The Plymouth Student Scientist - Volume 02 - 2009 The Plymouth Student Scientist - Volume 2, No. 1 - 2009

2009

Environmental enrichment for mammals in captivity focusing primarily on primates

Dawson, C.

Dawson, C. (2009) 'Environmental enrichment for mammals in captivity focusing primarily on primates', The Plymouth Student Scientist, p. 184-194.
http://hdl.handle.net/10026.1/13861

The Plymouth Student Scientist
University of Plymouth

Environmental enrichment for mammals in captivity focusing primarily on primates

Caroline Dawson

2009

Project Advisor: Stephen Burchett, School of Biological Sciences, University of Plymouth, Drake Circus, Plymouth, PL4 8AA

Introduction

In the wild animals must learn to survive by adapting to live in complex and challenging environments (Boere, 2001). Institutions that hold animals in captivity, such as zoos, safari parks or research facilities, result in the absence of major environmental factors that encourage and preserve species-typical behaviour in the wild (Markowitz, 1995). These factors include such behaviours as foraging, finding shelter, intraspecific relationships and anti predator behaviour (Boere, 2001). It is of utmost importance that these institutions promote these behaviours for two reasons. Firstly, if eventual reintroduction of the individual into its natural habitat is the aim, then an animal that exhibits species-specific behaviours is more likely to survive in the wild. Secondly, many institutions make it their aim to provide educational resources for people to learn about specific species. For this to happen, the animals need to exhibit similar behaviours to their wild counterparts (Young, 1995). Environmental enrichment is any mechanism that promotes these behaviours. Boere (2001) states that environmental enrichment is required as it provides an environment that allows for optimal well-being both physiologically and psychologically.

ISSN 1754-2383 [Online]

Problems with captive environments and the need for enrichment

Poole (1995) suggests that there are four main sources that cause behavioural problems for animals in captivity. The first is the lack of security an animal may feel if its environment does not provide it with a safe refuge from the stresses caused by captivity, such as constant human attention. Secure parts of the enclosure away from the public gaze should be provided, allowing the individual the choice as to whether or not they are seen, thus reducing stress. According to Carlstead (1996, as cited in Davis *et al*, 2005), animals in captivity will be able to cope with stressful situations, such as exposure to people, if they are given the opportunity to avoid the stressful stimulus. This can be achieved in such ways as providing locations where the individual can avoid eye contact and can be concealed from view; for example an area that is inaccessible to the general public. Additionally, a study conducted at Chester Zoo revealed that when spider monkeys (*Ateles* sp.) were not given opportunities to hide, their stress levels increased, as shown by increased hypothalamic-pituitary-adrenal (HPA) activity (Davis *et al* 2005). The end product of HPA activity is a practical measure of stress levels in captive animals (Ziegler *et al*, 1995, as cited in Davis *et al*, 2005).

The second source which may result in behavioural problems is the enclosure being too simplistic for the individual, which can result in a lack of species-specific behaviours being exhibited. Environments that house animals need to stimulate these types of behaviours (Boere, 2001). Animals can become lethargic if their environment does not stimulate them (Carlstead, 1996, as cited in Davis *et al*, 2005). One way to achieve this is by providing species-appropriate environmental enrichment. When environmental enrichment is appropriately implemented it can elicit responses such as reducing stress levels and improving an individual's physiological health (Boere, 2001). It can also decrease levels of aggression thus stabilising the social interactions within the group (Shepherdson & Carlstead, 1995). Environmental enrichment can have the desirable outcome of decreasing the frequency of stereotypic behaviours, such as head twisting and pacing, by positively reinforcing the animal when it initiates another, more natural, behaviour (Kuczaj *et al*, 1995). Stereotypic behaviour can be described as the response an animal elicits regardless of whether a positive or negative reinforcement accompanies the stimulus (Lawrence, 2000). It is thought that stereotypic behaviour exhibited in institutions, such as zoos, is caused by sub-standard living environments. An example would include small and under furnished enclosures where food is provided at set times of the day, normally in the same location within the enclosure (Carlstead, 1991, as cited in Poulsen *et al*, 1995). Prolonged stay in this environment may cause frustration and increase stress (Poulsen *et al*, 1995).

A lack of control an individual may have over their environment, within their enclosure, is the third source contributing to behavioural problems according to Poole (1995). The theory put forward is that apathy and stereotypic behaviours may arise if an individual is placed in an environment where there are reduced opportunities for achievement. Weiss (1968, as cited in Davis *et al*, 2005) asserted that existing research demonstrated that animals with no control over their environment experience more stress than those with control. To remedy this potential problem, Poole (1995) suggests environmental enrichment. A study by Mineka and Henderson (1985, as cited in Shepherdson & Carlstead, 1995) involved observing rhesus

ISSN 1754-2383 [Online]

monkeys (*Maccaca mullata*). A varied amount of control was given to three groups of monkeys over obtaining essentials, such as food and water, along with treats. It was concluded that the monkeys who had the most control over their environment were bolder and generally more inquisitive. It was also found that they coped better during separation from co-specifics.

The final source is a significant lack of variability in the individual's day-to-day life. Such a lack can occur even if the enclosure has been designed to be stimulating and to provide the individual with a certain degree of control. Habituation to the enrichment can occur if it is not frequently altered (Poole, 1995).Habituation is where an individual becomes accustomed to a stimulus. When continuing contact is made to the same stimulus, there is a reduction in the targeted behaviours (Lawrence, 2000). One way of increasing variability would be providing food in interesting ways, or perhaps supplying an individual's preferred treats in a novel way (Poole, 1995). Exploratory behaviours can be increased by intermittently changing where the food is located as well as introducing hidden items (Boere, 2001). Through these types of methods, one would hope to increase and stimulate curiosity (Poole, 1995). Another way of varying an individual's day-to-day life would be to provide mild stress stimuli. An example of providing a stimulus that induces behaviours seen in the wild would be to briefly expose individuals to a simulated predator (Chamove & Moodie, 1990, as cited in Boere, 2001). A group of cotton-top tamarins (*Saguinus oedipus*) were exposed to an over-flying bird model and their reactions were recorded. These reactions included social affiliative behaviours, such as increased grooming and contact throughout the rest of the day. These changes were in accordance with enrichment as opposed to long term stressors, showing brief increased arousal to be beneficial to captive animals (Chamove & Moodie, 1990). When considering potential changes to a captive individual's surroundings, those evaluating need to decide what kind of physical and mental health issues could be associated with these changes, and act accordingly (Novak & Suomi, 1988, as cited in Boere, 2001).

Social enrichment

Through being caged individually social animals can suffer from psychological stress (Dantzer, 1986) and develop abnormal behaviours such as stereotypical pacing (Carlstead *et al*, 1993 as cited in Kessel & Brent, 1995).This is particularly true of animals such as baboons (*Papio sp.)* which are highly sociable in nature (Dantzer, 1986). Reinhardt and Reinhardt (2000, as cited in Boere, 2001) considered that the presence of compatible individuals was of great significance for primates. This suggests the importance of enrichment that promotes socialising. Kessel and Brent (1995) observed nine baboons that were previously housed singularly for a period of 4-5 years. The individuals displayed significant levels of abnormal behaviour. They were re-housed to a social grouping environment with access to the outdoors. The aim of moving them was to decrease the levels of stereotypic behaviours. The outcome of transferring the individuals to a social situation was that all behaviours were significantly positively affected. When drawing conclusions from their study, Kessel and Brent (1995) made the assertion that, "an outdoor social environment may be the most enriching option that we can provide for captive baboons."

Social enrichment could, for instance, be an exhibit that has mixed species present; therefore the species are providing challenges to each other. Socialising brings with it

ISSN 1754-2383 [Online]

the ability to recognise emotional states in others, allowing individuals to react to them in better ways (Guerra *et al*, 1998, as cited in Boere, 2001). When introducing animals for the first time, the process has to be undertaken gradually, to prevent sudden changes in established groups. It must however be noted that the lack of aggressive behaviours towards a newly introduced individual does not indicate social acceptance (Kaplan *et al*, 1991). An example from Copenhagen Zoo involved connecting the Reindeer (*Rangifer tarandus*) and Common Seal (*Phoca vitulina*) enclosures. This allows contact between the species, and thus enrichment is achieved, but it also allows them to be separate if they so wish (Holst, 1995).

Physical Enrichment

"More than just physical space, environmental complexity or novelty, have been considered a basic element for enrichment" (Woolverton *et al*, 1989). An individual's surroundings should allow for exploratory behaviours and different devices can be used to allow species-specific behaviours to be exhibited. These can take the form of tree trunks, branches or ropes, which provide the stimuli for such behaviours (Snowdon & Savage, 1989, as cited in Boere, 2001) (as seen in Figure 1). A specific example would be providing soft wood for marmosets (*Callithrix* sp.) allowing them to use their specialised incisors for gauging (Boere, 2001).

Figure 1: An Orangutan and Gibbon utilising their shared enclosure at Zoo Leipzig, Germany. Environmental enrichment provided allows species-specific behaviours to be exhibited. (Fiby 2001)

As mentioned earlier animals may become habituated to the enrichment device. When the device is first installed, the reaction is often strong due to its novelty, but then the individual may lose interest. A study was conducted at Zurich Zoo focusing on the clouded leopard, *Neofelis nebulosa*, with the aim of enriching the environment with use of tight ropes. This type of enrichment is suitable for clouded leopards as it allows the individuals to express natural behaviours. The results of the study showed that the ropes encouraged a variety of behaviours, and that these behaviours were more variable than prior to the enrichment. Some years later a further study was conducted, where it was found that habituation to the ropes had not occurred, highlighting that the benefits from certain forms of enrichment are not lost over time (Hartmann & Schiess, 1995).

A behavioural study was conducted on 14 lowland gorillas (*Gorilla gorilla gorilla*) at Lincoln Park Zoo to investigate whether providing bedding had a significant effect on stereotypical and social behaviours. The conclusions drawn were that all bedding used in the study had a positive effect that was seen to be significant, on the

ISSN 1754-2383 [Online]

frequency of both social and stereotypical behaviours. In addition, bedding also positively affected feeding and foraging behaviours. The enrichment used in the gorillas' enclosure stimulated them to spend more time foraging and therefore exhibiting more species-specific behaviours (Brown & Gold, 1995).

Foraging and Food Handling as Environmental Enrichment

In the wild animals spend a great deal of their time foraging and feeding. Life in captivity, however, has removed this from the animals' behaviour repertoire by serving the food at certain times during the day (Holst, 1995). This has resulted in the animals becoming largely inactive (Maple & Perkins, 1996). Rodman (1979, as cited in Maple & Perkins, 1996) stated that the Bornean orangutan, *Pongo pygmaeus pygmaeus*, spends up to 45.9% of each day engaged in behaviours related to feeding, and 11.1% of each day travelling. Captivity largely removes these species-specific behaviours (Bloomsmith, 1989, as cited in Maple & Perkins, 1996). The diet that an animal is fed in captivity is such that it provides all the nutritional requirements to keep the individual healthy, but it often lacks the ability to instigate curiosity (Lindburg, 1998, as cited in O'Regan.H & Kitchener.C 2005). To increase interest levels, the way in which the animals are fed can be altered. For example, foods that are complicated to manipulate could be provided, for instance, coconuts. Another way would be to distribute food throughout the enclosure, as well as incorporating frequent feeds. This should hopefully alleviate boredom. (Bloomsmith, 1989, as cited in Maple & Perkins, 1996).

An example of food enrichment doubling as social enrichment is seen at Copenhagen Zoo. Here, the lions are fed a meal of half a cow at regular intervals. Giving them a significant large whole meal, rather than pieces of meat, allows them to exhibit species appropriate behaviours, such as would be seen in the wild. Providing large and intact food strengthens the social structure of the group. Having one meal to share ensures that all individuals respect the social hierarchy that will be present within the group. This hierarchy means the male will eat first, followed by the adult females and finally the cubs. Providing a large carcass forces them to show social behaviours that otherwise would not have been observed when fed traditionally, on one piece of meat per individual (Holst, 1995).

Reproduction as Environmental Enrichment

There are physiological, psychological and social stimuli that the animal must be responsive to in order to successfully reproduce in a captive environment. The stimuli need to be present in the surroundings and should be appropriate to encourage reproductive behaviours such as courtship, mating, pregnancy and rearing young. One aim of environmental enrichment is to try to create habitats that allows for the maximum behavioural response to be exhibited in accordance to the stimuli in question (Shepherdson & Carlstead, 1995).

Allowing individuals to have offspring at regular intervals gives them the opportunity to participate in behaviours such as rearing young, which would obviously occur in their natural environment. For some primate species the younger individuals learn what is involved in raising young from observing the older generations. This knowledge is invaluable and is vital for the future generations, especially if

ISSN 1754-2383 [Online]

reintroduction to the wild is a valid prospect (Holst, 1995).

The most critical contact occurs during infancy through the bond that exists between mother and infant (Boere, 2001). It is widely thought that young animals raised in the presence of their mothers go on to exhibit normal behavioural patterns (Mason, 1991, as cited in Boere, 2001). In many species, such as tamarins (*Saguinus* sp.), the whole group participates in parental care; therefore allowing breeding to occur in captivity can enrich the whole group (Boere, 2001).

Environmental Enrichment with the Outcome of Reintroduction

Reintroduction programmes are where individuals in captivity are placed in a suitable wild habitat (Primack, 2004). There have been a number of captive-release programmes that have failed due to the individuals being unable exhibit the appropriate behaviours, such as for foraging and recognising predators. Individuals have also been found to be unable to effectively utilise their habitat. (Wallace, 2000, as cited in O'Regan & Kitchener 2005). Cothran *et al* (1986, as cited in O'Regan & Kitchener, 2005) suggested that captivity unintentionally selects those individuals that are more manageable and those that are best suited to a captive environment. These traits may reduce the survival rate upon reintroduction.

Kleiman *et al* (1986 as cited in Price *et al*, 1989) explained how the first reintroduction of golden lion tamarins (*Leontopithecus rosalia*) was not successful as they did not have the appropriate species-specific behaviours and the necessary skills to survive. It was found that they were especially deficient in locomotion behaviours. On studying Siberian ferrets (*Mustela eversmannii*) Miller *et al* (1992) established that the individuals raised in a more enriched environment exhibited more anti predator behaviour than those raised in less enriched environments. Similarly, it has been found that black-footed ferrets (*Mustela nigripes*) that have been raised in more naturalistic outdoor environments had a higher rate of survival after release when compared to those raised in indoor cages (Biggins *et al*, 1998).

Physiological effects of environmental enrichment

There is suggestive evidence that indicates that the reduced activity levels of an animal in captivity can cause physiological, such as skeletal, changes (Kitchner, 2004, cited in O'Regan & Kitchener 2005). Duckler (1998) found that in some captive tigers (*Panthera tigris*), there was a marked effect on the shape and thickness on certain parts of the skull. From this, he came to the conclusion that the variations may have been due to stereotypical behaviours such as over grooming. Kitchener (2004, as cited in O'Regan & Kitchener, 2005) observed two Sumatran tigers, *Panthera tigris sumatrae,* where at feeding time a telegraph pole was used as enrichment to increase activity levels. It was found that there was a marked contrast between these tigers, and cats of a similar age that were less active, in that their skeletons were not affected by arthritis (O'Regan & Kitchener, 2005).

When compared to the wild, life in captivity can have effects on an individual's physiology. The nature of life in captivity is one that is more stationary and less stimulating. This can result in boredom, decreased attention and activity levels which can cause health issues. Environmental enrichment can help to alleviate boredom

ISSN 1754-2383 [Online]

and increase activity levels by introducing new stimuli (Boccia *et al*, 1992 as cited in Boere, 2001).

Where environmental enrichment can fail

Enrichment can fail when an animal displays obligatory behaviours which are not appropriate to the aim, and the intentional outcome of the enrichment device in question is not achieved (Young, 1995). Breland and Breland (1961, as cited in Young, 1995) give an example of one such situation where training enrichment was used for a raccoon, *Procyon lotor.* The racoon was trained to exchange a coin for food. However, the raccoon began to exhibit species-specific feeding behaviours towards the coin. The behaviour exhibited is abnormal rather than enriching (Young, 1995).

The environmental enrichment used and the time that it is given should be carefully considered, not only to make sure that it is encouraging species appropriate behaviour, but also that it is achieving the desired outcome of reducing stereotypic behaviour (Young 1995). An example that Kuczaj *et al* (1995) gives is that of a polar bear (*Thalarctos maritimus*). In this example, a stereotypical behaviour is displayed; pacing. Then, the bear ceases to pace and goes to play in its pool. If the enrichment is given at this point, and if this process is repeated often, then the bear will associate playing in the pool with the enrichment. If the enrichment is given to the bear whilst it is pacing, then the enrichment becomes a positive reinforcement for the stereotypical behaviour. This is therefore creating an undesirable association between the behaviour in question and the enrichment. The outcome of this may be an increase in the adverse behaviour. Therefore, the time at which enrichment is made available to the individual should be carefully considered (Kuczaj *et al*, 1995).

There is potential for some environmental enrichment techniques to have unexpected, sometimes harmful consequences (Bayne, 2005, Davis *et al*, 2005). The more frequent problems that have arisen due to enrichment are caused by the ingestion of foreign bodies, causing gastrointestinal obstructions. An example of enrichment resulting in a death is the case of a 2-year 7-month old male vervet monkey (*Chlorocebus aethiops*). An observation of this individual highlighted unusual activity, and consequently, an examination was performed, followed by a laparotomy. The colon was found to be significantly damaged; a phytobezoar (a mass of vegetable fibres found in the gastrointestinal tract, Teng *at al*, 2005) of straw about 5cm in diameter was removed. However, due to the extent of the damage, this individual was euthanised (Davis *et al*, 2005). Another example resulting in the death of a primate due to environmental enrichment occurred at the German Primate Centre. A baboon was showing signs of immense abdominal pain. After attempting some treatment, the baboon died. During a necropsy, a significant sized piece of wood was found within the right kidney and liver. On passing through the gastrointestinal tract, the foreign body had perforated part of the colon. The piece of wood in question was part of the environmental enrichment provided for the baboons (Floto *et al*, 2004).

Although environmental enrichment can have unexpected consequences, which can sometimes lead to the death of the individual, the problems do not always prove fatal. Another example of environmental enrichment causing gastrointestinal problems, but

ISSN 1754-2383 [Online]

not resulting in death, was a 9-year and 6-month old female rhesus macaque (*Macaca mulatto*). In May 2000, weight loss was observed. During inspection, a large phytobezoar of hay was found and removed from her stomach. In February 2004, weight loss was yet again observed, from 6.4kg down to 4.2kg. She was isolated for two weeks to monitor food intake. After no improvement, a gastroscope was used and hair like particles and blue plastic particles were observed. A small phytobezoar of hay containing 1mm plastic particles from an enrichment device was surgically removed. In this case the animal made a full recovery (Browning, Adams, 2004).

As earlier discussed, Carlstead (1996, as cited in Davis *et al*, 2005) explains that animals such as primates can become lethargic if their environment does not appropriately stimulate them. Providing species-specific enrichment allows for optimal well-being both physiologically and psychologically (Boere, 2001) such as by decreasing the frequency of stereotypic behaviour for example head twisting (Kuczaj *et al*, 1995). Careful consideration should be given before any form of enrichment is implemented to ensure that it is indeed encouraging species-specific behaviours (Young, 1995). The timing of implementing enrichment should also be considered to make sure that it does not become a positive reinforcement to the stereotypical behaviour (Kuczaj *et al*, 1995).

Institutions that hold animals in captivity, such as zoos, need to be made aware of the impact of providing environmental enrichment have on the individuals. Primates particularly benefit from having an enclosure that provides species appropriate enrichment. I mean to investigate and gather data highlighting the effect on behaviour of the Colombian Black Spider Monkey, *Ateles fusciceps robustus*, when enrichment is both implemented and not implemented. The investigation will use the following hypothesis;

Null Hypothesis (Ho): Introducing environmental enrichment does not have a significant effect on behaviour.

Alternative Hypothesis (Ha): Introducing environmental enrichment has a significant effect on behaviour.

ISSN 1754-2383 [Online]

References

Bayne.K 2005 Potential for Unintended Consequences of Environmental Enrichment for Laboratory Animals and Research Results *Institute for Laboratory Animal Research* **46** 129-139

Biggins.D, Godbey.J, Hanebury.L, Luce.B, Marinari.P, Matchett.M, Vargas.A 1998. The effect of Rearing Methods on Survival of Reintroduced Black-footed Ferrets. *Journal of Wildlife Management*. **62** (2) 643-653

Brown.D, Gold.K 1995 Effects of straw bedding on non-social and abnormal behaviour of captive Lowland Gorillas (*Gorilla gorilla gorilla*) Cited in *Proceedings of Zoo The Second International Conference Environmental Enrichment*. 24-38

Browning.M, Adams.R 2004 Gastric Foreign Body and Resulting Severe Weight Loss Associated with Environmental Enrichment Devices in a Rhesus Macaque *Contemporary topics: American Association for Laboratory Animal Science* **43** 68

Boere, V 2001 Environmental Enrichment for Neotropical Primates in Captivity *Ciência Rural* **31** (3) 543-551

Chamove.A, Moodie.E 1990 Brief threatening events beneficial for captive Tamarins? *Zoo Biology* **9** 275-286

Dantzer.R 1986 Behavioural, Physiological and functional aspects of stereotyped behaviour: a review and a re-interpretation. *Journal of Animal Science* **62** 1776-1786

Davis.N, Schaffner.C, Smith.T 2005 Evidence that zoo visitors influence HPA activity in spider monkeys (*Ateles geoffroyii rufiventris*) *Applied Animal Behaviour Science* **90** 131-141

Duckler.G 1998 An unusual osteological formation in the posterior skulls of captive tigers (*Panthera tigris*). *Zoo Biology* **17** 135-142

Fiby.M 2001Reconciling User Needs in Animal Exhibit Design [online] Available: http://www.zoolex.org/publication/worstell/gorilla/chap7.html [date accessed: 21.11.07]

Floto.A, Kaup.F, Mätz-Rensing.K 2004 Intraperitoneal foreign body disease in a baboon (*Papio hamadryas*) *Journal of Medical Primatology* **33**, 113-116.

Hartmann.M, Scheiss.M 1995 Ropes as climbing structures for Clouded Leopards (*Neofelis nebulosa Griffith*) Cited in *Proceedings of Zoo The Second International Conference Environmental Enrichment*. 62-71

Holst.B 1995 Introduction to the environmental enrichment program in Copenhagen Zoo Cited in *Proceedings of Zoo The Second International Conference Environmental Enrichment* 244-250

ISSN 1754-2383 [Online]

Kaplan.J, Adams.M, Clarkson.T, Manuck.S, Shively.C 1991. Social behaviour and gender in biomedical investigations using monkeys: studies in atherogenesis *Laboratory Animal Science* **41** (4) 334-343

Kessel.A Brent.L.1995 Behaviour effects of transferring singly housed Baboons to outdoor social groups. Cited in *Proceedings of Zoo The Second International Conference Environmental Enrichment* pg 142-148

Kuczaj.S, Lacinak.T, Turner.T 1995 When is Environmental Enrichment most Effective? Cited in *Proceedings of Zoo The Second International Conference Environmental Enrichment* Pg 309-313

Lawrence.E (ed) 2000 Henderson's Dictionary of Biological Terms, Pearson Education Ltd. Essex Pg 221, 263, 432

Maple.T, Perkins.L 1996 Wild Animals In Captivity; Principles and techniques.London:The University of Chicago Press. Chap 21 Pg 212

Markowitz.H 1995 Environmental Enrichment and the Conservation of Behaviour. Cited in *Proceedings of Zoo The Second International Conference Environmental Enrichment*. Pg: 17-23

Miller.B, Biggins.D, Hanebury.L, Conway.C 1992. Rehabilitation of a species: the black-footed ferret (*Mustela nigripes*) *Annual Proceedings of the National Wildlife Rehabilitation Association* **9** 183-192

O'Regan.H, Kitchener.C 2005 The effects of captivity on the morphology of captive, domesticated and feral mammals *Mammal Review* **35** 215-230
Poole.T 1995 Behavioural Problems in Captivity in General and their Management. Cited in *Proceedings of Zoo The Second International Conference Environmental Enrichment*. Pg: 118-130

Poulsen.E, Honeyman.V, Valentine.P Teskey.G, 1995. The successful treatment of a chronic stereotype in one polar bear (*Ursus maritimus*) using enrichment programming, enclosure redesign, and medical therapy. Cited in *Proceedings of Zoo The Second International Conference Environmental Enrichment* 209-217

Price.E, Feistner.A, Carroll.J, Young.J. 1989. Establishment of a free-ranging group of Cotton-top Tamarins, *Saguinus oedipus*, at the Jersey Wildlife Preservation Trust. *Dodo Journal, Jersey Wildlife Preservation Trust* **26** 60-69

Primack.R 2004 A Primer of Conservation Biology Third edition. Massachusetts: Sinauer Associates inc. 285

Shepherdson.D, Carlstead.K 1995 Understanding the relationship between Environment and Reproduction in Captive Animals: The Role of Environmental Enrichment. Cited in *Proceedings of Zoo The Second International Conference Environmental Enrichment* pg 218-230

ISSN 1754-2383 [Online]

Teng.H, Nawawi.O, Ng.K, Yik.Y 2005 Phytobezoar: an unusual cause of intestinal obstruction *Biomedical Imaging and Intervention Journal*. [online] **1** Available: www.biij.org/2005/1/e4/>

Woolverton.W, Ator.N, Beardsley.P, Carroll.M 1989 Effects of Environmental Conditions on the Psychological well-being of primates: a review of literature. *Life Sciences*, **44**, 901-917

Young.R 1995 Designing Environmental Enrichment Devices around Species-Specific Behaviour .Cited in *Proceedings of Zoo The Second International Conference Environmental Enrichment* Pg: 195-204

ISSN 1754-2383 [Online]