivably be argued that unique conditions pertain in circuses that mean no direct comparison can be made between circuses and any other captive or wild situation. It may be possible that circus animals are rendered, through a mixture of domestication and husbandry, fundamentally different to individuals of the same species occurring elsewhere, particularly in zoos or in the wild.

We believe there is no evidence to support this hypothesis, nor, for reasons we present, is there a sound scientific basis to this argument. In fact, we argue that animals in circuses face particular challenges unique to the circus environment with which their evolutionary history has ill-equipped them to cope.

Our report cannot go into great detail on each of the points we make; for this reason we have appended a fully referenced document bundle of all the references we use, so that reviewers can make their own assessments.

3 Have animals in circuses been domesticated?

Domestication is a complex process occurring at two levels. One level is genetic selection over many generations, the other the level at which the environment causes changes in the development of an animal and influences an animal's experience during its lifetime [16]. It is now clear that the characteristics of domestic animals, such as piebald coat colour (areas lacking pigmentation), curly hair, floppy ears and changes in reproductive cycle, were developed by selecting individuals for just one character: tameness [17,18].

Some wild-caught animals or captive-born animals have reproduced in circuses [19], but there is no evidence that they were selectively bred for tameness. Whilst it is argued that captive breeding programmes aim to produce animals that respond well to training, discipline and performing [20], this argument is not supported by the evidence. To be effective, intense selection must be applied over a significant number of generations. This is well illustrated by experiments on the domestication of the silver fox, a coat variety of the red fox. Consistent and prolonged selection for tameness was applied, yet after 42 generations (from 1959 to 2002) only 71% of fox cubs showed predominantly domestic traits and were behaving like domestic dogs; the remaining 29% still showed wild traits, such as fear of humans [21].

The argument is often made by elephant biologists that, despite living in captivity in Asian countries for around four thousand years and being subject to extensive training during this time, elephants are not domesticated e.g. [22]. In fact the number of keepers and visitors injured or killed by zoo elephants in the period between 1982 and 2004 averages between 1-11 per year [23].

Another example is provided by a recent study that revealed a high incidence of captive tiger attacks on people: 1.75 fatal and 9 non-fatal attacks per year in the USA [24]. The vast majority of these attacks occurred in circuses and theme parks and an equal number of visitors and handlers were injured. However, twice as many handlers were killed in private facilities, which included private owners, animal rental companies and circuses. The most common features of attacks were proximity to the animal, handling and being photographed with the animal.

The attacks involving tigers highlight that even trained tigers kept in captivity for generations retain the same attack/kill instinct as their wild counterparts [24,25]. We make the argument that proclivity to attack and kill can reasonably be used as a measure of lack of tameness – and this proclivity clearly has not disappeared in captive tigers. Whilst some domesticated breeds of dog retain their killer instincts, they can be trained not to kill [26]; in contrast, tigers cannot be trained not to kill.

3.1 Summary

There is no scientific evidence to suggest that wild animals can be truly domesticated simply by living in captivity. Moreover, domestication implies a degree of genetic distinction or identity and has been compared with speciation [27]. In fact, all the evidence suggests captive animals remain motivated to perform wild behaviours. On the basis of the low number of generations of wild-caught animals that have been bred in captivity and for the lack of selection for tameness, no captive animal (including hybrids) held in circuses or establishments for the entertainment industry should be considered domesticated.

4 Animals in captivity

As a general rule, free-living herbivores spend the majority of their time foraging and carnivores considerable energy locating their prey and hunting. In captivity, food is normally provided in concentrated rations (such as pellets), is readily available and provided at set times so that the captive animal normally performs little or no searching behaviour, and most of the time is spent idle.

Space is extremely limited when compared to free-living animals, especially large mammals (Table 1); for instance, a polar bear's average enclosure is about one-millionth of the area of its minimum range in the wild [28]. However, even compared to zoo enclosures, circus cages and pens provide a very restricted amount of space (Fig. 1). Clubb & Mason [28] showed in their work on captive carnivores that the more wide-ranging the animal, the more its welfare is compromised by captivity.

In captivity, and especially in circuses, it is often unavoidable that social animals are housed singly, in groups smaller than the average group size in the wild or in unnatural groupings, thereby preventing the establishment of normal social dynamics. This can have significant negative consequences on behaviour, welfare and reproduction (review in [29]). In zoos, equids, particularly zebras, have been reported to attack other species' young so that mixed exhibits are not generally recommended for wild equids [30]. In the wild, depending on the species, same sex conspecifics might not be tolerated and individuals at a particular age leave their natal group e.g. [31,32]. Mixed species groupings exist in the wild but with very little interaction and in captivity the restricted space may create tension e.g. [33].

Moreover, circuses have inappropriately hybridised big cats e.g. 'liger' a cross between a male lion and a female tiger.

In nature large carnivores are competitors and may predate upon smaller carnivores, kill competitors or commit infanticide upon other species' offspring [34].

Circuses often exchange animals with other institutions or obtain adult individuals rather than breeding them in-house [35,36]; this is especially true with animals difficult to breed in captivity, such as African and Asian elephants [37-39].

Table 1. Recommended minimum cage size (circus) and minimum or average[*] outdoor enclosure (zoo) compared to minimum or average[*] individual range size (wild) for some species held in circuses. Average enclosure size was calculated across the values provided by different references and/or for different species in the same reference (e.g. for big cats). All measures are in square metres. The species chosen as representatives of each category are those highlighted by the Association of Circus Proprietors [40] as acceptable circus species. All circus data are taken from the Association of Circus Proprietors [40], zoo data from Born Free Foundation & RSPCA [41] recalculated to account for the maximum number of animals kept in a circus cage and using only data from European zoos, with the exception of the pygmy hippo [42], giraffe [43], and of primates (capuchins) [44]. References (wild range sizes): big cats (lion, tiger, puma) and bears (American black bear) [45]; plains zebra [46]; camel (dromedary) [47]; pygmy hippo [48]; giraffe [49]; Asian elephant [50]; primates ([a]tufted capuchin monkey) [51], ([b]rhesus macaque) [52].

	Taxon							
Area (m^2)	Big cats	Bear	Zebra	Camel	Pygmy hippo	Giraffe	Elephant	Primates
Number of animals	1-5	1-5	1	1	1	1-3	1-3	1-2
Circus cage/pen	76	76	7.5	12	12	250	100	10
Zoo outdoor	118.5[*]	196.7[*]	350[*]	212.5[*]	100[*]	436	500*	60
For comparison								
Wild range	120,000,000[*]	56,300,000	80,000,000	3,187,000,000[*]	500,000	5,000,000*	100,000,000	1,610,000[*a] 210,000[*b]

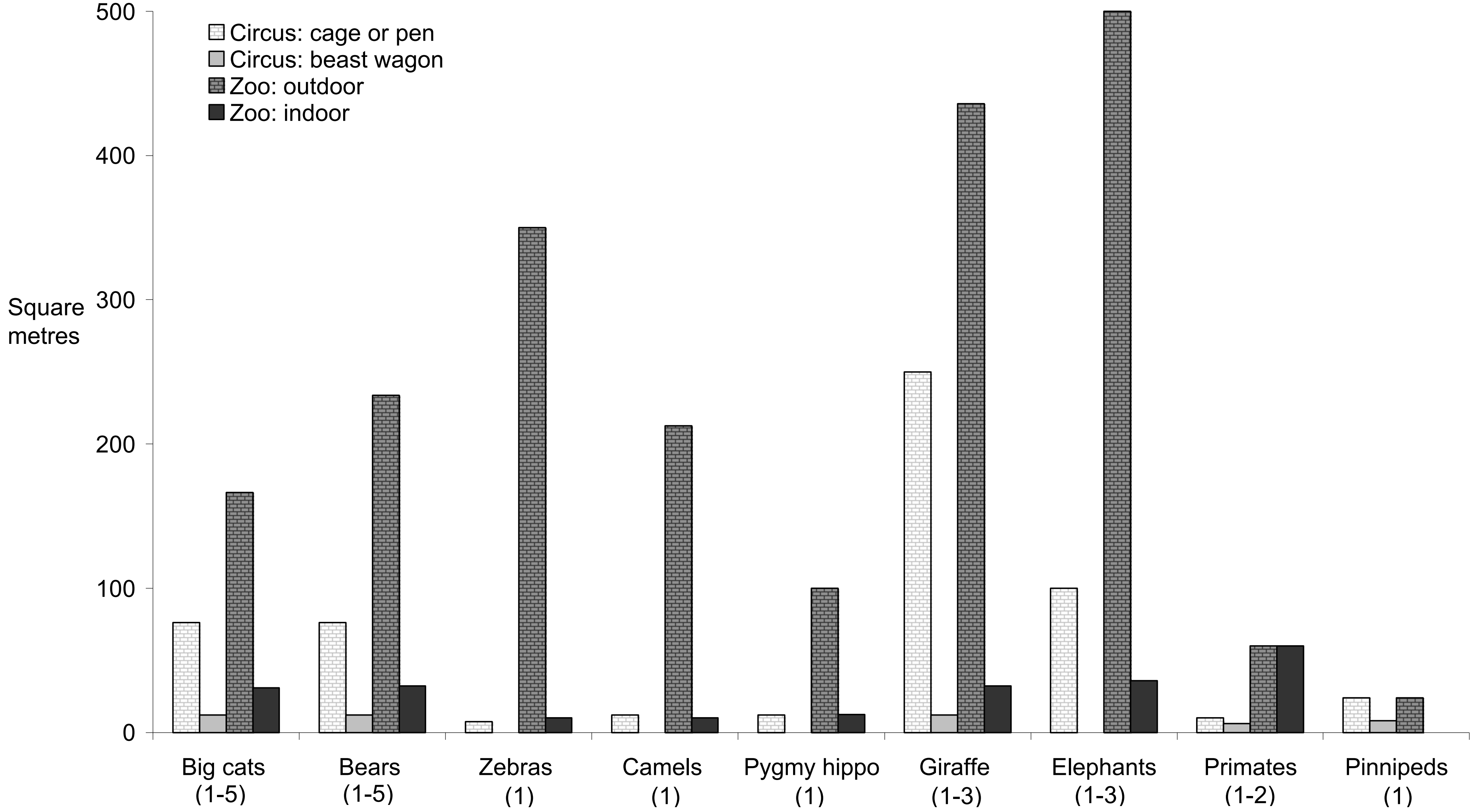

Fig. 1. Recommended minimum sizes of cage or pen and beast wagon (circuses) compared to recommended minimum or average size (zoos). Please see Table 1 for details of methods. The numbers below the species are the number of animals per enclosure. The species chosen as representatives of each category are those highlighted by the Association of Circus Proprietors [40] as acceptable circus species. All circus data are taken from the Association of Circus Proprietors [40], zoo data from Born Free Foundation & RSPCA [41] with the exception of the pygmy hippo [42], giraffe [43], primates [47] and of pinnipeds [53] .

This disrupts any existing group social bonds that highly social animals like elephants have developed in their former captive environment and has serious consequences for animal welfare and future reproduction [37-39].

Furthermore, prolonged breeding in captivity has essentially not changed the behaviour of these animals from that of their wild counterparts. In an experiment on farmed mink, which for 70 generations were selected for fur quality but not for tameness, animals were caged with no access to water. When given the opportunity to access water, where in the wild they hunt aquatic prey, mink showed high determination (were willing to pay a 'price') to access a pool of water [5].

Apart from living in restricted spaces, circus animals, especially elephants, may be kept chained (shackled individually or picketed in lines) continuously for between 12-23 hours per day [54,55] when not performing. Both shackling and picketing severely restrict the degree of social contact amongst individuals, basically reducing it to 'neighbouring' (i.e. to either side) elephants [55]. However, many handlers claim that chaining is needed for safety reasons, and because trainers regard it as a means to establish and maintain dominance over the animals [55].

Even when not chained, circus elephants are housed in barren pens surrounded by an electric fence, which is viewed as a 'revolutionary' improvement to circus elephant lives [56]. In a study of elephant behaviour during the transition between being restrained in a picket line to being confined in a pen, trainers acknowledge that penned elephants were more relaxed and showed reduced stereotypic behaviour [54]. However, the practice of picketing cannot be discontinued completely because the use of electric pens is not always feasible or because a more secure restraint is often needed [54]. Moreover, whilst some degree of socialisation is possible in penned elephants, uninhibited social interactions are not possible [57].

When animals are unsupervised, objects that might be used by zoos as environmental enrichment (e.g. logs) are generally not provided by circuses because they could be used to break the barriers [56,57].

4.1 Summary

In summary, because of the particular circumstance circuses present, neither natural environments nor many natural behaviours can be recreated. In zoos, the presence of a complex captive environment can mitigate behavioural problems stemming from captivity and provide the animal with a diverse arrange of stimuli [3]. Due to the mobile life of circuses, however, complex environments e.g. wallows, browse, facilities to brachiate [58], cannot be set up and the captive animal's life is unavoidably impoverished.

5 The health of captive animals

The physical restrictions of the captive environment have adverse effects on captive animals' health. Elephants lacking physical exercise in zoos and circuses can become obese, which in turn leads to defects of the joints and ligaments of feet and legs [59]. In a survey of 62 Asian and 5 African elephants from three circuses and five zoos, veterinarians found a high incidence of rheumatoid disorders and one of the authors observed chronic arthritis and lameness in captive elephants [60]. The development of lameness is common in circus elephants [61]; and more common in zoo than wild elephants [62]. These joint problems as well as hernia are thought to result from circus elephants repeatedly assuming unnatural

positions during performance [61,63]. In circuses, the lack of mud baths, which wild elephants use for skin care, commonly causes severe skin problems [64].

Teeth problems occur as a consequence of incorrect feeding practices in captive elephants [59] and wild ungulates [31]. Kurt [65], an elephant researcher, states that he has never observed teeth abnormalities in wild Asian elephants. In zoos, where elephants are kept on a sand surface, the animals may eat sand and stones and this is detrimental to their health [66]. Other typical health problems in circus animals are tuberculosis, protein deficiency in primates and mange in camelids [67].

Disease transmission may be faster and more common in captivity than in the wild. For instance, it has been suggested that African elephants transmit the lethal elephant endotheliotropic herpes virus (EEHV) to Asian elephants in European zoos [68]. The two species would not meet in the wild. This virus is found in very young or stillborn calves, and represents a further threat (added to offspring infanticide and abandonment) to elephant reproductive success in captivity [68].

Furthermore it is hard to prevent local wildlife coming into contact with zoo and circus animals attracted by food sources; this may facilitate disease spread, e.g. canine distemper virus was probably transmitted by wild animals, such as martens, to lions and tigers in Switzerland [69]. In zoos, walls or fences forming the outer perimeter limit the extent to which local wildlife comes into contact with the captive animals. In contrast, permanent and solid perimeters are not feasible for travelling circuses.

Disease transmission between captive animals and humans may also pose a threat to handlers or members of the public attending performances, as in the case of handlers being infected with tuberculosis transmitted by circus elephants [70]. Some diseases are rarely encountered in the wild and are present in captivity because of bad feeding practices [71]. For instance, circus lions developed botulism after consuming broiler chickens [72].

Many captive wild animals are kept outside their natural geographic distribution and this may have negative consequences on their health. For instance, veterinarians treating circus polar bears performing in Spain have diagnosed signs of depression and inappetance to extremely hot weather conditions [71]. Evidence from livestock research suggests that in colder and wetter climate there is a higher incidence of foot infections [73].

5.1 Summary

The physical restrictions of the captive environment have adverse effects on captive animals' health spanning from teeth abnormalities, to ligament problems and unusual diseases. In elephants, the unnatural postures assumed while performing are thought to induce joint problems. Disease transmission may spread faster in captivity than in the wild and because of their non-permanent nature, travelling circuses cannot erect permanent barriers to prevent local wildlife coming into contact with captive animals.

6 Captivity related stress

Restricted physical activity and social interaction, incorrect feeding practices or a forced reduction in the time spent foraging and in other highly motivated behaviours can represent stressors to captive wild animals. Stress can have short-term behavioural effects such as aversion, alarm, increased vigilance, and physiological effects such as tachycardia, increased respiration rate and an increase in glucocorticoids (GCC), as well as chronic long-term

behavioural and physiological effects [74-76]. For instance, moving felids to unfamiliar environments such as new cages creates rapid stress responses, evidenced by levels of urinary cortisol [77].

Prolonged stress has severe consequences for animal welfare, especially in confined individuals that cannot escape or otherwise behaviourally avoid the stressor. The effects of even minor stresses combine to suppress immune function, reproduction, metabolism and behaviour [76]. The direct and indirect repercussions on animal health are widespread and complex. Physiological effects include suppressed reproductive cycles and immune responses, reduced growth rates and reduced body weight. However, physiological measures of stress are not clear cut; different stressors have different and often contrasting effects on physiological measures so that they are difficult to interpret in terms of level of welfare e.g. [78], review in [79]. This is why it is essential to use several welfare indicators [12,80].

Many factors constitute stressors in captive environments. For instance, confined animals are unable to escape from nearby predators detected by olfactory, visual or auditory cues [81,82]. Noise [83] and the presence of the public are amongst other stressors from which there is often no escape for a confined animal [3]. In psittacine birds (which include parrots, macaws, parakeets) poor socialization, anxiety, boredom, hand-rearing and related human imprinting, with consequent failure to learn correct preening behaviours, may cause stress and, as a result, feather plucking [82,84].

In zoos, stress is a recognised problem [85], and environmental enrichment provides an opportunity to expand behavioural choices through physical environmental complexity, cognitive challenges and appetitive motivation [3,58]. Although the Association of Circus Proprietors of Great Britain refers to basic methods of behavioural enrichment in their manual, there is no evidence of comparable awareness of preventative measures against stress in circuses [40].

The circus environment seems likely to induce behavioural problems of the sort noted in other impoverished environments with confined spaces, barren enclosures and social isolation. Such effects vary from reduced reproductive behaviour, exploratory behaviour and behavioural complexity to increased abnormal, vigilance and hiding behaviours, behavioural inhibition, aggression, fearfulness and freezing behaviour (reviewed in [75]). For instance, social isolation and reduced space allowance have been linked to negative behavioural and physiological responses in farmed pigs [86,87], dogs, dairy calves and sheep amongst the domestic species (reviewed in [75]). In addition, social isolation and reduced space allowance cause increased levels of aggression and stress levels in a range of captive wild animals from primates, to deer and dolphins (reviewed in [75]). Moreover, barren cages were linked to negative physiological responses, reduced exploration and increased agonistic behaviour in silver foxes [88], and captive cheetahs and tigers suffer from chronic stress-induced gastroenteritis [83,89]. Given that social isolation, reduced space allowance and inappropriate housing conditions cause profound stress in domestic species and, given that there is partial evidence of their effect on captive wild species as well, it is reasonable to assume that the housing conditions of circus animals are likely to cause severe stress to wild animals.

In many respects, and despite the lack of predation, food shortage and adverse environmental conditions, animals kept in captivity experience poorer welfare than animals of the same species living free. Captivity-related stress is linked to the development of unusual diseases which affect captive-born and wild-caught but not wild free-ranging cheetahs [90]. Chronic

stress was found in captive clouded leopards held in North America; all captive leopards were found to be stressed but those cared for by a greater number of keepers experienced higher stress [82]. Clearly relevant to the circus situation, where such factors are unavoidable, felids displayed to the public and those housed close to potential predators were more stressed, as measured by faecal corticoid concentrations [72,82].

It has been suggested that the greatest stressor of captivity is the inability of captive animals to control all the stressors that afflict them, i.e. their inability to control the captive environment [67]. So, if the captive environment induces many different stressors that negatively affect the physiology and behaviour of captive animals, the animal's inability to avoid or control these stressors is itself a cause of stress.

6.1 Reproduction in captivity

Amongst the long-term effects of stress on aspects of an animal's life, one of the most studied is reproduction; this is due to its importance as a life-history trait and its crucial role for conservation and/or reintroduction programmes in zoos. In this section we will look into the effects of captivity-induced stress on reproduction and give some specific example from animals commonly kept in circuses.

6.1.1 The effects of captivity-related stress on reproduction

Many species are very difficult to breed in captivity as a consequence of the detrimental effects of the captive environment on an individual's development, modulation of stress and arousal, and on the modification of social interactions [91]. Breeding failure of captive animals is extremely common and its origin can almost invariably be linked to some unnatural aspects of captivity [92]. Even if viable offspring are produced, the abandonment of the offspring by the mother is common. As a consequence, hand-rearing was a widespread practice (and to some extent, still is) in captive environments [58]. However, hand-reared individuals fail to develop normal social and reproductive behaviours and develop abnormal behaviours [58,82,93] so that BIAZA-accredited zoos only recommend hand-rearing for pre-determined population management purposes e.g. according to TAG or EEP recommendations [11]. On the other hand, even if breeding were easy, there are concerns about this in terms of welfare. Alarmingly, it has been suggested that captive-born wild animals show more 'putative stereotypic behaviour'[ix] than wild-born animals captured as adults [94] although some species appear to fare badly in captivity regardless of their origin [90]. In circuses hand-rearing is probably common[x] and the animals might be reared with limited access to conspecifics. Therefore, it has been recommended that if hand-rearing is necessary in circuses, it should be accompanied by integration with conspecifics [19].

In the wild, environmental factors such as resource availability, predation and climate limit animal population reproduction, growth and mortality. In captivity these environmental effects are limited. Consequently, reduced or no reproductive life span [37,95,96], inapt copulatory behaviour, infanticide or abandonment of offspring due to social disruption or hand-rearing [37,93], high infant mortality [97] and/or reduced life expectancy, all represent the deleterious effects of husbandry-related stress.

[ix] The authors define 'abnormal repetitive behaviour' or 'putative stereotypic behaviour' as any abnormal behaviour that is suspected to be stereotypic (and further evidence will prove its nature) but it cannot be strictly defined as such because the cause of the named behaviour is unknown [98]

[x] Evidence for this is only circumstantial but in a description of a 'typical' circus some of the caravans included people and young animals to be hand-reared [19].

There is a lot of literature on this subject from zoos and a limited amount on circuses, but to illustrate the main problems we use examples from the literature on elephants, large and small wide-ranging carnivores, primates and ungulates.

6.1.2 Elephant reproduction

Elephants are very difficult to breed in captivity for several reasons, all of which are linked to environmental effects that are more acute in circuses than in zoos. Elephants are highly social, living in matriarchal societies in the wild. Groups are mixed aged, and young females grow up with older females, helping rear their calves and thereby learning mothering skills [59,65]. Cows are assisted by aunts or other females during parturition and afterwards, in rearing the calf. In captivity in contrast, elephants are moved among establishments, disrupting the existing social bonds amongst group members; females are often removed at birth and chained separately from the group [99]. Such treatment of females is thought to lead to the death of infants [69,65], and the cause of higher percentages of stillbirths and infant mortality due to infanticide by mothers in European zoos and circuses than in the wild [37,38]. Stillbirths seem to be correlated to the mother and/or calf being overweight, and allowing female elephants more movement or changing feeding practice would decrease female obesity [37].

Another reason for the low or absent reproductive performance of elephants in circuses is the lack of bulls. The keeping of bull elephants is normally avoided in circuses as they are extremely dangerous [59]. Aggressive behaviour in bull elephants is most pronounced in the period of musth; musth bulls show absolute dominance and, if keepers refuse to withdraw accordingly, the animals can become aggressive. Some handlers try to control aggressive bulls by beating them in sensitive areas such as the ears, eyes and penis, which is thought to cause circus bulls to refuse to breed [59,65]; for instance, of eight bull elephants kept in western European zoos but formerly living in circuses, two were moved to zoos before the age of 15 (prior to sexual maturity) and successfully bred whilst five of the remaining six, which lived in circuses until after 15 years old, refused to breed [65].

Husbandry practices seem to be responsible for the lower reproductive success of elephants in European zoos and circuses when compared to Asian extensive keeping systems [38,65,100]. A consequence of this low reproductive success is that if the trend cannot be reversed, more elephants will need to be imported from the range states to keep captive populations viable [39].

6.1.3 Carnivore reproduction

At the other end of the sociality scale, there are solitary species such as the majority of carnivores. Forced sociality in these species, even among single sex groups, may suppress reproduction. Males of small cats housed alone or with only one conspecific female had higher reproductive potential (larger testes, more semen volume and more sperm per ejaculate) than cats in group exhibits [101]. The presence of other reproductively active females in a group can suppress reproduction at various levels (physiological, behavioural, etc.). This is the case, for example, with female cheetahs housed in groups, where the presence of female conspecifics seemed to cause ovarian inactivity and consequently, inability to breed, in a large sample of zoos in North America [92,102].

6.1.4 Primate reproduction

Similarly in a non-group-living monogamous species of tamarin, infants born in a colony suffer significantly more abuse than non-colony housed infants, possibly as a consequence of

social stress [103]. In general, prosimians juvenile mortality in captivity is high, ranging from 25% to 45%; its main causes are related to captivity-induced stress which manifests itself in decreased conception rates, premature births, lactational failure and maternal neglect (review in [104]).

An argument could be made that hand-rearing produces animals well-adapted to a circus life. In fact hand-rearing and lack of social interactions are the main cause of breeding failure in captive primates. In chimpanzees only 30% of individuals hand-reared in isolation reproduce as adults, compared with nearly 90% of animals raised with at least one adult [93]. Rhesus monkeys raised in complete isolation never develop normal social behaviours, whilst monkeys raised without mothers but with peers show normal social development to a certain extent but an abnormal degree of peer attachment [105,106].

6.1.5 Ungulate reproduction

When subjected to incorrect social grouping or housing, ungulates may also experience decreased reproductive potential. Because equids are gregarious and form hierarchies, solitary males (bachelors) which grew up outside a normal herd structure or were subsequently introduced to more dominant mares, pace (stereotype) more than mares and may become impotent [31,32]. Mares can show stallion-like behaviour and high levels of aggression whilst stallions inappropriately moved from an established herd to a new herd may become infanticidal [31].

It must also be noted that, as pointed out earlier, some equids, particularly zebras, may actually represent a threat to other species' reproduction. In mixed exhibits, aggression directed to other species is common and in some cases leads to the killing of young antelope, bovine and deer calves [30].

6.2 Summary

All the evidence shows that circuses, more than zoos, are highly likely to both stress animals and reduce their ability to deal with that stress. This is because wild circus animals are subject to the effect of combined stressors (by being hand-reared and/or socially isolated, subject to performance and travel). One manifestation of the deleterious consequences may be found in their poor reproductive performance. In conclusion, the effects of confinement on a captive animal's freedom to perform highly motivated behaviours have a high toll on welfare by compromising health, altering brain functions [107], reducing breeding potential and life expectancy [59].

7 The effect of travel on animal welfare

Captive animals kept by circuses and establishments of the entertainment industry travel very often, about once a week[xi]**.** Forced movement, human handling, noise, cage motion and confinement constitute sources of stress to captive animals; loading and unloading, presence of water and food, the opportunity for rest and climate are key features to consider for the welfare of animals during transportation e.g. [108,109].

Inside circus trailers temperatures can reach extremes if ventilation or heating are not in place, and it is unclear how many circuses have air conditioning systems. For instance, in a study on the transport environment in six circuses, only two circuses used insulated walls and high capacity ventilation fans to maintain internal temperatures within a safe range [110].

[xi] It must be noted that not all animals travel to all sites and can instead be transported to some static site. Moreover, travel dates for circuses are not readily available.

Moreover, drivers/handlers may be unaware of any critical temperature increase in the trailers [110]. The temperature inside the trailers is of particular concern in cold weather; Asian and African elephants in their natural environments face temperatures as low as 0°C but can move and be active to keep their body temperature stable[xii]. Movement is not possible or only possible to a very limited extent in trailers as elephants are transported chained [110].

Transport can have deleterious effects on reproduction. For instance, Edwards *et al.* [111] found that transport stress reduced ovulation rate in domestic cows. In a study analysing 30 years of records from a captive colony of pigtailed macaques, the number of moves experienced by the mother during pregnancy was one of the main factors negatively influencing the probability of a viable birth [112].

Overall, there is very limited evidence on the effect of transport-related stress in circus animals. However, given that transportation is a significant stressor negatively affecting the welfare of domestic animals [113,114], it is reasonable to assume that the experience it is equally if not more stressful for wild animals. There is no indication of the negative effects of transportation stress on animals in the Association of Circus Proprietors of Great Britain Guidelines [40], or advice on the frequency of transport, although it refers to WATO Guidelines for optimum travelling time.

7.1 The transport of reptiles

It has been suggested that reptiles are unsuitable for frequent transportation, as they are sensitive to frequent vibrations and temperature changes [44]. In the natural environment, reptiles and amphibians are able to detect airborne and ground vibrations for the purpose of intraspecific communication, prey location and predator detection [115-118]. Sudden or persistent acoustic or vibratory stimulation can be stressful, and so sources of such stimuli, such as traffic or people, should be minimised [119].

Thermoregulation is the single most important physical factor in reptile ecology [120]. Many species undergo distinctive circadian patterns of thermoregulatory behaviour, which can be maintained even if the day-night cycle is altered [121]. If these circadian or seasonal patterns of thermoregulation are disrupted, the normal physiological activity is suppressed, with associated consequences such as inappetence, susceptibility to infections, abnormal or absent reproductive activity and even death (reviewed in [122]).

Thus, it is likely that frequent transport is unsettling to reptiles and amphibians as this might disrupt thermoregulatory patterns and probably involves considerable auditory and vibratory stressors. As a consequence, frequent transportation could lead to poor welfare for reptiles and amphibians, although research on this topic is missing. However, of all animal groups, amphibians and reptiles respond poorest to transport, with the highest average incidences of mortality, 5.0% and 3.1% respectively [123].

7.2 Do animals habituate to travelling?

Many factors act simultaneously to affect the welfare of transported animals [113]. Some relate to genetics (whether an animal is domesticated or wild), exposure (an individual may be naïve or experienced to travel), experience (positive experience in past travel or trauma/pain suffered during travel) or husbandry (intensively or extensively farmed) [113]. Wild animals

[xii] In the same study, some circuses in cold conditions successfully kept temperatures at acceptable levels by depending solely on the heat produced by the elephants themselves [110]. However, the only example given is by one of the two circuses with insulated walls [110].

and/or animals completely naïve to travel show signs of behavioural and physiological distress when subject to travel e.g. [114,124]. In contrast, domesticated animals accustomed to handling and human presence are generally less stressed by being restrained and transported (review in [113]). However, there is great individual variation in stress responses and Grandin [113] suggested that stress and discomfort should be evaluated using both behavioural and physiological measures.

To date, although some studies suggest that there is a degree of habituation to travel, other than body temperature only behavioural measures (stereotypies, see later Fig. 4) are available for circus tigers and elephants during transport [125-127]. In zoo tigers, where limited behavioural and physiological data are available, pacing varies individually but altered cortisol levels persist for 3-6 days after transport in animals experienced to travel (transported at least twice before) and 9-12 days in naïve tigers, suggesting that travelling is a stressful experience [128]. Circus animals could experience some degree of stress during travel even if, behaviourally, they show lower stress than a naïve animal, and given the frequency of travel, this is likely to be a welfare concern. These time periods are, in fact, as long as or longer than typical rest periods for circus animals and, therefore, it is possible that the animals have not recovered from one lot of transport stress before being moved to a new site. Although there is insufficient evidence to assess whether circus animals habituate to travelling [129, p.135], it is noteworthy that two studies examining transport in large felids found very similar levels of stereotypic behaviour in both zoo and circus animals [125,128], (see later Fig. 4).

7.3 Summary

Captive animals kept by circuses and establishments of the audio visual industry travel often. Many travel features such as forced movement, human handling, noise, cage motion and confinement constitute sources of stress to captive animals. There is no conclusive evidence on whether animals completely habituate to travelling. There is however, evidence that travelling is stressful for captive wild animals and it may have adverse effects on reproduction.

8 The behaviour of captive wild animals

In order to identify an acceptable level of animal welfare for captive animals, a comparison should be made with free ranging animals[xiii] [130]. The range of activities and behaviours performed by free animals, the time spent in each activity/behaviour, reproductive life span and life expectancy are all parameters that can be used as a baseline against which to measure the welfare of captive animals. Such a comparison is not always straight forward – a difference in activity budgets between wild and captive animals does not necessarily imply poor welfare – but it can be used alongside other measures of welfare and can provide a useful baseline.

8.1 Time budgets

Elephants (both species) spend anywhere between 40% and 75% of their time feeding [131]. Asian elephants may consume between 1.5-1.9% of their body weight in 12 hours, eating between 33.6-44.4 kg of grass per 12 hours [50]. In the wild, African elephants can cover 30-50 km in a single day [132] and African elephants spend 57% of daylight hours moving and feeding in the Okavango Delta [133]. In contrast, physical activity is limited in zoos and grazing is unavailable in 90% (18/20) of European zoos keeping Asian elephants [38]. In four circuses, elephants spent 12.6-22.7 hours/day shackled in an area 7-12 m^2, although they

[xiii] This does not mean we believe wild animal welfare is invariably better than captive animal welfare

could only move as far as the length of the chain, i.e. 1-2 m, 0.3-8.2 hours/day in a paddock measuring 22.7-72.0 m^2 and 0.3-2.1 hours/day training or performing [55]. Performing typically occupies 1% or less of observation times in circus animals [118], (Fig 2).

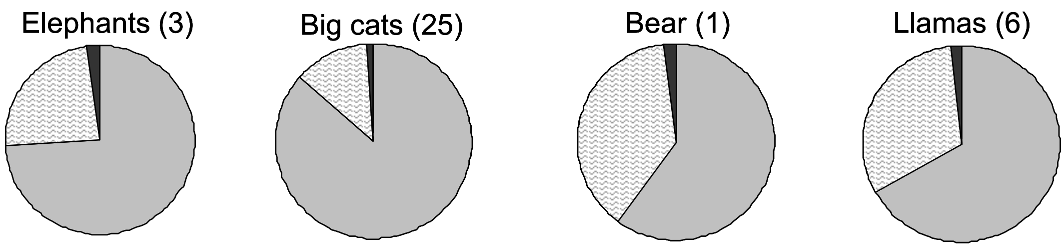

Fig. 2. Percentage time (24hr) spent chained or in wagon (light grey), in the exercise pen (wavy lines) and performing (dark grey) by captive wild animals in various UK circuses (the number of circuses varies with species) (data recalculated from [134]). The number of animals is in parentheses.

Similarly, captive ocelots, giraffes and okapi are less active (albeit the difference is not quantified for all species) than their wild counterparts [135-137]. In a comparative study between time budgets of wild and captive giraffes, the captive ungulates spent on average more time stereotyping (approximately 0% *versus* 14% respectively) but less time feeding (approximately 23% *versus* 42% respectively) [135] (Fig. 3). When the authors compared the zoo that most closely approached wild conditions (largest enclosure and herd size), there was still a significant difference in the time spent feeding (76.9% wild, 26% zoo) and stereotyping (0% wild, circa 13% zoo) [135].

There is no consensus as to whether elephants living in captivity have a lower life expectancy than wild elephants. Some studies have found that the life expectancy of zoo and circus elephants is lower than in the wild [65,100,138]; others have found that captive elephant life expectancy is similar to wild and working elephants, although this only considers individuals that survived to one year of age in zoos [139]. However, it must be noted that current life expectancy estimates in the wild for African elephants [139] are calculated from populations where the main cause of adult mortality is related to human activities rather than natural death [140].

8.2 Stereotypies

It has long been recognised that captivity may have deleterious effects on an animal's behavioural patterns. Normal behaviour gives way to a higher percentage of inactivity and/or increased abnormal behaviour (self-directed behaviour or self-injury) and stereotypies [141].

Stereotypies are repetitive behaviours with no apparent aim that develop when a captive animal is prevented from executing a highly motivated behaviour [141]. For instance, stereotypic pacing in captive carnivores generally increases during crepuscular hours [137] when wild carnivores are more active, or seasonally, when mate-seeking behaviour would be performed in the wild [142]. Although it is difficult to make generalisations about stereotypies, they are commonly associated with a sub-optimal environment and poor or compromised welfare [143], an environment we believe circuses represent. That is probably why primates confiscated from touring zoos and circuses exhibit undesirable behaviour more than primates reared in recognised zoos [144]. In addition, accumulating evidence suggests that it may also represent a captivity-induced dysfunction of the central nervous system [98].

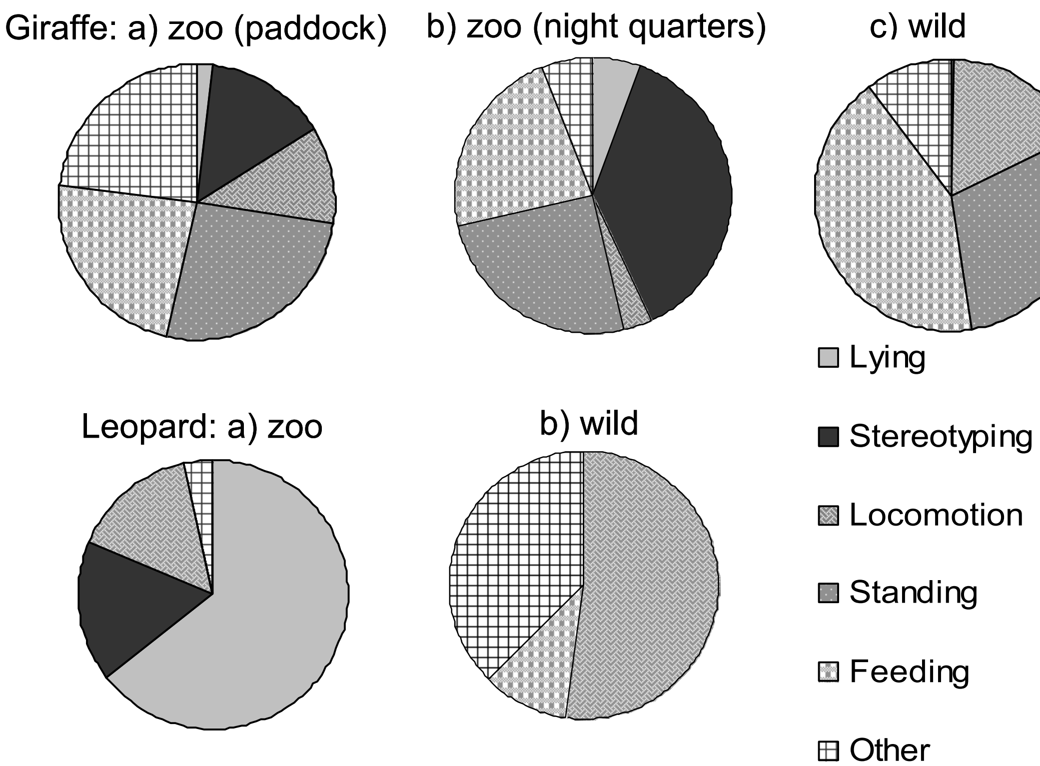

Fig. 3. Comparison between time spent in different activities (%) by giraffes (19) and leopards (7) in zoos (4 for giraffes, 1 for leopards) and in the wild (numbers sampled not stated) (data on giraffe recalculated from [135], leopards in a zoo from [145], in the wild from [86]).

Stereotypic pacing varies widely amongst captive carnivores, from an average of 0.16% of observations in red foxes to 30% in lions and 60% in tigers [97,146]. A significant proportion of this variation is explained by home range and distance travelled daily: species that travel over large distances in the wild show higher levels of stereotypic pacing in captivity [28,97]. Hand-rearing also negatively influences the development of stereotypies. For instance, captive-bred hand-reared bears, primates and African grey parrots exhibit significantly more stereotypies than captive-bred mother-reared individuals [147-149] and the development of feather plucking/chewing in psittacine birds has been linked to hand-rearing [82].

Stereotypies tend to increase in frequency with a higher degree of movement restraint and with more barren environments. For instance, circus elephants kept shackled or picketed weave and head-nod more than in paddocks [54,55], zoo bears and leopards pace more in the smaller off-exhibit enclosures than in the larger on-exhibit enclosures [145,150] and captive parrots perform more oral and locomotory stereotypies in barren cages than in enriched cages [151].

Some elephant handlers believe that stereotypic behaviour is part of an elephant's normal repertoire; for instance, weaving stereotypies are said to aid circulation in the same way that walking does in wild elephants [152]. The frequency of stereotypic behaviour, however, is significantly greater (about 30%) in chained circus elephants when compared to elephants in zoo or circus enclosures (about 4% and 10% respectively) [100]. Moreover, in captive animals, the frequency of stereotypic behaviour appears to be lower in zoo animals when compared to circus animals, with the exception of large felids, where it is comparable during transport or higher in inside and outside enclosures (Fig. 4).

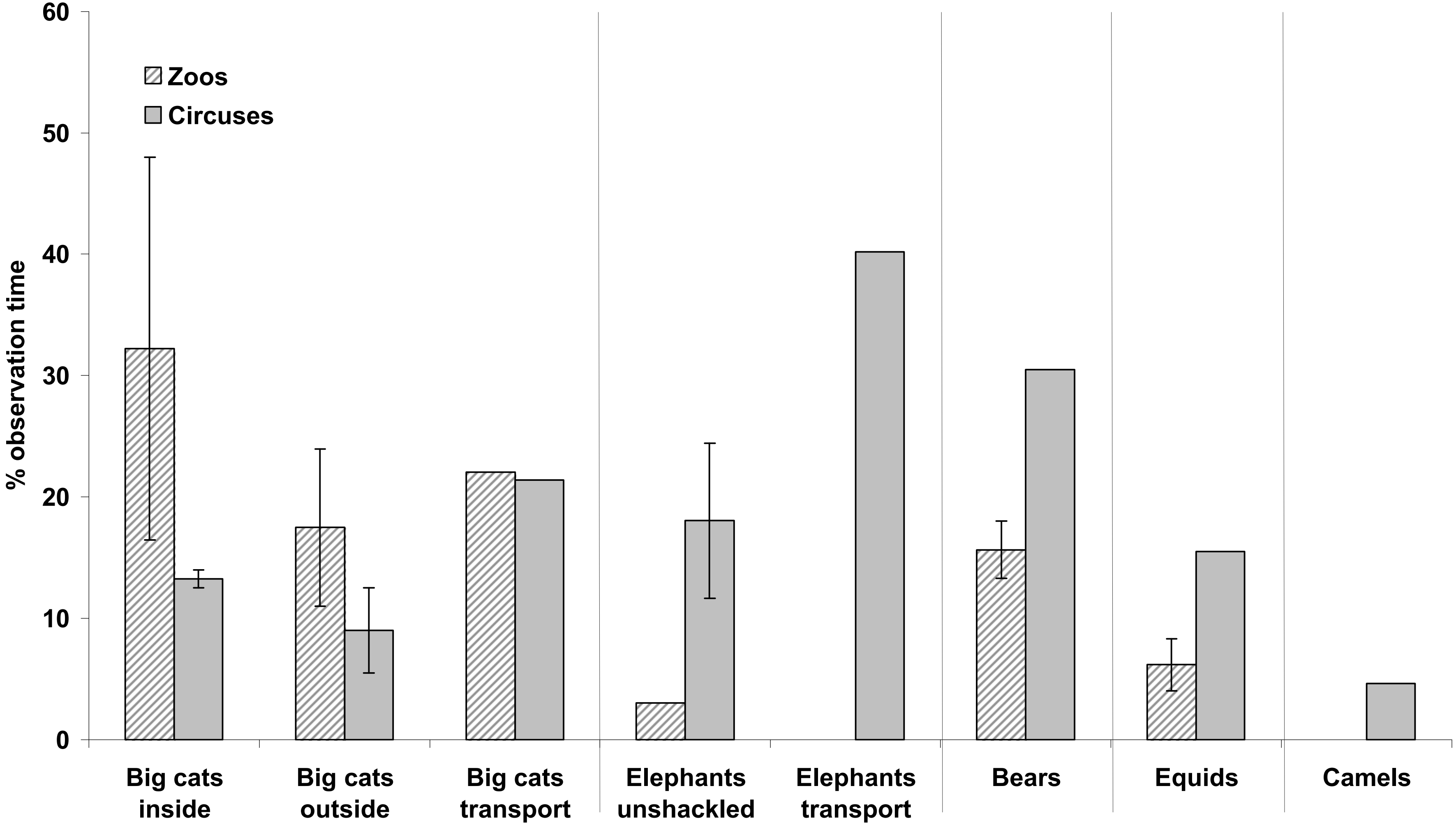

Fig. 4. The frequency of stereotypic behaviour in zoo and circus animals in outside enclosures unless otherwise stated. Values shown are study averages, or averages across studies and error bars refer to the error calculated on averages across multiple studies. The species chosen as representatives of each category are those highlighted by the Association of Circus Proprietors [40] as acceptable circus species (see also legend of Table 1). Figures are given or recalculated from the following references: *big cats inside*, zoo: n=21 individuals, [97], circus: n=13, [19]; *big cats outside*, zoo: n=42, [97], n=14 [145], circus: n=13, [19]; *big cats transport*, zoo: n=5, [128], circus: n=4, [125]; *elephants unshackled*, zoo: n=29, [153]; circus: n=21, [19], n=24, [55], n=9, [54], n=13, [57]; *elephants transport*, circus: n=11, [126]; *bears*: zoo: n=27, [154], n=1, [142], circus: n=9, [19]; *equids*, zoo: n=42 [32], n=9, [155], circus: n=5, [19]; *camels*, circus: n=16, [19]. Our definition of stereotyping differs from Kiley-Worthington's [19] as we defined (and therefore included) pacing (all animals), bar chewing and pawing (only for equids and camels) as stereotypies.

The causes and incidence of stereotypies appear to point strongly to the circus being an inadequate environment for wild animals. There has been little work done on stereotypies in circuses, but the evidence from one study across 15 British circuses suggests that all species of wild circus animals stereotype [19]. For instance, bears spent 30% of the observation time pacing and all elephants studied showed stereotypies; furthermore, in both zoos and circuses there was evidence of prolonged distress and abnormal behaviour [19]. For felids in circuses and zoos, larger crowds are related to higher frequency of pacing [145,156]. As stereotypies normally indicate sub-optimal environments, a higher degree of stereotyping in circuses may be considered indicative of poorer welfare.

8.3 Summary

The range of activities and behaviours free animals perform, the time spent in each activity/behaviour, reproductive life span and life expectancy are all parameters that can be used to measure welfare of captive animals. Circus animals spend the majority of the day confined in the beast wagon, about 1% performing and the remaining in exercise pens. They usually feed and move for less time compared to free-living wild animals but spend more time inactive or performing repetitive behaviours (stereotypies). Most species stereotype more in circuses than in zoos. As stereotypies normally indicate sub-optimal environments, a higher degree of stereotyping in circuses may be considered indicative of poorer welfare.

9 Training and performance

Although an in-depth examination of training and performance is not part of our mandate, we briefly discuss it here. Training and performance in circuses may be suggested as suitable compensation for a more natural habitat and lifestyle, such as are found in the wild and in good zoos. However, no research has been conducted to test this hypothesis and, furthermore, we believe there may be circumstances in which some training can be the cause of poor welfare. We do not believe that any convincing argument has been made that training and performance are adequate compensation for an impoverished captive environment.

Reward-based training (positive reinforcement) may enhance health and reproductive potential of captive animals and it is recognized by zoo managers as a useful tool to improve captive species management [2,157]. Training by means of negative reinforcement and/or punishment may be the cause of poor welfare for the captive animal and may also establish a poor relationship between trainer and animal [74,158]. Amongst zoo animals negative reinforcement and physical punishment are uniquely used for training elephants [65; 159].

Some circuses have no training [160] and, in general, animals are in their cages most of the time [161]; Fig. 2. It has been claimed e.g. [56,134,162,163] that circus acts in which animals are asked to perform actions outside their natural range of movements, such as walking on hind legs, jumping through fire hoops, walking on globes, climbing steep pedestals, are trained using pulleys, hoists, electric shocks, forceful beating, goading or withholding food. Some trainers openly admit to beating animals into submission [164,165]. Circus trainers have been prosecuted for inhumane treatment of animals in the UK[xiv].

However, it is extremely difficult to find reliable data on circus animal training (but see [56]). Two species for which there is reasonably reliable information on training are Asian and African elephants. Some UK, other European and US zoos still use training methods adapted

[xiv] Animal Defenders International and the National Anti-Vivisection Society, Annex A, Circuses and performing animals, http://www.publications.parliament.uk/pa/cm200405/cmselect/cmenvfru/52/52we136.htm

from circus methods, which in turn adapted the methods of Asian mahouts. Stunts such as headstands, hindleg stands, tubsits and lying down are trained using negative reinforcement [100], and it is difficult to see how such tricks could be taught using positive reinforcement.

Performance acts in the presence of spectators are likely to cause severe stress to captive wild animals even if they are not engaged in unnatural movements. Loud noise is a well known stressor to captive animals; acoustical stress within and outside the human hearing range can cause critical alteration in physiological parameters [166,167]. Tigers may develop gastroenteritis as a consequence of persistent high noise [83]. High noise and brilliant light during circus performance might have predisposed an Indian python to infection and septicaemia which subsequently caused its death [168]. Loud noise and the presence of human crowds solicits huddling, aversive behaviour, vigilance and escape in captive primates, bears and wild ungulates [169-171]. In tigers, in the hour prior to performance and when the animals are in display to the public, pacing may peak up to 80% [156]; similarly, stereotyping increases before performance in elephants [152]. All these parameters suggest that human audiences have stressful effects on captive animals [172].

9.1 Summary

Behavioural and physiological parameters indicate that human audiences have stressful effects on captive wild animals; thus, performance acts in the presence of spectators are likely to cause stress.

10 How many wild animals are there in European circuses?

The total number of wild animals kept in captivity in European circuses is unknown; estimates of the number of captive animals (including domestic animals) range from a minimum figure of 2,400 to a maximum of 5,900 individuals. This estimate is based on data from the Czech Republic, Denmark, Finland, France, Germany, Italy, Latvia, Lithuania, Poland, Portugal, Sweden and the UK but no information is available for Belgium, Greece, Hungary, Ireland, the Netherlands and Spain [36]. A few species represent a large proportion of all captive animals; for instance, there are 90 elephants in Germany and 490 big cats in France [41]. Between 31 and 36% of all European captive elephants are kept in circuses, the remaining being housed in zoos [100].

Many European countries prohibit the use of all wild-born animals in circuses [36]: Denmark (although some species are exempted), Estonia and Poland ban all wild-born animals, whilst the Czech Republic, Finland and Sweden ban the majority of large-bodied wild-born species. Austria is the only European country that bans all wild animals from circuses, not just wild-born animals. Malta and Slovakia ban CITES-listed species. There are currently only a few captive wild animals in UK circuses: 1 Asian elephant, 4 zebras, 5 pythons, 12 big cats (lions and tigers), 10 camels and 1 black bear [41]. However, there is no restriction on foreign circuses travelling to the UK once the relevant permits have been acquired [173].

In Europe, some investigations highlighted the financial difficulties of the majority of small circuses [36,163] and consequently, a high risk of poor husbandry, veterinary care and feeding for the animals [174]. It must also be noted that most research on circus animals is conducted in the largest and better financed circuses and, therefore, is likely to represent the best husbandry and welfare in circuses rather than representing a cross-section of conditions found in circuses with a range of finances. Thus the data presented here are likely to be biased towards the best circuses, and do not represent the norm.

10.1 Summary

Across Europe there are between 2,400-5,900 wild and domestic captive animals in circuses. Between 31-36% of all European captive elephants are kept in circuses. The majority of circuses are small and financial difficulties are widespread. This is a major cause of concern for the risk of poor husbandry, veterinary care and feeding for the animals. There is no information available on the number of animals in the film and stills industry.

11 The origin of captive wild animals in circuses

Kiley-Worthington [19] reported that 40% of carnivores and 14% ungulates in 15 British circuses were unwanted zoo animals. Of all the wild animal species, the vast majority of elephants were wild-caught (approximately 94%) [19]. However, it must be noted that although the remaining animals were classified as bred in circuses, the category 'circus' actually included "private owners, market, etc." [175]. This implies that an unknown percentage of animals classified as captive-bred in circuses were actually bred in other private facilities.

The International Tiger Studbook states that there is no record of the numbers of tigers bred in zoos and subsequently released before the age of three to circuses, safari parks and private owners. Thus an unknown proportion of captive-born tigers passes into private hands [176]. It is estimated that the number of tigers (5,000-12,000) kept privately as exotic pets in non-accredited zoos, circuses and safari parks exceeds the combined number of wild and accredited zoo tigers [24]. The origin and lineage of the majority of these animals is unknown and their contribution to captive breeding conservation programs is negligible if existent.

11.1 Summary

In one study on 15 British circuses, 40% of carnivores and 14% ungulates were unwanted zoo animals. The origin and lineage of the majority of these animals is unknown and their contribution to captive breeding conservation programs is negligible if existent.

12 Which species of animal are suitable for life in circuses?

Some species of animal may be more suitable for a circus life than others. To be considered suitable for a circus life, such animals should exhibit all of the following characteristics:

(i) low space requirements,
(ii) simple social structures,
(iii) low cognitive function,
(iv) non-specialist ecological requirements,
(v) ability to be transported without adverse welfare effects.

Of all the animal species we consider that only reptiles, birds and mammals need be subject to a test of suitability on welfare grounds for circus life. The remaining species of animal, most of which are very small, have never been used in circuses, nor are they likely to be. On welfare grounds alone, however, many of these smaller species of lower vertebrates may meet our criteria of suitability for a circus life, since animals with large brains relative to their body size lead more complex lives [177].

13 Conclusions

In this report we have reviewed the available scientific literature with regard to the health status, living and travel conditions, social, normal, repetitive and reproductive behaviour, and

the number and origin of wild animals in the circus industry. The vast majority of the information we found related to zoo and, secondarily, to circus animals.

Since captive animals have not been selected for tameness and have been bred for a relatively low number of generations they cannot be considered domesticated. In circuses, most wild animals are bred in captivity as opposed to being wild-caught, although the origin of most animals is unknown, but this does not mean such animals are fundamentally different from free-living animals.

Nor is there any scientific reason to believe that the natural needs of wild animals can be met through the living conditions and husbandry offered by circuses. Neither natural environment nor much natural behaviour can be recreated in circuses.

In zoos, the presence of a complex captive environment (naturalistic displays with plants, objects, perches, etc.) can in part alleviate behavioural problems stemming from captivity and provide the animal with a diverse array of stimuli. In contrast, due to the mobile life of circuses, complex environments cannot be set up and a captive animal's life is consequently impoverished.

Captivity can induce very poor welfare in animals but circuses in particular fail to provide some of the most basic social, spatial and feeding requirements of wild animals. The ability to execute many natural behaviours is severely reduced, with a concomitant reduction in welfare, health and reproduction.

We found no evidence that performance of circus acts is enriching. In contrast, we found that human crowds are likely to cause stress to captive animals.

Training in circuses is an opaque issue. No science-based evidence has been seen which persuades us that training and performance demonstrably cater for those needs not met by the impoverished living accommodation provided by circuses.

Circuses may be suitable environments for animals with low space requirements, simple social structures, low cognitive function, non-specialist ecological requirements and which are capable of being transported without adverse welfare effects. Wild mammals, birds and reptiles should be subject to a test of suitability to circus life.

14 References

[1] Price, E.O. (1999) Behavioral development in animals undergoing domestication. *Applied Animal Behaviour Science* 65: 245-271

[2] Hediger, H. (1964) *Wild animals in captivity*. Dover Publications, New York, USA

[3] Carlstead, K. & Shepherdson, D. (2000) Alleviating stress in zoo animals with environmental enrichment. In: *The biology of animal stress* (eds. Moberg, G.P. & Mench, J.A.), pp. 337-354. CABI Publishing, Oxon, UK

[4] Knight, J. (2001) Animal data jeopardized by life behind bars. *Nature* 412: 669

[5] Mason, G.J., Cooper, J. & Clarebrough, C. (2001) Frustrations of fur-farmed mink. *Nature* 410: 35-36

[6] Hemsworth, G. (1980) Mary Chipperfield and her horses at Blackpool Tower Circuses. *Stable Management* 16: 4-15

[7] Conway, W. (2003) The role of zoos in the 21st Century. *International Zoo Yearbook* 38: 7-13

[8] Rabb, G.B. & Saunders, C.D. (2005) The future of zoos and aquariums: conservation and caring. *International Zoo Yearbook* 39: 1-26

[9] World Association of Zoos and Aquariums (2006) *Understanding animals and protecting them – about the World Zoo and Aquarium Conservation Strategy*. WAZA, Bern, Switzerland

[10] Anonymous (1999) Council Directive 1999/22/EC of 29 March 1999 relating to the keeping of wild animals in zoos. *Official Journal of the European Communities* L94: 24-26

[11] British and Irish Association of Zoos and Aquariums (2005) Animal Transaction Policy. BIAZA, London, UK. Available at: http://www.biaza.org.uk/resources/library/images/ATP%20june%2004.pdf

[12] Broom, D.M. (1991) Animal welfare: concepts and measurement. *Journal of Animal Science* 69: 4167-4175

[13] Goodwin, D. (1999) The importance of ethology in understanding the behaviour of the horse. *Equine Veterinary Journal* Supplement 28: 15-19

[14] Cooper, J.J. & Albentosa, M.J. (2005) Behavioural adaptation in the domestic horse: potential role of apparently abnormal responses including stereotypic behaviour. *Livestock Production Science* 92: 177-182

[15] Schrøder-Petersen, D.L. & Simonsen, H.B. (2001) Tail biting in pigs. *Veterinary Journal* 162: 196-210

[16] Price, O. (1984) Behavioral aspects of animal domestication. *Quarterly Review of Biology* 59: 1-32

[17] Trut, L.N. (1999) Early canid domestication: the farm-fox experiment. *American Scientist* 87: 160-169

[18] Dobney, K. & Larson, G. (2006) Genetics and animal domestication: new windows on an elusive process. *Journal of Zoology* 269: 261-271

[19] Kiley-Worthington, M. (1990) *Animals in circuses – Chiron's world?* Little Eco-Farms Publishing, Essex, UK

[20] Cox, R. (1998) *The welfare of animals in circuses: a review*. A report for the Circus Working Group of the All Party Parliamentary Group for Animal Welfare, unpublished report

[21] Trut, L.N., Plyusnina, I.Z. & Oskina, I.N. (2004) An experiment on fox domestication and debatable issues of evolution of the dog. *Russian Journal of Genetics* 40: 644-655

[22] Sukumar, R. (2006) A brief review of the status, distribution and biology of wild Asian elephants. *International Zoo Yearbook* 40: 1-8

[23] Gore, M., Hutchins, M. & Ray, J. (2006) A review of injuries caused by elephants in captivity: an examination of predominant factors. *International Zoo Yearbook* 40: 51-62

[24] Nyhus, P.J., Tilson, R.L. & Tomlinson, J.L. (2003) Dangerous animals in captivity: ex situ tiger conflict and implications for private ownership of exotic animals. *Zoo Biology* 22: 573-586

[25] Chapenoire, S., Camiade, B. & Legros, M. (2001) Basic instinct of a feline. *American Journal of Forensic Medicine and Pathology* 22: 46-50

[26] Coppinger, R. & Schneider, R. (1995) Evolution of working dogs. In: *The domestic dog: its evolution, behaviour and interactions with people* (ed. Serpell, J.), pp. 21-47. Cambridge University Press, Cambridge, UK

[27] Crockford (2002) in Spotorno, A.E., Marín, J.C., Manríquez, G. Valladares, J.P., Rico, E. & Rivas, C. (2006) Ancient and modern steps during the domestication of guinea pigs (*Cavia porcellus* L.) *Journal of Zoology* 270: 57-62

[28] Clubb, R. & Mason, G. (2003) Captivity effects on wide-ranging carnivores. *Nature* 425: 473-474
[29] Price, E.E. & Stoinski, T.S. (2006) Group size: determinants in the wild and implications for the captive housing of wild mammals in zoos. *Applied Animal Behaviour Science* doi: 10.1016/j.applanim.2006.05.021
[30] Wakefield, S., Winkler, A. & Zimmermann, W. (2003) EAZA Equid Tag Regional Collection Plan. In: *EAZA Equid Taxon Advisory Group Regional Collection Plan 2003* (eds. Winkler, A., Rademacher, U. & Zimmermann, W.), pp. 29-38. European Association of Zoos and Aquaria, Druckstudio Rhein-Ruhr, Duisberg, Germany
[31] Boyd, L. (1986) Behavior problems of equids in zoos. *The Veterinary Clinics of North America. Equine Practice* 2: 653-664
[32] Boyd, L.E. (1988) Time budgets of adult Przewalski horses: effects of sex, reproductive status and enclosure. *Applied Animal Behaviour Science* 21: 19-39
[33] Armstrong, S. & Marples, N. (2003) Nutrition, foraging behaviour and space use by plains zebras (*Equus burchelli*) housed in mixed species exhibits. In: *Proceedings of the Fifth Annual Symposium on Zoo Research at Marwell Zoological Park* (ed. Gilbert, T.C.), pp. 84-93. Federation of Zoological Gardens of Great Britain and Ireland, London, UK
[34] Palomares, F. & Caro, T.M. (1999) Interspecific killing among mammalian carnivores. *American Naturalist* 153: 492-508
[35] Fleming, E.H. (1994) *CITES and the regulation of wildlife trade for European circuses*. TRAFFIC Europe, Brussels, Belgium
[36] Galhardo, L. (2005) *Animals in circuses: legislation and controls in the European Union*. Eurogroup for Wildlife and Laboratory Animals, unpublished report
[37] Kurt, F. & Khyne U Mar. (1996) Neonate mortality in captive Asian elephant (*Elephas maximus*). *Zeitschrift für Säugetierkunde* 61: 155-164
[38] Taylor, V.J. & Poole, T.B. (1998) Captive breeding and infant mortality in Asian elephant: a comparison between twenty western zoos and three eastern elephant centers. *Zoo Biology* 17: 311-332
[39] Brown, J.L., Olson, D., Keele, M. & Freeman, E.W. (2004) Survey of the reproductive cyclicity status of Asian and African elephants in North America. *Zoo Biology* 23: 309-321
[40] Anonymous (2001) *Standards for the care and welfare of circus animals in tour*. David Hibling/Zippo's Circus on behalf of the Association of Circus Proprietors of Great Britain
[41] Born Free Foundation & RSPCA (2006) *It's time parliament changed its Act*. Born Free Foundation/RSPCA, unpublished report
[42] Steck, B. *personal communication*
[43] Lee, A. (1991) *Management guidelines for the welfare of zoo animals − Giraffe*. The Federation of Zoological Gardens of Great Britain and Ireland, London, UK
[44] Gsandtner, H., Pechlaner, H. & Schwammer, H.M. (1997) *Guidelines for the keeping of wild animals in circuses*. Office of the Environmental Commissioner of the City of Vienna, Vienna, Austria
[45] Gittleman, J.L. & Harvey, P.H. (1982) Carnivore home-range size, metabolic needs and ecology. *Behavioral Ecology and Sociobiology* 10: 57-63
[46] Klingel 1969a, b, 1972, Rudnai 1974 and Smuts 1974 cited in Linklater, W.L. (2000) Adaptive explanation in socio-ecology: lessons from the Equidae. *Biological Reviews* 75: 1-20
[47] Edwards, G.P., Eldridge, S.R., Wurst, D., Berman, D.M. & Garbin, V. (2001) Movement patterns of female feral camels in central and northern Australia. *Wildlife Research* 28: 283-289

[48] Roth, H.H., Hoppe-Dominik, B., Mühlenberg, M., Steinhauer-Burkart, B. & Fischer, F. (2004) Distribution and status of the hippopotamids in the Ivory Coast. *African Zoology* 39: 211-224
[49] van der Jeugd, H.P. & Prins, H.H.T. (2000) Movements and group structure of giraffe (*Giraffa camelopardalis*) in Lake Manyara National Park, Tanzania. *Journal of Zoology* 251: 15-21
[50] Sukumar, R. (1992) *The Asian elephant: ecology and management*. Cambridge University Press, Cambridge, UK
[51] Di Bitetti, M.S. (2001) Home-rage use by the tufted capuchin monkey (*Cebus apella nigritus*) in a subtropical rainforest in Argentina. *Journal of Zoology* 253: 33-45
[52] Makwana, S.C. (1978) Field ecology and behaviour of the rhesus macaque (*Macaca mulatta*): I. Group composition, home range, roosting sites, and foraging routes in the Asarori Forest. *Primates* 19: 483-492
[53] Anonymous (1999) Code of Federal Regulations. Title 9, Volume 1, Chapter I, Part 3, Subpart E – *Specification for the humane handling, care, treatment, and transportation of marine mammals*. Section 3.104 – *Space requirements*. Pp. 95-100. The U.S. Government Printing Office via GPO Access
[54] Friend, T.H. & Parker, M.L. (1999) The effect of penning versus picketing on stereotypic behavior of circus elephants. *Applied Animal Behaviour Science* 64: 213-225
[55] Schmid, J. (1995) Keeping circus elephants temporarily in paddocks – the effects on their behaviour. *Animal Welfare* 4: 87-101
[56] Cimino, R. (1994) Cooperative elephant breeding between zoos and circuses - a realistic proposal? *International Zoo News* 41: 29-35
[57] Gruber, T.M., Friend, T.H., Gardner, J.M., Packard, J.M., Beaver, B. & Bushong, D. (2000) Variation in stereotypic behaviour related to restraint in circus elephants. *Zoo Biology* 19: 209-211
[58] Young, R.J. (2003) *Environmental enrichment for captive animals*. UFAW Animal Welfare Series. Blackwell Science Ltd, Oxford, UK
[59] Kurt, F. & Hartl, G.B. (1995) Asian elephants (*Elephas maximus*) in captivity – a challenge for zoo biological research. In: *Research and captive propagation* (eds Gansloßer, U., Hodges, J.K. & Kaumanns, W.), pp. 310-326. Finlander Verlag, Furth
[60] Clark, H.W., Laughlin, D.C., Bailey, J.S. & Brown, T.McP. (1980) Mycoplasma species and arthritis in captive elephants. *Journal of Zoo Animal Medicine* 11: 3-15
[61] Lindau, K.-H. (1970) Lameness in circus elephants – a result of training? Verhandlungsberichte des 12 Internationalen Symposiums über die Erkrankungen der Zootiere: 129-131
[62] Schmidt, M. (1986) Elephants (Proboscidae). In: *Zoo and Wild Animal Medicine* (ed. Fowler, M. E.), pp. 883-923. W. B. Saunders Company, Philadelphia
[63] Kuntze, A. (1989) Work-related illness: *Hernia perinealis*, Bursitis praepatellaris and *Tyloma olecrani* in female circus elephants (*Elephas maximus*). Verh. Ber. Erkrg. Zootiere 31: 185-187
[64] Reitschel, W. (2002) Haltung von Elefanten im Zoo und Zirkus [Keeping of elephants in zoo and circus]. *Deutsche Teiraztliche Wochenschrift* 109: 123-126
[65] Kurt, F. (1995) The preservation of Asian elephants in human care – a comparison between the different keeping systems in South Asia and Europe. *Animal Research and Development* 41: 38-60
[66] Schulze, W. (1986) Zur Haltung von Elefanten im Zirkus mit Beruecksichtigung ihrer Minimalbeduerfnisse [On the keeping of elephants in a circus with regard to their minimal environment]. *Praktische Tierarzt* 67: 809-811

[67] Wiesner, H. (1986) Probelme bei der Haltung von Zirkustieren [Problems of circus animals]. *Tieraerztliche Umschau* 41: 753-755

[68] Fickel, J., Richman, L.K., Montali, R., Schaftenaar, W., Göritz, F., Hildebrandt, T.B. & Pitra, C. (2001) A variant of the endotheliotropic herpesvirus in Asian elephants (*Elephas maximus*) in European zoos. *Veterinary Microbiology* 82: 103-109

[69] Myers, D.L., Zurbriggen, A., Lutz, H. & Pospischil, A. (1997) Distemper: not a new disease in lions and tigers. *Clinical and Diagnostic Laboratory Immunology* 4: 180-184

[70] Michalak, K., Austin, C., Diesel, S., Bacon, J.M., Zimmerman, P. & Maslow, J.N. (1998) Mycobacterium tuberculosis infection as a zoonotic disease: transmission between humans and elephants. *Emerging Infectious Diseases* 4: 283-287

[71] Banks, M., Monsalve Torraca, L.S., Greenwood, A.G. & Taylor, D.C. (1999) Aujeszky's disease in captive bears. *Veterinary Record* 145: 362-365

[72] Greenwood, A.G. (1985) Diagnosis and treatment of botulism in lions. *Veterinary Record* 117: 58-60

[73] Vaarst, M., Hindhede, J. & Enevoldsen, C. (1998) Sole disorders in conventionally managed and organic dairy herds using different housing systems. *Journal of Dairy Research* 65: 175-186

[74] Hemsworth, P.H. & Barnett, J.L. (2000) Human-animal interactions and animal stress. In: The biology of animal stress (eds. Moberg, G.P. & Mench, J.A.), pp. 309-335. CABI Publishing, Oxon, UK

[75] Morgan, K.N. & Tromborg, C.T. (2006) Sources of stress in captivity. *Applied Animal Behaviour Science* doi: 10.1016/j.applanim.2006.05.032

[76] Moberg, G.P. (2000) Biological response to stress: implications for animal welfare. In: *The biology of animal stress* (eds. Moberg, G.P. & Mench, J.A.), pp. 1-21. CABI Publishing, Oxon, UK

[77] Carlstead, K., Brown, J.L., Monfort, S.L., Killens, R. & Wildt, D.E. (1992) Urinary monitoring of adrenal responses to psychological stressors in domestic and nondomestic felids. *Zoo Biology* 11: 165-176

[78] Wilson, M.L., Bloomsmith, M.A. & Maple, T.L. (2004) Stereotypic swaying and serum cortisol concentrations in three captive African elephants (*Loxodonta africana*). *Animal Welfare* 13: 39-43

[79] Barnett, J.L. & Hemsworth, P.H. (1990) The validity of physiological and behavioural measures of animal welfare. *Applied Animal Behaviour Science* 25: 177-187

[80]Dawkins, M.S. (1990) From an animal's point of view: motivation, fitness, and animal welfare. *Behavioral and Brian Sciences* 13: 1-61

[81] Carlstead, K., Brown, J.L. & Seidensticker, J. (1993) Behavioral and adrenocortical responses to environmental change in leopard cats (*Felis bengalensis*). *Zoo Biology* 12: 321-331

[82] Chitty, J. (2003) Feather plucking in psittacine birds 2. Social, environmental and behavioural considerations. *In Practice* 25: 550-555

[83] Cociu, M., Wagner, G., Micu, N.E. & Mihaescu, G. (1974) Adaptational gastro-enteritis in Siberian tigers *Panthera tigris altaica* at Bucharest Zoo. *International Zoo Yearbook* 14: 171-174

[84] Chitty, J. (2003)a Feather plucking in psittacine birds 1. Presentation and medical investigation. *In Practice* 25: 484-493

[85] Smith, T. (2004) *Zoo Research Guidelines: Monitoring Stress in Zoo Animals*. BIAZA, London, UK

[86] Barnett, J.L., Cronin, G.M., Winfield, C.G. & Dewar, A.M. (1984) The welfare of adult pigs: the effect of five housing treatments on behaviour, plasma corticosteroids and injuries. *Applied Animal Behaviour Science* 12: 209-232

[87] Barnett, J.L., Winfield, C.G. Cronin, G.M., Hemsworth, P.H. & Dewar, A.M. (1985) The effect of individual and group housing on behavioural and physiological responses related the welfare of pregnant pigs. *Applied Animal Behaviour Science* 14: 149-161
[88] Jeppesen, L.L. & Pedersen, V. (1991) Effects of whole-year nest boxes on cortisol, circulating leucocytes, exploration and agonistic behaviour in silver foxes. *Behavioural Processes* 25: 171-177
[89] Terio, K.A. & Munson, L. (2000) Gastritis in cheetahs and relatedness to adrenal function. In: *Felid Taxon Advisory Group Action Plan* (eds. Pukazhenthi, B., Wildt, D. & Mellen, J.), p. 36. American Zoo and Aquarium Association, Wheeling, Virginia, USA
[90] Terio, K.A., Marker, L. & Munson, L. (2004) Evidence for chronic stress in captive but not free-ranging cheetahs (*Acinonyx jubatus*) based on adrenal morphology and function. *Journal of Wildlife Diseases* 40: 259-266
[91] Carlstead, K. & Shepherdson, D. (1994) Effects of environmental enrichment on reproduction. *Zoo Biology* 13: 447-458
[92] Lindburg, D.G. & Fitch-Snyder, H. (1994) Use of behaviour to evaluate reproductive problems in captive mammals. *Zoo Biology* 13: 433-445
[93] King, N.E. & Mellen, J.D. (1994) The effects of early experience on adult copulatory behaviour in zoo-born chimpanzees (*Pan troglodytes*). *Zoo Biology* 13: 51-59
[94] Latham & Mason submitted, cited in Mason *et al.* [98]
[95] Wielebnowski, N.C., Fletchall N., Carlstead, K., Busso, J.M. & Brown, J.L. (2002) Noninvasive assessment of adrenal activity associated with husbandry and behavioural factors in the North American clouded leopard population. *Zoo Biology* 21: 77-98
[96] Mellen, J.D. (1991) Factors influencing reproductive success in small captive exotic felids (*Felis* spp.): a multiple-regression analysis. *Zoo Biology* 10: 95-110
[97] Clubb, R., & Mason, G. J. (2006) Natural behavioural biology as a risk factor in carnivore welfare: How analysing species differences could help zoos improve enclosures. *Applied Animal Behaviour Science* doi: 10.1016/j.applanim.2006.05.033
[98] Mason, G., Clubb, R., Latham, N. & Vickery, S. (2006) Why and how should we use environmental enrichment to tackle stereotypic behaviour? *Applied Animal Behaviour Science* doi: 10.1016/j.applanim.2006.05.041
[99] Schmid, J. (1998) Hands off hands on: some aspects of keeping elephants. *International Zoo News* 45: 478-486
[100] Clubb, R. & Mason, G. (2002) *A review of the welfare of zoo elephants in Europe*. RSPCA, Horsham, West Sussex, UK
[101] Swanson, W.F., Johnson, W.E., Cambre, R.C., Citino, S.B., Ouigley, K.B., Brousset, D.M., Morals, R.N., Moreira, N., O'Brien, S.J. & Wildt, D.E. (2003) Reproductive status of endemic felid species in Latin American zoos and implications for ex situ conservation. *Zoo Biology* 22: 421-441
[102] Wildt, D.E., Brown, J.L., Bush, M., Barone, M.A., Cooper, K.A., Grisham, J. & Howard, J.G. (1993) Reproductive status of cheetahs (*Acinonyx jubatus*) in North American zoos: the benefits of physiological surveys for strategic planning. *Zoo Biology* 12: 45-80
[103] Kuhar, C.W., Bettinger, T.L., Sironen, A.L., Shaw, J.H. & Lasley, B.L. (2003) Factors affecting reproduction in zoo-housed Geoffroy's tamarins (*Saguinus geoffroyi*). *Zoo Biology* 22: 545-559
[104] Debyser, I.W.J. (1995) Prosimian juvenile mortality in zoos and primate centers. *International Journal of Primatology* 16: 889-907
[105] Harlow, H.F. & Harlow, K. (1962) Social deprivation in monkeys. *Scientific American* 207: 136-146

[106] Harlow, H.F. (1969) Age-mate or peer affectional system. *Advances in the Study of Behavior* 2: 333-383
[107] Würbel, H. (2001) Ideal homes? Housing effects on rodent brain and behaviour. *Trends in Neurosciences* 24: 207-211
[108] Hartung, J. (2003) Effects of transport on health of farm animals. *Veterinary Research Communications* 27 Suppl. 1: 525-527
[109] Anonymous (2004) Opinion of the Scientific Panel on Animal Health and Welfare on a request from the Commission related to the welfare of animals during transport. *EFSA Journal* 44: 1-36
[110] Toscano, M.J, Friend, T.H. & Nevill, C.H. (2001) Environmental conditions and body temperature of circus elephants transported during relatively high and low temperature conditions. *Journal of the Elephant Managers Association* 12: 115-149
[111] Edwards, L.M., Rahe, C.H., Griffin, J.L., Wolfe, D.F., Marple, D.N., Cummins, K.A. & Pitchett, J.F. (1987) Effect of transportation stress on ovarian function in superovulated Hereford heifers. *Theriogenology* 28: 291-299
[112] Ha, J.C., Robinette, R.L. & Sackett, G.P. (1999) Social housing and pregnancy outcome in captive pigtailed macaques. *American Journal of Primatology* 47: 153-163
[113] Grandin, T. (1997) Assessment of stress during handling and transport. *Journal of Animal Science* 75: 249-257
[114] Trunkfield, H.R. & Broom, D.M. (1990) The welfare of calves during handling and transport. *Applied Animal Behaviour Science* 28: 135-152
[115] Hartline, P.H. (1971) Physiological basis for detection of sound and vibration in snakes. *Journal of Experimental Biology* 54: 349-371
[116] Lewis, E.R. & Narins, P.M. (1985) Do frogs communicate with seismic signals? *Science* 227: 187-189
[117] Barnett, K.E., Cocroft, R.B. & Fleishman, L.J. (1999) Possible communication by substrate vibration in a chameleon. *Copeia* 1: 225-228
[118] Young, B.A. & Morain, M. (2002) The use of ground-borne vibrations for prey localization in the Saharan sand vipers (*Cerastes*). *Journal of Experimental Biology* 205: 661-665
[119] Ewert, J.-P., Cooper, J.E., Langton, T., Matz, G., Reilly, K. & Schwantje, H. (2004) *Background information on the species-specific proposals for reptiles presented by the Expert Group on Amphibians and Reptiles. Part B.* 8th Meeting of the Working Party for the preparation of the fourth multilateral consultation of parties to the European Convention for the Protection of Vertebrate Animals used for experimental and other scientific purposes (ETS 123). Council of Europe, Strasbourg
[120] Heatwole, H. (1976) *Reptile Ecology*. University of Queensland Press, St. Lucia, Queensland, Australia
[121] Cowgell, J. & Underwood, H. (1979) Behavioral thermoregulation in lizards: a circadian rhythm. *Journal of Experimental Zoology* 210: 189-194
[122] Zwart, P. (2001) Assessment of the husbandry problems of reptiles on the basis of pathophysiological findings: a review. *Veterinary Quarterly* 23: 140-147
[123] Schütz 2003 in [129]
[124] Montes, I., McLaren, G.W., Macdonald, D.W. & Mian, R. (2004) The effect of transport stress on neutrophil activation in wild badgers (*Meles meles*). *Animal Welfare* 13: 355-359
[125] Nevill, C.H. & Friend, T.H. (2003) The behavior of circus tigers during transport. *Applied Animal Behaviour Science* 82: 329-337
[126] Williams, J.L. & Friend, T.H. (2003) Behavior of circus elephants during transport. *Journal of Elephant Managers Association* 14: 8-11

[127] Nevill, C.H., Friend, T.H. & Toscano, M.J. (2004) Survey of transport environments of circus tigers (*Panthera tigris*). *Journal of Zoo and Wildlife Medicine* 35: 164-174
[128] Dembiec, D.P., Snider, R.J. & Zanella, A.J. (2004) The effects of transport stress on tiger physiology and behaviour. *Zoo Biology* 23: 335-346
[129] Anonymous (2004) *The welfare of animals during transport*. Scientific Report of the Scientific Panel on Animal Health and Welfare on a request from the Commission related to the welfare of animals during transport. European Food and Safety Authority, Annex to the Opinion [109], available at: http://www.efsa.europa.eu/etc/medialib/efsa/science/ahaw/ahaw_opinions/424.Par.0002.File.dat/ahaw_report_animaltransportwelfare_en1.pdf
[130] Barnard, C.J. & Hurst, J.L. (1996) Welfare by design: the natural selection of welfare criteria. *Animal Welfare* 5: 405-433
[131] Sukumar, R. (2003) *The living elephants – evolutionary ecology, behaviour, and conservation*. Oxford University Press, New York, USA
[132] Leuthold, W. (1977) Spatial organization and strategy of habitat utilization of elephants in Tsavo National Park, Kenya. *Zeitschrift für Säugetierkunde* 42: 358-379
[133] Evans, K. *personal communication*
[134] Creamer, J. & Phillips, T. (1998) *The ugliest show on earth: a report on the use of animals in circuses*. Animal Defenders, London, UK
[135] Veasey, J.S., Waran, N.K. & Young, R.J. (1996) On comparing the behaviour of zoo housed animals with wild conspecifics as a welfare indicator, using the giraffe (*Giraffa camelopardalis*) as a model. *Animal Welfare* 5: 139-153
[136] Bashaw, M.J., Tarou, L.R., Maki, T.S. & Maple, L.R. (2001) A survey assessment of variables related to stereotypy in captive giraffe and okapi. *Applied Animal Behaviour Science* 73: 235-247
[137] Weller, S.H. & Bennett, C.L. (2001) Twenty-four hour activity budget and patterns of behavior in captive ocelots (*Leopardus pardalis*). *Applied Animal Behaviour Science* 71: 67-79
[138] Schmid, J. (1998) Status and reproductive capacity of the Asian elephant in zoos and circuses in Europe. *International Zoo News* 45/6: 341-351
[139] Wiese, R.J. & Willis, K. (2004) Calculation of longevity and life expectancy in captive elephants. *Zoo Biology* 23: 365-373
[140] Moss, C.J. (2001) The demography of an African elephant (*Loxodonta africana*) population in Amboseli, Kenya. *Journal of Zoology* 255: 145-156
[141] Mason, G.J. (1991) Stereotypies: a critical review. *Animal Behaviour* 41: 1015-1037
[142] Carlstead, K. & Seidensticker, J. (1991) Seasonal variation in stereotypic pacing in an American black bear *Ursus americanus*. *Behavioural Processes* 25: 155-161
[143] Mason, G.J. (1991) Stereotypies and suffering. *Behavioural Processes* 25: 103-115
[144] Mallapur, A. & Choudhury, B.C. (2003) Behavioral abnormalities in captive nonhuman primates. *Journal of Applied Animal Welfare Science* 6: 275-284
[145] Mallapur, A. & Chellam, R. (2002) Environmental influences on stereotypy and the activity budget of Indian leopards (*Panthera pardus*) in four zoos of Southern India. *Zoo Biology* 21: 585-595
[146] Bashaw, M.J., Bloomsmith, M.A., Marr, M.J. & Maple, T.L. (2003) To hunt or not to hunt? A feeding enrichment with captive large felids. *Zoo Biology* 22: 189-198
[147] Forthman, D.L. & Bakeman, R. (1992) Environmental and social influences on enclosure use and activity patterns of captive sloth bears (*Ursus ursinus*). *Zoo Biology* 11: 405-415
[148] Marriner, L.M. & Drickamer, L.C. (1994) Factors influencing stereotyped behavior of primates in a zoo. *Zoo Biology* 13: 267-275

[149] Schmid, R., Doherr, M.G. & Steiger, A. (2006) The influence of the breeding method on the behaviour of adult African grey parrots (*Psittacus erithacus*). *Applied Animal Behaviour Science* 98: 293-307
[150] Montaudouin, S. & Le Pape, G. (2005) Comparison between 28 zoological parks: stereotypic and social behaviours of captive brown bears (*Ursus arctos*). *Applied Animal Behaviour Science* 92: 129-141
[151] Meehan, C.L., Garner, J.P. & Mench, J.A. (2004) Environmental enrichment and development of cage stereotypy in Orange-winged Amazon parrots (*Amazona amazonica*). *Developmental Psychobiology* 44: 209-218
[152] Friend, T.H. (1999) Behavior of picketed circus elephants. *Applied Animal Behaviour Science* 62: 73-88
[153] Quaid, U., Harris, M., Sherwin, C. & Harris, S. unpublished data
[154] Vickery, S. & Mason, G. (2004) Stereotypic behavior in Asiatic black and Malayan sun bears. *Zoo Biology* 23: 409-430
[155] Hogan, E.S., Houpt, K.A. & Sweeney, K. (1988) The effect of enclosure size on social interactions and daily activity patterns of the captive Asiatic wild horse (*Equus przewalskii*). *Applied Animal Behaviour Science* 21: 147-168
[156] Krawczel, P.D., Friend, T.H. & Windom, A. (2005) Stereotypic behavior of circus tigers: effects of performance. *Applied Animal Behaviour Science* 95: 189-198
[157] Desmond, T. & Laule, G. (1994) Use of positive reinforcement training in the management of species for reproduction. *Zoo Biology* 13: 471-477
[158] Siemoneit-Barum, G. (1995) Zur Praxis von Dresser und Tierhaltung im Zirkus. [The practice of training and animal husbandry in circuses]. *Deutsche Tieraztliche Wochenschrift* 95: 77-79
[159] Kurt, F. (2006) Die Geschichte der Haltung von Elefanten in Menschenobhut [History of management in captive elephants]. *Zeitschrift des Kölner* Zoo 2: 59-74
[160] Kiley-Worthington, M. (1990). The training of circus animals. In: *Animal Training: Proceedings of a Universities Federation for Animal Welfare Symposium*, *26-27 September 1989*, pp. 65-81. UFAW, Hertfordshire, England
[161] Pollmann, U. (2002) Pferdehaltung in Zirkus-und Schaustellerbetrieben [Horses in circus and showman businesses]. *Deutsche Teiraztliche Wochenschrift* 109: 126-129
[162] Johnson, W. (1990) *The rose-tinted menagerie*. Heretic Books Ltd., London, UK
[163] Né, S. & Nouet, J.-C. (2000) *The condition of circus animals*. The French Animal Rights League Foundation, LFDA, Paris, France
[164] Richard 1966 cited in Né & Nouet [143]
[165] Clermont, E. (2005) Circuses and elephants: the truth under the big top. *AV Magazine* 113: 12-14
[166] Stoskopf, M.K. (1983) The physiological effects of psychological stress. *Zoo Biology* 2: 179-190
[167] Bowles, A.E. & Thompson, S.J. (1996) A review of nonauditory physiological effects of noise on animals. *Journal of the Acoustical Society* 100: 2708
[168] Martínez, J., Segura, P., García, D., Aduriz, G., Ibabe, J.C., Peris, B. & Corpa, J.M. (2006) Septicaemia secondary to infection by *Corynebacterium macginleyi* in an Indian python (*Python molurus*). *Veterinary Journal* 172: 382-385
[169] Thompson, V.D. (1989) Behavioral response of 12 ungulate species in captivity to the presence of humans. *Zoo Biology* 8: 275-297
[170] Birke, L. (2002) Effects of browse, human visitors and noise on the behaviour of captive orang utans. *Animal Welfare* 11: 189-202

[171] Owen, M.A., Swaisgood, R.R., Czekala, N.M., Steinman, K. & Lindburg, D.G. (2004) Monitoring stress in captive giant pandas (*Ailuropoda melanoleuca*): behavioral and hormonal responses to ambient noise. *Zoo Biology* 23: 147-164
[172] Hosey, G.R. (2000) Zoo animals and their human audiences: what is the visitor effect? *Animal Welfare* 9: 343-357
[173] Anonymous (1998) Commission regulation (EC) No 865/2006 of 4 May 2006 laying down detailed rules concerning the implementation of Council Regulation (EC) No 338/97 on the protection of species of wild fauna and flora by regulating trade therein. *Official Journal of the European Union* L 166: 1-69
[174] Goldhorn, W. & Kraft, H. (1985) Die tiergerechte Haltung von Zirkustieren [The proper care of circus animals]. *Tieraerztliche Umschau* 40: 809-814
[175] Kiley-Worthington, M. (1989) *Animals in circuses*. RSPCA, unpublished report
[176] Müller, P. (2004) 30 Jahre Internationales Tigerzuchtbuch in Leipzig [Thirty years International Tiger Studbook in Leipzig]. *Zoologische Garten* 74: 65-76
[177] Jensen, Hahn & Dudek 1979 cited in Shoshani, J., Kupsky, W.J. & Marchant, G.H. (2006) Elephant brain Part I: gross morphology, functions, comparative anatomy, and evolution. *Brain Research Bulletin* 70: 124-157

15 Appendix I

Scientific names of animals cited in the text

Common name	**Latin name**
African elephant	*Loxodonta africana*
American black bear	*Ursus americanus*
alpaca	*Lama pacos*
Asian elephant	*Elephas maximus*
camel	*Camelus bactrianus*
cheetah	*Acinonyx jubatus*
chimpanzee	*Pan troglodytes*
clouded leopard	*Neofelis nebulosa*
dromedary	*Camelus dromedarius*
giraffe	*Giraffa camelopardalis*
Indian python	*Python molurus*
llama	*Lama glama*
leopard	*Panthera pardus*
lion	*Panthera leo*
mink	*Mustela vison*
ocelot	*Leopardus pardalis*
okapi	*Okapi johnstoni*
pigtail macaque	*Macaca nemestrina*
polar bear	*Ursus maritimus*
puma	*Puma concolor*
pygmy hippo	*Hexaprotodon liberiensis*
python	*Boid* spp.
red fox	*Vulpes vulpes*
rhesus macaque	*Macaca mulatta*
tamarin	*Saguinus geoffroy*
tiger	*Panthera tigris*
tufted capuchin monkey	*Cebus paella nigritus*
zebra	*Equus burchelli*

16 Appendix II

"**23 May 2006 : Column GC177**

Lord Rooker: I was asked whether Defra has done any species research. No research has been commissioned on particular animal species within the circus environment at present, but we will look to a wide variety of experts in the field to advise us on the continued use of certain non-domesticated species in circuses and keep the policy under review. As I have said, we hope that those discussions will begin shortly.

More than one reference has been made to something that I was not aware of: the fact that there is only one elephant in the circuses referred to. I understand that the animal does not perform, and I leave to one side the point that the animal lives on its own and the issues related to that. No doubt we can come back to this.

Questions were also asked about the evidence required to ensure a ban on the use of a particular species. It is a fair point and I shall focus on it in my conclusion. The Government are willing to consider any evidence that has a sound scientific base, preferably peer-reviewed and conducted in an environment where the animals were performing and travelling. We acknowledge that there is likely to be a lack of scientific evidence related to animals used specifically in entertainment, and we would be willing to consider sound scientific results obtained on species kept in different conditions, if we can establish that those results could reasonably be extrapolated to other circumstances. We do not consider photographic or video evidence to be sufficient to base policy decisions on. Such evidence can be open to misinterpretation and gives only a snapshot in time. A film showing a lion pacing up and down may indicate evidence of stereotypical behaviour, but equally the film may have been shot when the lion had seen its keeper approaching with food. So the context in which the film was made is important and the evidence has to go wider.

On evidence of particular instances of cruelty, while that is distressing, it is of course not sufficient to demonstrate that a particular environment necessarily causes animal suffering. Animals in any environment may be subject to particular instances of cruelty—private pet ownership is the most common example, even though one assumes that animals are safe and well looked after in those circumstances. In order to establish that a certain environment inevitably causes suffering or distress to an animal, supporting scientific evidence set out in published papers that have been peer reviewed would have to be submitted. The point here is that it must be demonstrated that animals suffer and are in distress simply by being in a certain environment, and that is why it is not something that can be proved with a snapshot."