

# The Detrimental Effects of Captivity on the Behaviour of Wild Animals

## 1.0 INTRODUCTION

Since Hediger stressed the importance of studying the reactions of animals to their confinement back in 1934 [Meyer-Holzapfel, 1968], much research has focussed on animal behaviour in captivity. It is clear that the typical captive environment does very little to satisfy the needs of an animal, and usually results in behaviour considered to be “abnormal”. This concept of abnormality has proven very difficult to define since many believe such behaviour may be an adaptation by the animal to help it cope with the environment. Abnormality is therefore usually demonstrated by comparing captive animals with their wild counterparts, which frequently reveals stark differences in their time budgets and behavioural totipotentiality. Although well studied in their developed form, there is a distinct lack of research behind the origins of abnormal captive behaviour, the risk factors that predispose to them, and from which particular behaviours they arise. With such an emphasis on animal welfare in recent times, it is extremely important that these source behaviours are identified as this could take us one step further to helping improve the lives of captive animals and perhaps even aid conservation efforts in the long-term.

## 2.0 THE CAPTIVE ENVIRONMENT

### 2.1 Response of Animals to their Environment

Besch and Kollias [1994] define an animal’s environment as including all internal (e.g. parasites), external (e.g. social interactions) and non-hereditary conditions under which an animal lives. In the wild, animals are able to thrive by way



of having control over their environment via regulatory behavioural adjustments [Poole, 1995]. It is considered to be impossible to replicate an animal's natural environment in captivity as the variables to take account of are infinite, although many believe this is not actually important for the animal's well-being. According to Price [1984] and Wyers [1994], natural selection continues in captivity, and therefore copying realism from nature is simply unnecessary. However, as Terlouw et al. [1991] show with the effects of restraint and food restriction on sows (*Sus scrofa*), most captive situations do take control away from the animal and end up creating a very barren, restrictive and monotonous environment, with obvious welfare implications for the animal. Broom [1988] defines welfare as the state of an individual as regards its attempts to cope with the environment and implies that control over the environment is extremely important for welfare reasons [Broom, 1991]. This is supported by Carlstead [1996] who describes the reactions of deer mice (*Peromyscus maniculatus*) to lighting which, although had an aversion to it, preferred to have control over the illumination rather than it be switched off permanently.

Wemelsfelder [1993] proposes that the resulting monotony experienced by the animal in such environments is actually a parameter of the animal-environment relationship, not a trait of the physical environment by itself. The terms in the literature used to describe the resultant feelings include frustration, boredom, depression and anxiety, all indicative of an animal suffering from stress. Wemelsfelder [1993] suggests that these feelings contribute and form the pathway to behavioural fixation, gradually impairing the animal's ability to interact with its environment. The all-important end-stage to this process is that of stereotypical-like behaviour. Since frustrated feelings are frequently implicated in stereotypy development as demonstrated in domestic hens (*Gallus domesticus*) unable to reach their food [Duncan and Wood-Gush, 1972], I decided to focus my study on the role such frustration seems to play in bears.



## 2.2. Captive *Versus* Wild Time Budgets

Captive



Wild



*Versus*

Hughes and Duncan [1988] explain the notion of a time budget as the existence of a number of tendencies, each with its own costs and benefits and all competing for the use of a limited commodity, that of time. According to Halliday [1980], an animal has to organise this behaviour so as to fulfil its biological requirements in a given period of time which is demonstrated by the time budgets of animals in the wild (for example, Garshelis et al. [1980] show that American black bears (*Ursus americanus*) can spend up to 75% of their time foraging). However, as Ames [2000] demonstrates in captive polar bears (*Ursus maritimus*), with the removal of control comes the removal of all such time constraints so that the problem for the animal becomes more how to fill the time with the relatively limited number of behavioural patterns available.

Since an animal must always be doing something, it is this idea that led Hughes and Duncan [1988] to believe captive animals must have elastic behaviour in their repertoire. Consequently, compared to the same animal in the wild, these behaviours expand and take up a proportionately larger segment of their budget. It appears that this elastic behaviour, since it can completely dominate the time budget, is often perceived as being abnormal [e.g. Meyer-Holzappel, 1968; Glickman and Caldwell, 1994]. Time budget studies of captive animals also reveal a high frequency of abnormal stereotypical behaviour, that could perhaps be considered in the same



light as these elastic behaviours, i.e. as Mason and Latham [2004] suggest with their 'enrichment' hypothesis, they simply give the animal something to do with their time, a situation that a wild animal would never face.

Using a sample of bears in a large enclosure, Koene [1995] demonstrates that, by comparing how a captive animal allocates its time with a semi-wild conspecific, this can help establish how good or poor their welfare is. In support, Grandia et al. [2001] state that bears in zoos often have behavioural time budgets that differ largely from their wild counterparts because of sub-optimal conditions. Therefore I chose to include this comparison in my investigation into the Asiatic black bear (*Ursus thibetanus*), enabling me to make valid comparisons between the behaviour of caged bears and those remaining in a pseudo-wild environment.

### **3.0 BEHAVIOURAL NEEDS OF BEARS IN CAPTIVITY**

#### **3.1 The Concept of 'Ethological Need'**

In recent times, as discussed by Poole [1998], there has been much concern raised as to whether animals have specific *needs* to carry out particular behavioural patterns; for example, do predators *need* to hunt? Ames [2000] summarises the central question surrounding this concept: if the goal or needs of a captive animal can be met without the animal having to exhibit species-specific appetitive behaviour, can the animal be truly satisfied? This is a much-debated topic. Ethologists have attempted to show certain activities do represent a need but this has come up against opposition since animals can and do exist without behaviours that are not essential to their survival. Many are quick to point out however, that it is not a need for survival that should be considered, but a need for their welfare which, of course, includes their psychological well-being [Broom, 1991; Duncan et al., 1993].

Dawkins [1983] considers ethological need to be the result of high levels of causal factors initiating the performance of a particular behaviour. She relates it to the consumer demand theory such that only those considered an absolute necessity for



their psychological well-being (i.e. given as high a priority as feeding in preference tests) are ‘ethologically needed’. This is in stark contrast to those behaviours considered ‘luxuries’ which immediately disappear once ‘income’ is reduced. Play behaviour is considered to be an example of such a luxury [O’Grady, 1994] and, as Fagen and Fagen [1990] discuss, its presence or absence is a good indicator of well-being of the animals (Fig. 1).

Fig. 1. Illustration of a wild polar bear playing [Anonymous, 2000]



Expanding on this idea in their review of the ‘ethological needs’ model, Hughes and Duncan [1988] propose strong evidence consistent with the notion that there are many instances in which the performance of the behaviour itself has motivationally significant consequences which are not necessarily related to the functional requirements. For example, Inglis and Ferguson [1986] demonstrate that, if given the choice, starlings (*Sturnus vulgaris*) prefer to obtain the large majority of their food from under flaps in a board rather than just from an open dish. Hughes and Duncan [1988] suggest, as a result, that there are degrees of need from ‘no need’ to ‘critically important need’ and this must be taken into consideration when assessing welfare.

Baxter [1983] takes a different approach to this concept and proposes that, for welfare reasons, it is not the actual performance of the behaviour that is important but more the environmental end-point that is accomplished by it. Therefore, so long as all the animal’s environmental requirements are met by design, the behaviour is not triggered and ethological need is not an issue. To demonstrate this, I chose to



compare the behaviour demonstrated in caged bears with those in a naturalistic enclosure where most requirements were met.

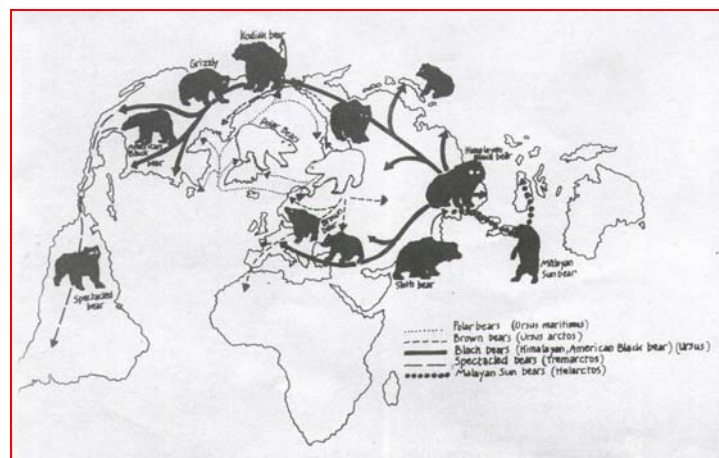
### 3.2. A Bear's Behavioural Needs

To ensure a bear's psychological needs are being met, certain criteria have been established. Poole [1994] and O' Grady [1994] identify the following: a sense of security; a predictable but not invariable routine; facilities to conduct a wide range of activities involving sensory stimuli; opportunities to achieve rewards; intellectual stimulation and novel situations to keep their behaviour flexible. This kind of environment is clearly proving very difficult to cater for however, since bears are still kept in sub-optimal conditions throughout the world [Carlstead et al., 1991; Kolter, 1995], with the notorious Japanese bear parks shown in Figure 4 as one prime example [Watkins, 1994].

### 3.3. Susceptibility of Bears to the Captive Environment

As Huber [1995] surmised perfectly, specific behavioural, nutritional and morpho-physiological features of bears place them in a unique niche in nature as well as in captive keeping. Bears are total opportunists, exploiting a wide variety of habitats, as shown by their geographical distribution (Fig. 2).

Fig. 2. World distribution of bears [Van Keulen-Kromhout, 1976]



As a result, bears have evolved a particularly neophilic character and a known abhorrence of inactivity. In fact, Morris [1964] claims that this exploration has become completely emancipated from its ultimate goals and exists as an independent separately motivated activity. Morris [1964], Mench [1998] and many others believe it is for these reasons that generalist animals develop extreme adverse reactions to captivity. Conversely, Boorer [1972] proposes that it is not these species that suffer in captivity, but more the specialists. If prevented from carrying out their own form of specialised activity, as Carlstead [1992] demonstrates in leopard cats (*Felis bengalensis*), Boorer [1972] believes this leaves them more prone to developing stereotypical-like behaviours. In addition, some believe that those animals with a highly evolved level of intelligence (amongst which bears are certainly ranked) have behavioural capabilities sufficiently flexible to allow them to adapt and cope with captivity [Poole, 1998].

However, there is a large body of evidence against this view. Van Keulen-Kromhout [1978] was one of the first to highlight the high incidence of stereotypies in zoo bears and, since then, such behaviour has been reported in many of the Ursidae species, including the polar bear [Kolter and Zander, 1995], American black bear [Carlstead and Seidensticker, 1991], sloth bear *Ursus ursinus* [Forthman and Bakeman, 1992], spectacled bear *Tremarctos ornatus* [Fischbacher and Schmid, 1999], Asiatic black bear [Forthman et al., 1992] and the giant panda *Ailuropoda melanoleuca* [Swaigood et al., 2001]. Perhaps due to their individual species ecology and evolutionary history as Clubb and Mason [2004] hypothesize, each species appears to have specific stereotypical behaviour. For example, polar bears pace in a very repetitive and rigid fashion, thought to reflect their long-ranging migratory behaviour [Wechsler, 1991; Clubb and Mason, 2003], whilst Malayan sun bears (*Helarctos malayanus*) show considerable degrees of bar chewing, possibly due to the high feeding motivation of the species [Vickery and Mason, 2003a].

Despite the diversity of these stereotypic behaviours, many like Mason [1991a] and Broom and Johnson [1993] acknowledge that they represent poor past or present welfare due to chronic under-stimulation which, according to both Newberry



[1995] and Shepherdson [2003] should be ameliorated immediately by environmental enrichment. Law et al. [1989] and The Polar Bear Project at Philadelphia Zoo [Anonymous, 1999] provide a good example of when this has been achieved (Fig. 3).

Fig. 3. Boomer ball used for enrichment at Philadelphia Zoo [Anonymous, 1999]



## 4.0 STEREOTYPIC BEHAVIOUR

### 4.1. Defining Stereotypes

Stereotypical behaviour is defined as “a behavioural pattern that is repetitive, invariant and has no obvious goal or function” [Mason, 1993a]. The first two criteria have caused considerable problems however, because the decision itself is essentially arbitrary, particularly since there is often a continuum between stereotypes and the normal behaviour from which they develop [Duncan et al., 1993; Würbel et al., 1996]. In addition, as discussed by Mason [1993b], rigidity and repetitiveness are widespread in many forms of normal behaviour (grooming or courting displays for example), thus creating a large grey area in stereotype classification. Therefore it is the apparent lack of function that is primarily used to determine stereotypical behaviour, although this is certainly not without its opposition too. Firstly, according to Dantzer [1991], ascribing a lack of function to a behaviour pattern is an extremely subjective process. Many like Cooper and Nicol [1991] have then taken this one step further and proposed stereotypes do actually serve a purpose in which case the definition simply does not stand true. Perhaps the most extreme example is that of Boorer [1972] who suggests that they provide the animal with much-needed exercise opportunities. It



therefore appears that defining, identifying and then studying stereotypies is an extremely difficult task, confounded by much uncertainty.

#### 4.2. Types of Stereotypic Behaviour

To blur the boundaries of definition further, there are numerous different types of stereotypic behaviour. The environment-induced types are the most common in zoo animals and are usually referred to as “cage stereotypies” [Carlstead, 1998]. Mallapur and Chellam [2002] show that such stereotypies in Indian leopards (*Panthera pardus*) appear to result from a lack of sensory input and thwarted appetitive behaviours.

As Mason [1991b; 1993a] emphasises and later demonstrates in farmed mink (*Mustela vison*), stereotypies are heterogeneous in morphology, timing, underlying motivation and function. As well as being species-specific, they also have a very idiosyncratic nature, and as Clubb and Mason [2004] show, can cause large variation amongst very similar individuals. These individual differences have traditionally been viewed as a significant statistical challenge [Ladewig et al., 1993], however, Dantzer and Mittleman [1993] and Rushden et al. [1993] recommend that these idiosyncrasies actually be used to investigate stereotypies, an idea I hope to test with my study.

#### 4.3. The Associations with Stereotypic Behaviour

Although little appears to be known regarding the underlying processes of stereotypic behaviour, it is thought that the two main predisposing factors to its development are frustration and the associated stress. Thus it is usually assumed that stereotypy stems from thwarted appetitive behaviours that simply can not be expressed. As Mason [1993a] and Carlstead [1998] discuss, the most common source of such frustration in captivity appears to be the expected arrival of food. Hughes and Duncan [1988] then believe it is a matter of threshold levels for motivation so that once this threshold is reached, the appetitive behaviour (that can not proceed to the consummatory phase due to environmental restrictions) continues in an abbreviated



form, i.e. stereotypic behaviour. Terlouw et al. [1991] however demonstrate a concomitant increase in the stereotypy frequency of tethered sows with increasing appetitive behaviour, as well as stereotypy performance being concentrated in the post-feeding period, one of many experiments which contradict the hypothesis of Hughes and Duncan [1988].

Studies have also been conducted into investigating the corresponding changes in such parameters as pathology and physiology. For example, stereotypies have frequently been associated with the activation of endogenous opioids, which could act as the necessary reinforcer behind stereotypy persistence [Ödberg, 1993]. Although the aim of such studies is to provide reasons behind the ontogeny of stereotypic-like behaviours, the results are very discordant and, as such, the theories behind why stereotypic behaviour develops are still very much disputed.

#### **4.4. Stereotypy Development & its Consequences: The Theories**

Much evidence suggests stereotypical behaviour is a result of frustrated behaviours. For example, by studying the ontogeny of wire gnawing stereotypical behaviour in laboratory mice (*Mus musculus*), Würbel et al. [1996] were able to demonstrate the source behaviour pattern as being intense sniffing of the bars, an activity which most probably represented thwarted escape attempts.

There is also a large school of thought, however, that believes stereotypic behaviour is a homeostatic adaptation by the animal to help it cope with its perceived aversive environment. For example, associations have been drawn with the animal's arousal levels such that stereotypies may be subserving a neurophysiological system whose function is to regulate the high arousal level that occur in insoluble situations (for example, Meyer-Holzapfel [1968] and Carlstead [1991] both report the increased stereotypic frequency of captive animals after being disturbed by cleaning). In this way, Mason and Latham [2004] consider that stereotypies could have a "mantra-like" calming effect. Some authors propose that, as an extension to Wemelsfelder's [1993] idea of captivity creating an increasing concept of psychological time, stereotypies have evolved as a kind of self-generated enrichment [e.g. Bareham, 1972; van



Keulen-Kromhout, 1976; Ödberg, 1993]. Conversely, Wechsler [1995] argues that, although coping behaviour does appear to be an adaptation to aversive situations, the resulting abnormal behaviour actually represents *unsuccessful* coping attempts.

The variable that seems to play most part in these opposing views is that of the stage of stereotypy development, be it established or developing. It has been shown very clearly that, at some point, control over the behaviour shifts into a form of automatic processing with a corresponding reduction in cognitive processing and reliance on sensory feedback [Fentress, 1976]. The stereotypy itself then becomes uncoupled from its original stimulus and can be performed in a variety of situations, not necessarily reflective of the animal's present state or feelings. Once they become like habits in this way [Meyer-Holzapfel, 1968], both the origins and consequences of stereotypies are very difficult to establish. This is an area of much-needed research that I hope to contribute to by comparing individual bears, all at different stages of the behavioural fixation process.

## 5.0 OTHER ABNORMAL BEHAVIOURS

### 5.1. What Constitutes “Abnormality”?

The point at which normal behaviour becomes abnormal is clearly very difficult to identify. Many take the view that, when particular behaviour patterns are absent from the animal's wild counterparts, then they must lack a function and be considered abnormal [Mason, 1993a]. Bareham [1972] however asks a very key question to refute this claim: can behaviour which does not occur in free-ranging animals actually be a means by which acclimatisation to captivity is achieved? As discussed in section 4.4, this is thought to be the case for some stereotypical behaviour. In such instances, the behaviour should then be regarded as ‘normal for a captive animal’. For example, zoo animals may beg for food from visitors (Fig. 4), not out of hunger, but as a normal substitute for foraging [Markowitz, 1982].



Fig. 4. Bears begging for food in a Japanese bear park [WSPA, 2004]



In comparison, Wemelsfelder [1993] suggests abnormal behavioural patterns are all those which impair the subjective integrity of the animal and provide direct evidence for suffering. However, Meyer-Holzapfel [1968] probably takes the most appropriate approach and uses the term “abnormality” not to mean the reactions in captivity are maladaptive, but that they are just uncommon in free-ranging animals.

## **5.2. Exaggerated Aggression**

This is a common observation in many captive animals and, as Bareham [1972] discusses, is thought to be a result of frustrated behaviours that are given an outlet. According to Morris [1964] and Meyer-Holzapfel [1968], this can often be self-directed, progressing into self-mutilation and, along with the associated frustration, may be a pre-cursor to stereotypic-like behaviour (for example, Cronin [1985] cited in Mason [1993b] suggests restraint of sows leads to frustration and redirected aggressive behaviour from which bar-biting stereotypes develop).

## **5.3. Displacement Activities**

Meyer-Holzapfel [1968] defines displacement activities as those caused by a drive other than the instinct to which they belong, as a result of surplus motor impulses. This activation frequently leads to irrelevant behaviour and, as Meyer-Holzapfel [1968] points out, can be so intense that it overrules even strong social



inhibitions. They appear to be common in captive bears as shown by the high incidence of tongue flicking and yawning in polar bears [Wechsler, 1991] and can also act as the source behaviour for stereotypies [Mason, 1991b].

#### **5.4. Overflow Activities**

Overflow or vacuum activities are described by Morris [1964] as being normal reactions given to an inferior stimulus that would never release the response in the wild state. Since the specific stimulus is not present in the captive environment, only a feeble substitute is required to trigger the behaviour off and it then becomes a regular feature in their behavioural repertoire. Glickman and Caldwell [1994] label these activities as “excessive behaviours” which can involve complete sections of the animal’s consummatory repertoire (for example, grooming). There is then the possibility that these could progress into a type of obsessive compulsive disorder which, as Poulsen [2000] suggests, are common with sensory deprivation.

#### **5.5. Lethargy**

Lethargy is characterised by relative inactivity and drowsiness and forms part of the conservation-withdrawal pattern of response to captivity described by Carlstead [1996]. Morris [1964] considers gross inactivity to be the most dangerous state of all and many observers like Boorer [1972] have implied that stereotypic behaviour is actually preferable to this condition. The feelings that have been associated with lethargy in the literature include depression, boredom and chronic stress [Fox, 1986 cited in Wemesfelder, 1993; Carlstead, 1996], demonstrated by such observations as a reduced exploration rate [Carlstead, 1992].

#### **5.6. Abnormality as an Adaptation**

As already discussed, these ‘abnormal’ behaviours could form part of the elastic behavioural repertoire that prevents boredom taking hold [Hughes and Duncan, 1988]. In fact, Morris [1964] and Van Keulen-Kromhout [1976] both interpret many of these activities as being “occupational” in nature in order to compensate for what is



not possible in captivity. Hughes and Duncan [1988] also suggest that they may actually help maintain optimal levels of arousal in chronically under-stimulated environments whilst Delius [1967] hypothesises that they form part of a de-arousal process to reduce the information processing rate. Similarly, Carlstead [1992] shows in her study of captive leopard cats, that displacement activities could also help animals cope with stressful situations, such as a lack of hiding places. The conservation-withdrawal type of behaviour seems harder to explain in adaptation terms. It has been construed by Koene [1995] to be a passive coping response or, as Cronin et al. [1984] (cited in Wechsler [1991]) discuss, lethargy may form the second stage on the pathway to achieving coping. Carlstead [1996] believes that this reduction in stimulation-seeking behaviour allows animals to suppress their expectations of the environment when there are no natural behavioural outlets available.

However these behaviours are interpreted, it has become very clear that they can all represent good to poor welfare, and should be employed far more than they currently are in time budget studies and animal welfare assessments [Stoskopf and Gibbons, 1994].

## **6.0 WELFARE IMPLICATIONS**

### **6.1. Stereotypic Behaviour in Welfare Assessments**

Stereotypic behaviour is often associated with poor welfare [Carlstead, 1998], since according to Mason [1993a] and many others, it is usually the result of the animal unable to take effective consummatory action. This is assumed to be synonymous with frustration and therefore, most probably, suffering.

Mason and Latham [2004] estimate that stereotypies occur in over 85 million animals worldwide which suggests a potential significant welfare problem for a vast number. The use of stereotypic behaviour to signify sub-optimal environments for zoo animals has a particularly long history [Duncan et al., 1993], probably because



these animals are on public display and thus must be seen to be “normal” and healthy. There are large discrepancies between authors, however, on what level of stereotypy indicates poor welfare, for example some believe *any* stereotypical behaviour should be used whilst others consider welfare to be compromised only if levels increase [Broom and Johnson, 1993]. It is not clear which theory is correct, particularly since the exact causes and consequences of stereotypy are still largely unknown.

If it were to be the case that stereotypical behaviour was beneficial to the animal, then animals performing such behaviours may not be suffering to the extent that is often perceived. However, Wemelsfelder [1993] argues that this coping hypothesis evokes the suggestion that stereotypies are continuous with normal forms of behavioural control, which is simply not the case. She therefore believes that stereotypies at any stage signify suffering and poor welfare.

Unfortunately, assessing the welfare of these animals is confounded further by the process of stereotypic development itself. According to Dantzer [1986], the *established* stereotypies are controlled at such a hard-wired level that they cease to have any emotional significance to the animal which, of course, leaves open the issue of whether suffering is involved. In fact, stereotypical behaviour has been observed in situations where the welfare of the animal was most certainly improved, for example, Korhonen et al. [2001] describe an increase of locomotory stereotypic behaviour in farmed blue foxes (*Alopex lagopus*) when they were provided with larger cages.

It is clear that using the level of stereotypy for welfare grading purposes is extremely problematic, however the overriding opinion in the literature appears to be that, at least in their development, stereotypic behaviour does indicate some measure of arousal, stress and consequently suffering and must be investigated further.

## 6.2. Welfare of Non-Stereotypic Animals

It has become very apparent that, apart from stereotypies, a huge and diverse range of behaviours can equally result from time in captivity. Behaviour that is

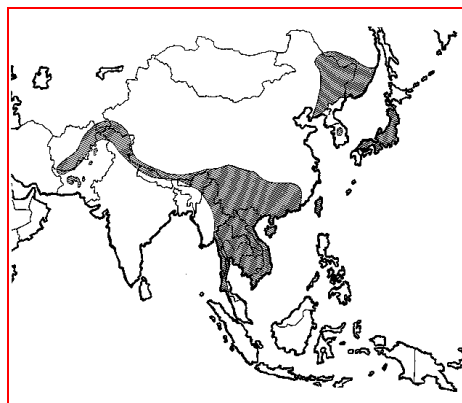


aberrant in form and different from the norm seems to be the general response to a sub-optimal environment and is therefore assumed to represent poor welfare. Since many authors believe that the non-stereotypers are the ones failing to cope, it is proposed that their welfare could perhaps be worse [Mason and Latham, 2004]. Unfortunately, however, captive animal behavioural research seems very much biased towards documenting stereotypic behaviour, without much focus on the other potential signs of poor welfare that are less “dramatic”.

## 7.0 CONSERVATION IMPLICATIONS

Attention has recently begun to turn towards the consequences of captivity on the broader conservational issues of many species, since attempts to augment the fragile wild populations is becoming increasingly dependent on captive populations [Shepherdson, 1990; Miller et al., 1998]. The historic range of Asiatic black bears stretches from Iran across to Japan (Fig. 5), however, over the last two decades, there has been a rapid decrease in numbers [Sathyakumar, 2001]. With numbers currently below 20,000 [Anonymous, 2004], much emphasis is now being placed on how this population can be supplemented by reintroducing captive individuals [e.g. CBSG, 2001].

Fig. 5. World distribution of the Asiatic black bear [Servheen, 1989]



In order to achieve such re-introductions, an animal's natural species-specific behaviour must be preserved. Poole [1998] and Castro et al. [1998] stress however that the mental model of the world acquired by animals in captivity is largely irrelevant for survival in the natural environment. As a result, many like Huber [1995] believe that captive animals should *never* be used for reintroductions. Indeed, the IUCN [2002] clearly states that animals held in captivity can acquire an inappropriate behavioural repertoire that could jeopardise their individual welfare and the conservation of the species following release. These warnings are supported by the results from past reintroduction projects using captive animals that show high failure rates [Frantzen et al., 2001].

Stereotypic behaviour could have a large role to play in these failures since it is thought by some to cause such detrimental effects on brain functioning that learning ability and possibly survival back in the wild is seriously impeded [Vickery and Mason, 2003b]. Indeed, stereotypies have been shown to be associated with impaired behavioural flexibility [e.g. Garner and Mason, 2002; Garner et al., 2003]. However, there are many uncertainties to this line of thinking, particularly since the whole process of stereotypy development can occur over very prolonged periods, and even be reversed with sufficiently enriched and naturalistic environments [Carlstead et al., 1991; Swaisgood et al., 2001]. Results from previous studies have shown that captivity does not necessarily result in behavioural degeneracy and the animals themselves may be more like their wild brethren than is often thought [Wyers, 1994]. For example, Novak et al. [1994] comment on a group of captive primates which, although were socially maladapted through early deprivation, rapidly readjusted to normal social behaviour when part of a group. These findings suggest that captive animals may possess a certain psychological resiliency against the adverse effects of time in confinement and should not be immediately excluded from important reintroduction schemes without further assessment.



## 8.0 SUMMARY

Stereotypical behaviour is widespread amongst captive animals and, since many consider it abnormal, is the cause for much concern with regards to animal welfare. Stereotypies are proving extremely challenging to study however and, as a result, there is still much disagreement as to their origins, proximate causes and final consequences. Therefore, research into other, more subtle deviant behaviour is becoming increasingly important, supported largely by time budget comparisons of captive animals and their wild counterparts. Such comparisons often highlight the fact that, besides high incidences of abnormal behaviour in confinement, animals do have certain behavioural 'needs' which captivity rarely caters for. There appears to be a general consensus that the generalist species are most susceptible to developing these abnormal behaviours because their 'need' for stimulation is greater. This claim is certainly supported by previous studies on captive bears. Despite the detrimental effects of captivity however, consideration is now being given to the fact that these captive held animals could form an integral part of conservation programs. With so many of the world's species under threat, reintroductions of captive animals are currently being conducted but are unfortunately often met with limited success. It is thought that this could be due to the proposed association between stereotypies that develop from time in captivity and reduced learning ability however a great deal more research needs to be conducted in this area before firm conclusions are drawn.

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## Time Budget Analysis of Asiatic Black Bears with a Focus on Stereotypic Behaviour

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The effects on the behaviour of six Asiatic black bears (*Ursus thibetanus*) when placed in a barren environment were studied at a wildlife breeding centre, northern Thailand. Since bears are frequently housed in sub-optimal conditions and renowned for their abnormal captive behaviours, the focus of this study was on stereotypic behaviour, with an aim of investigating its source behaviour and final consequences, with particular regards to welfare. With the use of camera and recording equipment, simultaneous focal samples were conducted, along with scan samples made of the caged bears and those that remained in the enclosure. Four of the caged bears exhibited established stereotypical behaviour that increased in duration over the period, however did not appear to be elicited by any particular cue and was thus hypothesised to be a coping strategy. In comparison, two of the caged bears demonstrated a distinct increase in agitated scratching behaviour, considered to be the source behind their developing stereotypy of head circling. This agitation peaked in the pre-feeding hour and late afternoon suggesting it represented thwarted foraging and nest-building appetitive behaviours. The significant increase in time spent resting also suggested the two bears were adopting a withdrawal means of coping, a different strategy to the four with established stereotypical behaviour. Scan sampling revealed significant differences between the behaviours of caged and enclosure bears, supporting evidence that, in a semi-wild setting, bears do show a repertoire resembling that of wild bears whilst captivity induces a wide variety of abnormal behaviours.

**Key words:** *Ursus thibetanus*; stereotypic behaviour; source behaviour; coping; conservation withdrawal; agitation

### INTRODUCTION

Animals have been removed from the wild and maintained in captivity throughout history, however it is only recently with the development of sophisticated



techniques for analysing animal behaviour and an increased awareness of welfare that the detrimental consequences of a captive life have been identified [Carlstead, 1992]. Free-ranging animals are constantly exposed to unpredictability in their environment, offering infinite opportunities for expressing their naturally evolved and specific behavioural repertoire. Caging, however, removes these important eliciting stimuli and a whole host of contextually inappropriate behaviours often result, such as self-directed harm behaviour, exaggerated aggression and certain stereotypies [Meyer-Holzapfel, 1968; Boorer, 1972; Poole, 1995].

Stereotypical behaviour is characterised by its repetitive, invariant nature and lack of function [Mason, 1991a]. Many of the explanations to account for such behaviour however contradict this definition, since they propose that stereotypies are an adaptation to help the animal cope with their sub-optimal environment [Cooper and Nicol, 1991]. For example, stereotypical behaviour could provide a source of enrichment or have a “mantra-like” calming effect against chronic stress [Mason and Latham, 2004] or, by requiring less processing capacity than the more complex patterns of behaviour, may help to decrease arousal levels associated with aversive situations [Wechsler, 1991]. This coping theory has a large following since evidence supporting its cause is strong [Wiepkema et al., 1987]. Nevertheless, many also believe there is an element of ‘wishful thinking’ to this [Rushden, 1993], instead proposing that stereotypies result from intense frustrated appetitive behaviours, when the animal can not find adequate stimuli to perform the crucial consummatory act that would reduce the underlying motivation [Hughes and Duncan, 1988].

Unfortunately, research into stereotypies is proving all the more challenging because of their idiosyncratic, changeable and heterogeneous nature [Mason, 1991a]. Further studies need to be conducted into investigating the reasons behind such behaviours and from exactly which source behaviours they arise, particularly since stereotypies are often so persistent that simply improving the animal’s welfare by enrichment does not reduce them [Poulsen, 2000].

The association that has been drawn between stereotypies and welfare has been much debated. There is little doubt that they do initially develop from aversive situations and are, at some point, a sign of poor welfare. However, evidence exists that control over the stereotypical movements does shift into a form of automatic



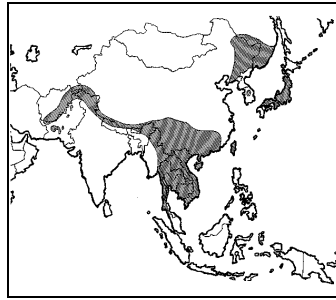
processing (Fentress, 1976), they become divorced from their original eliciting stimuli (termed emancipation) and they appear more like habits [Mason, 1993a]. Stereotypies can then be performed in circumstances where well-being is not at stake [Mason, 1991b], thus some suggest there should perhaps be more concern for the least stereotypic animals in captivity [Mason and Latham, 2004]. Presence or absence of many other constellations of behaviour should therefore be used to rank animals along the welfare scale [Stoskopf and Gibbons, 1994; Koene, 1995a], all of which can be gauged from studying the time budgets of captive animals [Ames, 2000].

These effects of captivity have been documented in a large range of species [e.g. Mason, 1993b; Mallapur and Chellam, 2002]. It is estimated that 85 million animals worldwide perform stereotypic behaviour [Mason and Latham, 2004], however bears, in particular, are renowned for their reaction [Vickery and Mason, 2003a], displaying a diversity of abnormal behaviours [e.g. Carlstead and Seidensticker, 1991; Swaisgood et al., 2001]. By their neophilic and destructive nature, bears are not only a source of much curiosity and thus popular zoo exhibits, but are usually housed in traditional bear pits, with little furnishing [Forthman et al., 1992]. Polar bears (*Ursus maritimus*) are reported as being the most affected by this investigatory deprivation [Kolter, 1995], however, bears of all species are strongly resistant to lowering their activity and show species-specific abnormal behaviours [e.g. Clubb and Mason, 2003]. Asiatic black bears (*Ursus thibetanus*) are known to spend much of their time engaged in nest building activities [Law et al., 1992], a behaviour that is clearly very important to them [Ames, 1998]. However, due to their reputation as fierce bears [van Keulen-Kromhout, 1976], they are often placed in impoverished conditions [O'Grady, 1994] and consequently exhibit high degrees of stereotypic behaviour.

This concern with regards to the effects of captivity extends beyond the welfare of the individual to the broader conservation issues of the species, particularly since attempts to augment threatened populations has become increasingly more dependent on the small but vital captive populations [Shepherdson, 1990]. Figure 6 shows the range of Asiatic black bears, however their numbers are rapidly decreasing [Mills and Servheen, 1994] and attempts to restore populations could soon rely on reintroducing captive bears [e.g. CBSG, 2001].



Fig. 6. Distribution of the Asiatic black bear (Servheen, 1989)



Previous studies, however, have indicated that, via its effects on brain functioning, stereotypic behaviour has detrimental effects on learning ability [Garner et al., 2003]. It is further proposed that this may impede survival once back in the wild and thus could account for the poor post-release results obtained from captive-raised animals [Vickery and Mason, 2003b]. Therefore, studies into the effects of confinement on behaviour are a high priority, whether that be in intensive sub-optimal conditions or in more naturalistic enclosures [Wyers, 1994; Koene, 1995b].

This present study was conducted in order to show the consequences of removing bears from an enriched setting and placing them in a barren and restrictive environment. With the use of camera recorded analysis, it was hoped to chronicle the process of behavioural adaptation to a caged life, in particular the ontogeny of any stereotypic-like behaviour and coping mechanisms. The following hypotheses were tested:-

1. There is no difference between time spent in certain behaviours at the end of the 6-week period as compared to the start
2. On a daily basis, no behaviour is seen at significantly increased or decreased levels at particular times
3. There is no difference between the time budgets of those bears that exhibit *established* stereotypic behaviour and those where it is considered *developing*
4. There is no difference between the time budgets of caged and enclosure bears
5. There is no correlation between frequency of stereotypic behaviour and other behaviours



## METHODS

### **Subjects**

Six female Asiatic black bears were observed over a six week period at Pang Tong Wildlife Centre in Nam-Tok-Mae-Surin National Park, Thailand. Details prior to them residing at the centre are contained in Appendix A. The bears were as follows: *Benji*; *Joy*; *Jip*; *Marsha*; *Maem-song*; *Tuk-tik*.

The three bears that remained in the enclosure to serve as a comparison in time budgets were: *Maem-neung*; *Maem-saam*; *Michael* (male).

### **Facility**

The six bears were housed individually in identical cages measuring 3m(length) x 3m(width) x 4m(height) (see Appendix B). Two of the walls and the floor were concrete, the front was constructed of 1” diameter steel bars, and a steel partition existed between cages so that the bears had no contact with each other. No cage furnishings were provided.

The adjacent enclosure measured approximately 120m(l) x 90m(w) and contained vegetation, platforms, dens and several pools (see Appendices C and D). Access for the bears to one cage was permanently available.

### **Procedure**

To aid in developing a suitable ethogram and establish the bears’ diurnal patterns, preliminary observations were conducted on all nine bears in the enclosure. Scan samples were taken every 5 minutes between 6am and 6pm. On the basis of these observations, the main study began on June 26<sup>th</sup> 2004, and ran until August 7<sup>th</sup> 2004 (although technical difficulties and a necessary switch-over of bears did cause some disruption to filming). Six of the eight females were randomly selected and, after moving the bears into their cages, observations began on the following day.

The use of video cameras placed 3m away from each cage enabled focal sampling of the six bears [Martin and Bateson, 1994] and thus temporal



synchronisation of data sets during three 2-hour segments each day: 7.00-9.00; 11.00-13.00; 15.00-17.00. Segment times were selected to encompass daylight hours and accommodate feeding (occurred at 12.00 to enable pre- and post-feeding observations). It was also felt that these time periods best represented their daily patterns of activity, as well as allowing time in between recordings to playback the footage (using *Pico 2000 1.8.0* software) and record all aspects of behaviour onto the relevant ethograms that contained 25 mutually exclusive behavioural categories (see Appendix E). This method of observation allowed near real-time analysis of approximately 15,000 minutes of observation per subject, offering a more complete representation of behaviour than the traditional scan sampling technique where vital but inconsistent behaviour could be missed. To allow for a comparison in behaviours however, scan samples using the same pre-determined categories were also conducted on all bears at 15 minute intervals throughout the 2-hour segments.

### **Analyses**

For statistical analysis purposes and to increase the chance of detecting patterns, six one-hour segments were employed (period **1**: 7.00-8.00; **2**: 8.00-9.00; **3**: 11.00-12.00; **4**: 12.00-13.00; **5**: 15.00-16.00; **6**: 16.00-17.00). For hypotheses 1 and 5, the bears were analysed individually.

To establish the presence or absence of particular behavioural trends over the study for hypothesis 1, a Chi-Squared Test for Trend in Proportions in behaviour was conducted [Dalgaard, 2002]. Trends on a daily basis for hypothesis 2 were determined by Friedman's Chi-Squared test [Higgins, 2003]. To reject or accept hypothesis 3, the six bears were divided into two groups, those with established stereotypic behaviour and those with developing stereotypies. This was conducted on the basis of results obtained from Principal Components Analysis [Quinn and Keough, 2003] that used the four primary categories of behaviour to demonstrate the similarity of each individual relative to another. A 2-Sample Test for Equality of Proportions in behaviour was then conducted between the two bear groups [Higgins, 2003]. This method was also used for hypothesis 4 to detect differences in activity between the caged and enclosure bears. The final hypothesis was tested using Spearman's Rank Correlation analysis [Quinn and Keough, 2003] and compared the



frequency of the specific stereotypic behaviour with other frequencies of behaviour. R statistical computer program was used for hypothesis 1 whilst Minitab 13 was used for hypotheses 2, 3, 4 and 5.

## RESULTS

### Summary Statistics

From the first day of observations, it became apparent that the six bears displayed very individualistic behaviour with regards their response towards captivity and, as a result, general patterns in data were difficult to detect. The mean and maximum number of minutes per hour of certain selected behaviours are summarised in Table 1.

Table 1. Summary statistics for Asiatic black bears, detailing mean and maximum number of minutes per hour spent in certain behaviours

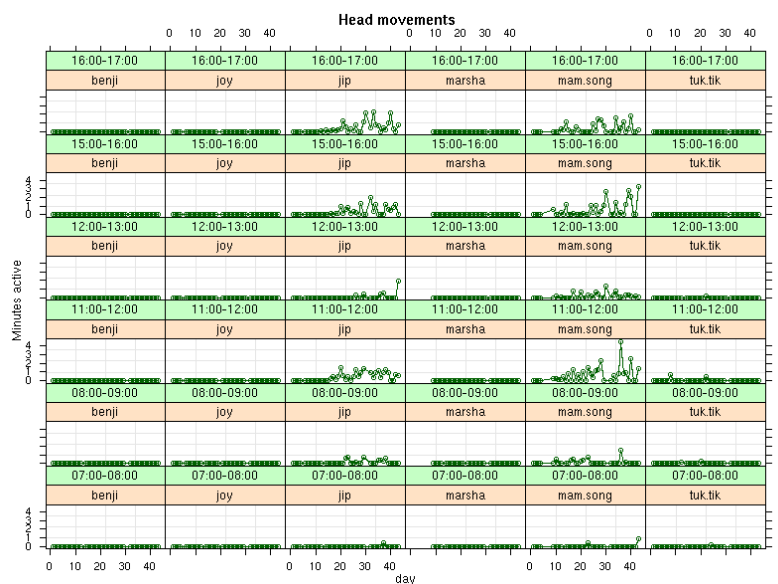
BEHAVIOUR										
	Pace	Weave	Loop	Repetitive head movements	Agitation	Sleep	Resting but alert	Drink	Investigation	Maintenance
<b>Benji</b>										
Mean (min)	0.00	6.69	0.00	0.00	0.02	18.00	26.10	0.23	2.93	1.44
Std. Dev.	0.00	11.42	0.00	0.00	0.10	22.40	17.21	1.04	3.59	2.31
Max. (min)	0.00	51.47	0.00	0.00	1.02	60.00	59.88	9.85	19.47	14.80
<b>Joy</b>										
Mean	0.00	14.38	0.00	0.00	0.04	20.79	16.92	0.02	2.92	1.02
Std. Dev.	0.00	15.91	0.00	0.00	0.29	23.19	14.09	0.14	3.51	1.84
Max.	0.00	58.43	0.00	0.00	3.05	60.00	56.63	1.22	19.52	9.95
<b>Jip</b>										
Mean	0.00	0.00	0.00	0.19	2.68	20.58	24.30	0.05	5.73	0.88
Std. Dev.	0.00	0.00	0.00	0.37	4.48	22.05	17.49	0.23	6.06	2.02
Max.	0.00	0.00	0.00	2.03	22.33	60.00	58.97	2.15	25.83	16.30
<b>Marsha</b>										
Mean	0.00	5.57	0.00	0.00	0.00	22.07	20.73	1.41	5.01	1.09
Std. Dev.	0.00	9.28	0.00	0.00	0.01	21.14	14.53	2.74	4.87	1.58
Max.	0.00	40.77	0.00	0.00	0.15	60.00	59.87	17.27	26.05	9.20
<b>Maem-song</b>										
Mean	0.00	0.00	0.00	0.27	4.29	17.70	23.04	0.33	8.76	0.70
Std. Dev.	0.00	0.00	0.00	0.55	8.52	22.18	15.48	1.07	8.45	1.47
Max.	0.00	0.00	0.00	3.85	41.03	60.00	59.42	7.18	43.28	9.13
<b>Tuk-tik</b>										
Mean	5.61	0.00	5.26	0.01	0.12	22.74	13.90	0.09	5.24	2.00
Std. Dev.	10.79	0.00	10.92	0.06	0.48	24.79	13.43	0.30	5.28	3.37
Max.	49.70	0.32	54.38	0.63	3.45	60.00	57.95	2.13	23.67	19.80



### Trends in Behaviour Over Time

Results from the chi-squared test for trends in proportions exposed a large number of significant changes over time in many of the behaviours and time periods, thus rejecting hypothesis 1. Unfortunately, however, the combination of a small number of bears in the sample with large amounts of data generated for each resulted in highly significant statistical trends despite the biological significance being minimal. Nevertheless, Figures 7 - 9 below show those selected abnormal behaviours which the author feels do represent an obvious and important change over time.

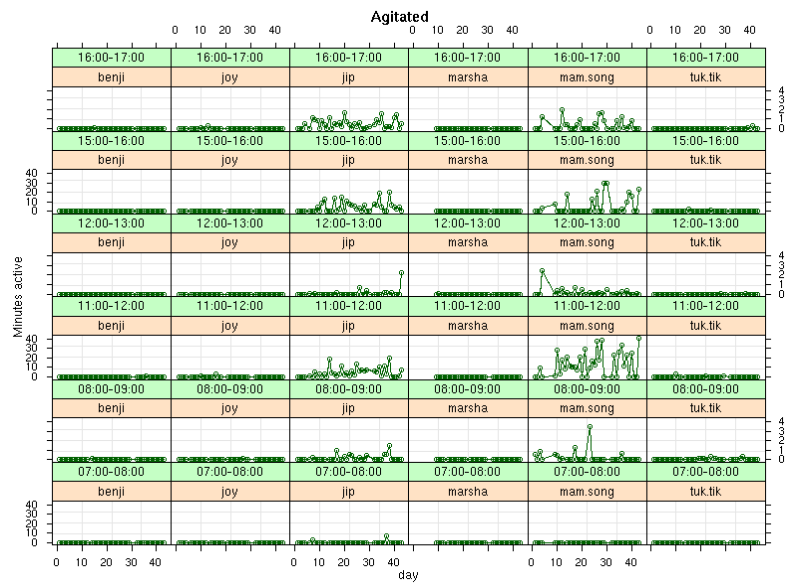
Fig. 7. Change in repetitive head movements over study period



Aside from time period 1, repetitive head movements increase with respect to number of minutes the activity was seen, in Jip and Maem-song over the 6 weeks. The most noticeable increase occurs in periods 3, 5 and 6 for Jip ( $\chi^2=435.4, P<0.001$ ;  $\chi^2=444.8, P<0.001$ ;  $\chi^2=552.5, P<0.001$  for respective periods) and Maem-song ( $\chi^2=407.2, P<0.001$ ;  $\chi^2=730.2, P<0.001$ ;  $\chi^2=175.0, P<0.001$ ).

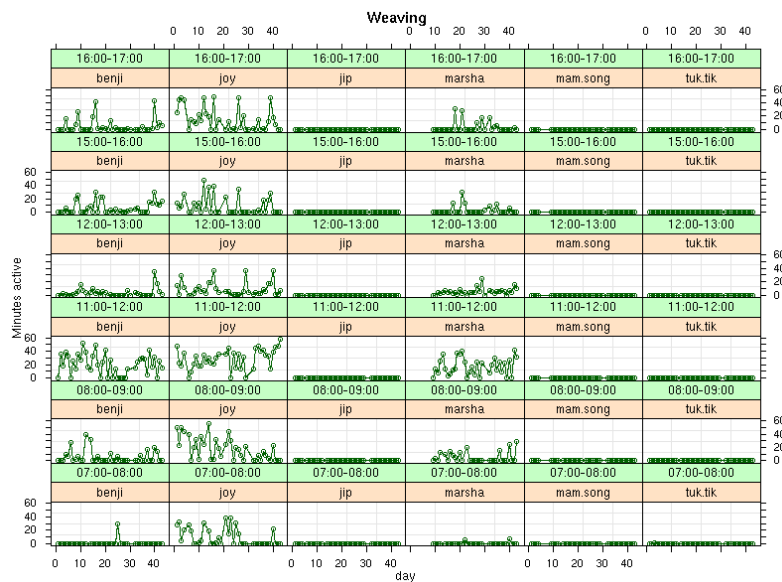


Fig. 8. Change in agitated behaviour over study period



Both Maem-song and Jip display an obvious increase in time spent in agitated behaviour. This increase is most pronounced for periods 3 and 5 ( $\chi^2 = 1230.3, P < 0.001; \chi^2 = 994.3, P < 0.001$  for respective periods with Jip.  $\chi^2 = 1961.5, P < 0.001; \chi^2 = 3984.8, P < 0.001$  for Maem-song).

Fig. 9. Change in weaving behaviour over study period



Weaving, the established stereotypic behaviour displayed by Benji, Joy and Marsha, appears to show several noticeable trends over time in certain periods. All three bears show a highly significant increase in weaving time in period 3 ( $\chi^2 = 995.8,$



$P < 0.001$  for Benji;  $\chi^2 = 2462.5$ ,  $P < 0.001$  for Joy;  $\chi^2 = 277.6$ ,  $P < 0.001$  for Marsha), although Joy's weaving behaviour seems to decrease significantly over time in time periods 1 and 2 ( $\chi^2 = 6868.9$ ,  $P < 0.001$ ;  $\chi^2 = 14296.9$ ,  $P < 0.001$ , respectively).

### **Diurnal Patterns in Behaviour**

Hypothesis 2 is rejected since Friedman's chi-squared test for analysis of trends revealed several significant behavioural patterns ( $P = 0.05$ ) including resting but alert ( $\chi^2 = 22.29$ ,  $P = 0.000$ ), investigation ( $\chi^2 = 21.81$ ,  $P = 0.001$ ) and maintenance ( $\chi^2 = 11.24$ ,  $P = 0.047$ ). As with hypothesis 1 however, the large degree of scatter obscured any particular patterns in the majority of behaviours, with the exception of sleeping (shown at significantly higher levels in periods 1, 2, 5 and 6 with a value of  $\chi^2 = 26.67$ ,  $P = 0.000$ ) and agitation. Agitated behaviour is seen at significantly higher levels ( $\chi^2 = 16.41$ ,  $P = 0.006$ ) in periods 3, 5 and 6 (Fig 8). Those behaviours with no significant daily patterns were pacing, weaving, looping and repetitive head movements.

### **Comparisons Between "Established" and "Developing" Stereotypic Bears**

Using the 4 categories of behaviour, principal components analysis allowed a distinction to be made between the six bears into two groups, named according to the level of their stereotypic behaviour:-

**"Established"** : Benji; Joy; Marsha; Tuk-tik

**"Developing"** : Jip; Maem-song

A 2-sample test for equality of proportions revealed highly significant differences ( $P < 0.001$ ) between the two groups for time spent in 24 of the 25 behaviours (human-directed behaviour was the exception), thus hypothesis 3 is rejected. The most important behaviours with regards to this study are shown in Table 2.



Table 2. Proportion of time per hour spent on specific behaviours by the “established group” and “developing group”

Behaviour	Prop. of time – “established group” (n=4)	Prop. of time – “developing group” (n=2)	X-squared value	P-value
Pace	0.02511	0.00000	42577	<0.001
Weave	0.11095	0.00000	199674	<0.001
Loop	0.02798	0.00000	47533	<0.001
Repetitive head movements	0.00000	0.00442	14190	<0.001
Agitation	0.00008	0.05796	185252	<0.001
Sleep	0.34676	0.32023	3490	<0.001
Resting but alert	0.32391	0.39514	24812	<0.001
Drink	0.00657	0.00313	2434	<0.001
Investigation	0.06754	0.12069	40146	<0.001
Maintenance	0.02393	0.01346	6079	<0.001

### Comparisons Between “Caged” and “Enclosure” Bears

A test for the equality of proportions demonstrated certain highly significant differences and similarities ( $P<0.001$ ) between the two groups in many of the abnormal and normal behaviours, thus rejecting hypothesis 4. Table 3 highlights the most relevant to this study:-



Table 3. Proportion of scans spent on specific behaviours by the “caged group” and “enclosure group”

Behaviour	Prop. Of scans – “caged group” (n=6)	Prop. of scans – “enclosure group” (n=3)	X-squared value	P-value
Pace	0.00163	0.00000	50.91	<0.001
Weave	0.07809	0.00000	260.4	<0.001
Loop	0.00149	0.00000	46.38	<0.001
Agitation	0.02034	0.00000	64.06	<0.001
Sleep	0.32759	0.36100	10.47	0.001
Resting but alert	0.36532	0.28616	59.16	<0.001
Investigation	0.08322	0.15472	113.3	<0.001
Maintenance	0.02360	0.00755	29.66	<0.001
Random movements	0.00140	0.08553	528.6	<0.001
Play	0.00000	0.01132	70.19	<0.001

### Correlations Between Frequencies of Stereotypic Behaviour and Other Behaviours

On an individual bear basis, several highly significant correlations were seen ( $P < 0.001$ ) between the frequencies of stereotypy and certain other behaviours leading to the rejection of hypothesis 5 on several counts. The following correlations were significant and relevant to this study:-

#### Jip

Repetitive head movements–agitation:  $P_{(s)}=0.793$ ;  $P$  value<0.001

#### M-song

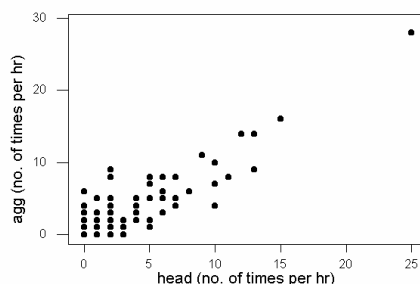
Repetitive head movements–agitation:  $P_{(s)}=0.724$ ;  $P$  value<0.001 (Fig. 10)

#### Tuk-tik

Pacing–investigation:  $P_{(s)}=0.710$ ;  $P$  value<0.001



Fig. 10. Plot demonstrating the relationship between agitated behaviour and head circling for Maem-song.



true, then the head circling could indicate the final stage of this behavioural fixation process [Wemelsfelder, 1993]. It is therefore proposed that, in Asiatic black bears, stereotypic behaviour develops from frustrated behaviour associated with hunger (although head movements were seen throughout the day) and thwarted nest-building or foraging activities. Indeed, nest-building behaviour has often been suggested as the source of specific stereotypies [Mason, 1993a] with Thieme and Kolter [1995] (cited in Fischbacher and Schmid [1999]) reporting a correlation between lack of appropriate resting sites with stereotypic head tossing in a spectacled bear (*Tremarctos ornatus*).

Trends over time can also be seen in the three bears that displayed weaving stereotypic behaviour. Despite the large amount of scatter in Figure 9, an increase in time spent weaving over the study did become apparent in the majority of the time periods. It is suggested that this particular stereotype, which was certainly established in their behavioural repertoire, took up an increasing proportion of the time as the bears realised their never-changing environment. Rather than the stereotype being triggered by thwarted appetitive behaviour as was perhaps the case when it was developing, it was used more as a method for actively coping with their perceived insoluble situation (such as the “DIY enrichment” or “mantra” hypotheses described in Mason and Latham [2004]). Since the stereotypic behaviour had a positive beneficial effect on the bears, this reinforced its performance.

There is strong evidence that the weaving stereotypy had become separated from its original eliciting stimuli in all three bears, as well as the pacing and looping stereotypical behaviour of Tuk-tik since they were performed throughout the day even in the post-feeding hour. Wechsler [1991] also concluded that the stereotypies in captive polar bears were distributed over the day and not released by any obvious disturbances. In particular, there was no significant correlation between stereotypy frequency and human-directed behaviour suggesting such behaviour was rarely elicited or interrupted by human presence.

These features of prolonged bouts of stereotypic behaviour that have undergone emancipation and are not stimulated by any particular cues, are very indicative of a stereotypy that is *established* [Fentress, 1976]. They are quite distinct from *developing* stereotypies in a number of ways, and, as a result, did seem to cause



substantial contrasts in the characteristics of the individuals involved in this study. Aside from the obvious differences between the two groups for time spent pacing, weaving and looping, the most noticeable difference involved much lower incidences of agitated behaviour in the established group. These findings lend support to the hypothesis that stereotypic behaviour is linked to reduced distress [Mason, 1991a]. Perhaps this is achieved through their calming, “mantra-like” effect, particularly demonstrated by the fact that the established group also spent significantly more time sleeping.

Coping is defined as a pertinent behavioural and/or psychological strategy developed to reduce physiological activation elicited by a stressor [Friend, 1991] and it is hypothesised that there are two types of coping styles, passive or active [Koene, 1995a]. These variations in coping mechanisms are highlighted by the differences between the two groups in their time spent resting (but alert). The developing group spent significantly more time in this “activity” than the established group, suggesting that this was their passive “conservation-withdrawal” means of coping [Carlstead, 1996]. Such withdrawal can develop into a state of lethargy and Maem-song was often observed with the characteristic glazed-over look. It is also significant that Joy, in particular, spent progressively less time weaving and more time sleeping and resting in the first 2 periods (i.e. chi-squared test for trend in proportions showed  $\chi^2 = 7496$ ,  $P < 0.001$  for sleep and  $\chi^2 = 2018$ ,  $P < 0.001$  for resting but alert in period 2), since this suggests a conversion from an active form of coping to a more passive one. In fact, individuals are often reported as exhibiting both types of response [Koene, 1995a], dependent on how they choose to take control over the aversive situation [Carlstead, 1996].

According to Cronin et al. [1984] (cited in Wechsler [1991]), there are four distinct stages of coping which certainly seem applicable here. The initial stage is that of a frantic resistance, shown by Jip and Maem-song, throughout the 6 weeks. However, on the basis of their time spent resting, they also seemed to be progressing onto the second stage, that of an increased drowsiness, but not yet reaching the third stage characterised by short bouts of repetitive exploratory behaviour. The final stage, when coping is achieved, is stereotypic-like behaviour. This stage was shown at high levels in the four other bears, and it is speculated that they had all gone



through the previous phases when their particular stereotypy was developing. This gradient of the response, along with the idiosyncratic coping styles makes interpretation of behaviour very challenging, particularly since decisions must be made as to when the animal is relaxing or attempting to passively cope via entering a state of submission. In particular, the apathy that was seen in the developing group could have reflected their feelings of depression, a state considered to be the precursor to stereotypic behaviour in behavioural fixation [Wemelsfelder, 1993]. These findings all support the suggestion that, with regards to animal welfare, we should perhaps be more concerned with those animals that are not stereotyping but showing gross inactivity.

Another trait distinguishing the two groups is that of time spent investigating. The developing group spent almost twice the time investigating than the established group demonstrating their continual search for stimulation. According to Benus et al. [1990], passively coping animals do explore their environment more intensely than active copers which, in contrast, have a reduced sensitivity to extraneous inputs [Fentress, 1976] and lower exploration rates [Wemelsfelder, 1993]. A depressed exploration rate is a reliable behavioural indicator of chronic stress [Carlstead, 1992], thus it could be assumed that the established group were suffering from chronic stress whilst the developing group were still in the acute stages.

There have been several studies in the past proposing a correlation between stereotypic behaviours and those regarded as displacement activities or excessive behaviours. Glickmen and Caldwell [1994] proposed that these behaviours can involve whole segments of an animal's consummatory repertoire (e.g. nest building) that appear much more frequently than normal. In this study, the apparently "normal" behaviours of drinking and bodily maintenance could be interpreted as displacement or excessive activities since they were seen at significantly higher levels in the established group of bears. Indeed, polydipsia was particularly noticeable in Marsha, whilst Tuk-tik was frequently observed grooming. In addition, correlation analysis for Tuk-tik showed a significant association between pacing and investigation, suggesting exploration was also a displacement activity which she constantly interspersed with her stereotypy. It could be that these are activities created by the bear to be "occupational" in nature [e.g. Morris, 1964] or, similar to stereotypical



behaviour, form part of the de-arousal process that reduces the information processing rate below its limited channel capacity [Delius, 1967]. In fact, polydipsia is often considered an interim form of stereotypic behaviour [Terlouw et al., 1991]. Thus it would be expected that those bears displaying advanced stereotypies also show higher degrees of displacement or excessive activities, all three behaviours helping to regulate arousal levels and achieve coping.

Similar conclusions can be made with regards to the time budgets of caged bears versus enclosure bears. In all of those behaviours considered abnormal, very highly significant differences were detected between the two groups. This suggests that the ethological needs of the enclosure bears were completely satisfied and, as a result, abnormal behaviour had no place in their behavioural repertoire. The time animals spend in leisure activities is believed to be a useful indicator of when such needs are met [Koene, 1995a] since they do not provide a reward in the form of some immediate benefit to survival [Poole, 1998]. Play is a prime example of such behaviour [e.g. Baldwin and Baldwin, 1974]. The difference between time spent in play between the two bear groups was very stark and there are certainly many indications in previous studies that stressed bears play less or not at all [e.g. Fagen and Fagen, 1990]. Other normal behaviours that were demonstrated at significantly higher levels in the enclosure were investigation and random movements, two activities one would expect to dominate the repertoire of wild bears particularly when associated with foraging behaviour [e.g. Garshelis et al., 1980]. Foraging is considered to be an essential reinforcing behaviour required to satisfy ethological needs and is therefore performed for reasons other than merely fulfilling its functional role [Hughes and Duncan, 1988]. Foraging and locomotory opportunities however are severely limited in a cage, reflected by the results obtained from the caged group.

The caged bears spent significantly more time in resting behaviour suggesting, again, that this could be a withdrawal-type response. They also spent more time occupied in bodily maintenance. The extremely limited opportunity for “food for thought” in the cage, coupled with the bear’s known abhorrence of inactivity possibly led to the caged group focussing much of their attention onto what was available, their own self (borne out by observations of grooming progressing to self stimulation and mutilation).



An extremely worthwhile extension to this study for welfare and conservation purposes would be to track the behaviour of the two bears demonstrating the initial stages of stereotypy on release back into their enclosure. This could offer important clues as to how firmly entrenched a stereotypy must be before it a) is not removed by placement in a semi-wild environment and b) has long-lasting detrimental effects on brain functioning shown by such experiments as reduced learning ability [Criswell and Fuller, working paper]. This would then provide further clues as to the suitability of release candidates for future reintroductions and could mean that those held for periods of time in captivity are not immediately excluded on the basis of possible permanent behavioural abnormalities.

## CONCLUSIONS

1. Agitated scratching behaviour significantly increased over the study period and is hypothesised to be the source behaviour from which stereotypical head circling arose. Considering the time of day in which frustration peaked, it is proposed that the development of stereotypical behaviour occurred due to hunger and/or thwarted nest building and foraging activities.
2. Weaving stereotypical behaviour also significantly increased over time and did not appear to be elicited by any particular stimuli; both findings that indicate this established stereotypy had become more of a means to help the bears cope with their aversive situation.
3. The considerable contrasts in time budgets between the two types of caged bears highlight their different strategies or stages of coping – active or passive conservation withdrawal and it is thus proposed that the welfare of the bears with developing stereotypic behaviour was poorer than those with established stereotypies.
4. Compared to the time budgets of the enclosure bears which showed a complete absence of any abnormal behaviour, the caged bears demonstrated high degrees of stereotypical, agitated and displacement and/or excessive activities, and a distinct lack of those behaviours regarded as “ethologically needed” (i.e. foraging, play).



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