NOVIA
UNIVERSITY OF APPLIED SCIENCES

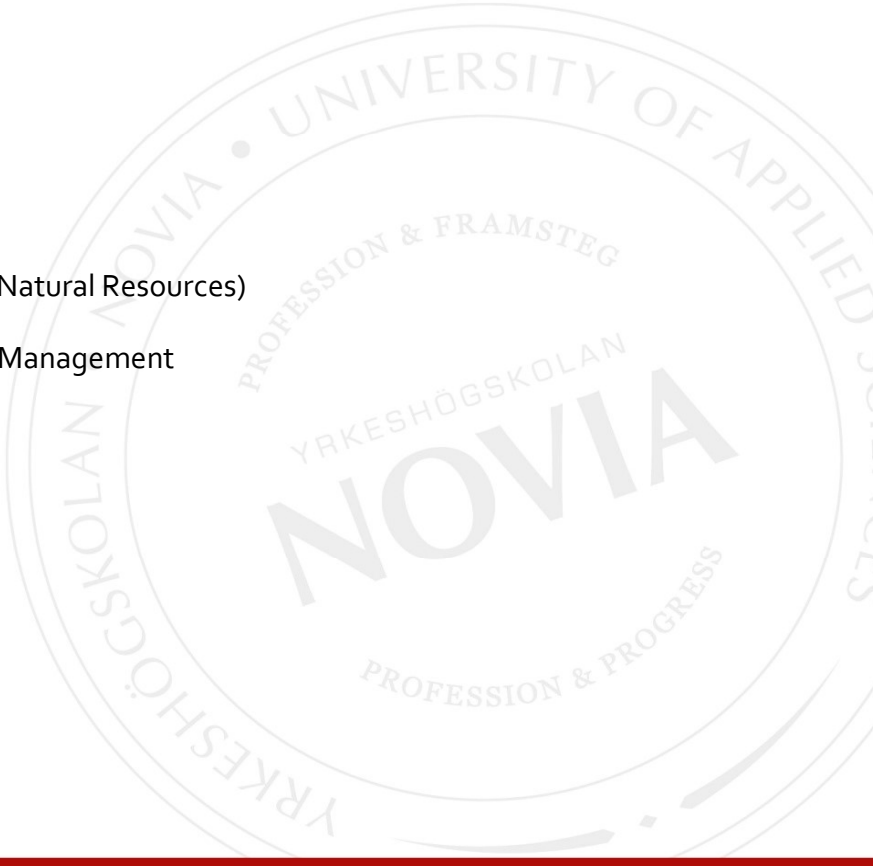
EVALUATION OF DEVELOPMENT AND PERFORMANCE OF ABNORMAL BEHAVIOR IN CAPTIVE PREMATES

Tateh Ngulefac Henry

Thesis for a bachelor's degree (Bachelor of Natural Resources)

Degree Programme in Sustainable Coastal Management

Raseborg, May 2019



BACHELOR'S THESIS

Author: Tateh Ngulefac Henry
Degree Programme: Sustainable coastal Management, Raseborg
Supervisors: Patrik Byholm and Stefan Heinänen

Title: Evaluation of Development and Performance of Abnormal Behavior in Captive Primates

---

Date: May 2019 Number of pages: 46 Appendices: 3

Abstract

This study was carried out to evaluate the development, performance and the effect of captive environmental features on the performance of abnormal behaviour. The study population was made up of 6 species of primates with 71 individuals made up of 49 males and 22 females. The convenience sampling method was used to select species while observation was by intervals (10am — 3pm) using instantaneous scans every 15 minutes. Three measures of behaviour were constructed (diversity, prevalence and frequency) for analyses. It was observed that all species presented a total of 27 behavioural abnormalities (such as floating limb, self-clasping, self-biting, stereotypic pacing, bang self against surface, clap, fumble nipple, groom stereotypically, self-hit, pat genital, pluck hair, pluck hair of other, poke anus, poke anus of other, poke eye, coprophagy, face rubbing, teeth exposure, genital display, masturbation, grin, structure-biting, structure shaking, Wall liking, spinning, drink urine, drink urine of other) with the most prevalent being genital display (54.9%) followed by poke anus (28.2%) and masturbation(28.2%), with 67% of total population performing an abnormal behaviour. Males are more vulnerable in captivity than female with our result showing 75.5% and 72.7% respectively as far as sexes are concern. The factors influencing the development and performance of abnormal behaviour were identified as group size and composition (100% for singly housed, male- female pairs and single sex, and 67.9% for groups), enclosure complexity and substrate (100% for barren but enriched enclosures with hard substrate and 79% for complex enclosure with soft substrate) and enclosure size (100% for enclosures 1,3,4,5,6,7,8,9,10,11; 62.5% and 58.3% for enclosures 2 and 12 respectively), although all these factors did not affect the frequency at which abnormal behaviours were performed. Our results support a conclusion that, more attention should be paid to the captive environment to encourage naturalistic behaviour in captive animals.

Language: English Key words: Abnormal Behaviour, Primates, Captivity, Enclosure environments

---

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

CITES- Convention on International trade of Endangered Species

GEF - Global Environment Facility

IUCN - World Conservation Society

MINEF - Ministry of the Environment and Forestry

MINFOF Ministry of forestry and wildlife

NGO - Non Governmental Organization

NHPs - Non Human Primates

MBZBG – Mvog-Betsi Zoo Botanical Garden

INTRODUCTION AND LITERATURE REVIEW

1.1 INTRODUCTION

1.1.1 Background to the study

Nature conservation is one of the world's most important aspects of environmental management nowadays. This care to conserve nature is bound to partial or total ecosystem degradation which poses a threat to human survival. Conservation will permit a sustainable use of existing resources. The creation of National Parks and wildlife sanctuaries is one of the most important strategies of conserving biodiversity and natural ecosystems. This concept of national parks took its concept in North America within the 19th century with the creation of the Yellow Stone Park (Ramade, 1981). The aim was to protect biodiversity. This goal has been relatively met since many countries over the world today, with Cameroon inclusive posses a park which constitute a primary site for biodiversity conservation.

Within the group of species found in national parks and wildlife sanctuaries, the primates are of great importance. They serve as natural forest gardeners by dispersing seeds and in structuring habitats. Conserving them will contribute to the protection of the integrity and diversity of African ecosystems.

Many primate species are now in danger of becoming extinct which would eventually affect natural tree species regeneration, forest composition and productivity. The primary cause is commercial hunting. Monkeys and apes are popular sources of "bush meat" in West Africa. Despite the fact that the sale of "bush meat" is outlawed and most primate species are protected by the law in most countries, they are still being hunted and their meat being sold illegally. In the quest of fighting against illegal transactions and promote their conservation, animals seized from poachers are kept in captivity in different zoological parks. In order to better care for these animals, it is important to know how various factor surrounding their environment in captivity affects them.

Captivity imposes on animals in the wild an environment that differs vastly from that in which they have evolved. To thrive in captivity, a species must accommodate these differences. The ability of a species to respond to captive conditions with behaviour from its normal repertoire

depends on the degree to which the particular captive condition resembles its natural environment (Caristead and Shepherdson, 1994).

NHPs, due to their level of intelligence when compared to other animals, and also due to their evolutionary closeness to man are maintained in several types of captive facilities like laboratories, zoological parks, animal circuses and conservation breeding centers. Being popular exhibits, most zoological parks maintain primates in their collections. In some cases, these primates are maintained in environments, which are un-stimulating, and sub-optimal (Erwin and Deni, 1979). Captive environments such as these, biologically and spatially restrict the animal from performing its species-specific behavior. Such an inability to adapt to their artificial surroundings results in the exhibition of behavioral patterns typical to captive animals and are called abnormal behaviours (Duncan et al., 2000).

Abnormal behaviour is defined as a behaviour that is rarely seen in wild populations and does not promote the success and the survival of the individual or its close relatives (i.e. it does not increase fitness). It appears not to be goal-oriented, so that its function is not apparent. Sometimes it may refer to some normal activities which are being carried out in an abnormal way (Poole, 1988). They vary with species, age and sex differences as well as temperament and prior experience.

Abnormal behaviour may be divided into qualitative abnormal behaviour, which is not or only rarely found in wild populations, and quantitative abnormal behavior, which includes elements of normal behaviour that are performed inappropriately in terms of context, sequence, frequency or duration (Erwin and Deni, 1979). It is well known that adverse early rearing conditions and restricted environments may be conducive to the development of abnormal behaviour in diverse animal species, including humans (Latham and Mason, 2008; Mason and Rushen, 2006).

Abnormal behaviours may indicate psychological suffering (Rollin, 2006), but this is seldom considered directly. Principles of evolutionary psychiatry suggest that some abnormal behaviours may be symptomatic of underlying mental illness, a neglected area of research in great apes (Brune et al., 2006). However, several factors may cause the development of abnormal behaviour in different primate species in captivity.

In this study, a total of 27 behavioural abnormalities were observed and studied such as floating limb, self-clasping, self-biting, stereotypic pacing, bang self against surface, clap, fumble nipple,

groom stereotypically, self-hit, pat genital, pluck hair, pluck hair of other, poke anus, poke anus of other, poke eye, coprophagy, face rubbing, teeth exposure, genital display, masturbation, grin, structure-biting, structure shaking, Wall liking, spinning, drink urine and drink urine of other, with the most prevalent being genital display, with more than half of the total population performing an abnormal behaviour. It equally shows that males are more vulnerable in captivity than female as far as gender is concern. The factors influencing the development and performance of abnormal behaviour were identified as group size and composition (singly housed, male- female pairs and single sex, and groups), enclosure complexity and substrate (barren but enriched enclosures with hard substrate and complex enclosure with soft substrate) and enclosure size. Even though all these factors did not affect the frequency at which abnormal behaviours were performed, we still need to pay attention to captive environment to encourage naturalistic behavior in captive animals.

1.1.2. Problem Statement

Applied behavioral studies are the most popular and easiest ways to identify problems in primate husbandry. However, captivity has been largely understudied regarding its effect on behaviour. With these limited studies on the effects of captive environments, if reintroduction is the ultimate goal therefore there is a reason to equally study and understand the how habitat affect the behavior of primates in captivity. It is important to determine whether different captive environments differentially affect the development of skills appropriate to living in the wild and if the habitat is dynamic enough to encourage flexibility of behaviour.

1.1.3. Objectives of the Study

The main objective of this study is to evaluate the development and performance of abnormal behaviour in captive primates so as to propose better management strategies.

Specifically, this study is aimed to:

- Identify, describe and determine the overall levels of abnormal behaviors exhibited by captive primates at the experimental sites;
- Determine the vulnerability of primates in the development of abnormal behaviour with respect to sex;

- Evaluate the effect of captive environmental features on the performance of abnormal behaviour.

1.2. LITERATURE REVIEW

1.2.1 Global Biodiversity

Biological diversity can be defined as the differences which exist among living organisms and the ecological complexes in which they occur with respect to their variety and variability. Diversity could therefore be simple defined as the difference in number of an item in relation to its frequency. Thus, the term biological diversity takes into account the different species, ecosystems, genes, and their relative abundance.

The number of species that exist on earth has long been contested, with the figure put somewhere between 5- 30 million species (May, 1992), even though recent findings suggest that there are about 8.7 million species on earth (Mora et al., 2011), even though out of these, we have some 86% of terrestrial and 91% of marine species which are still unclassified or unknown (ibid). The areas which hold the highest biological diversity are generally found in the tropics (23° 26' 1 6"N and 23° 26' 16" S), though other "biodiversity hotspots" are found extralimital to this area (Myers et al., 2000), such as the Cape Floristic Province and the Caucasus mountain region (Fig 1). Biodiversity hotspots are areas of high biological importance, which hold not only high concentrations of biodiversity, but also high numbers of endemics (Reid, 1998). Myers et al., (2000) identified 25 key hotspots, which held up to 44% of all vascular plant species, and 35% of all vertebrate species which are areas of high conservation value. The combined total for these areas covered only 1.4% of the earth's surface.

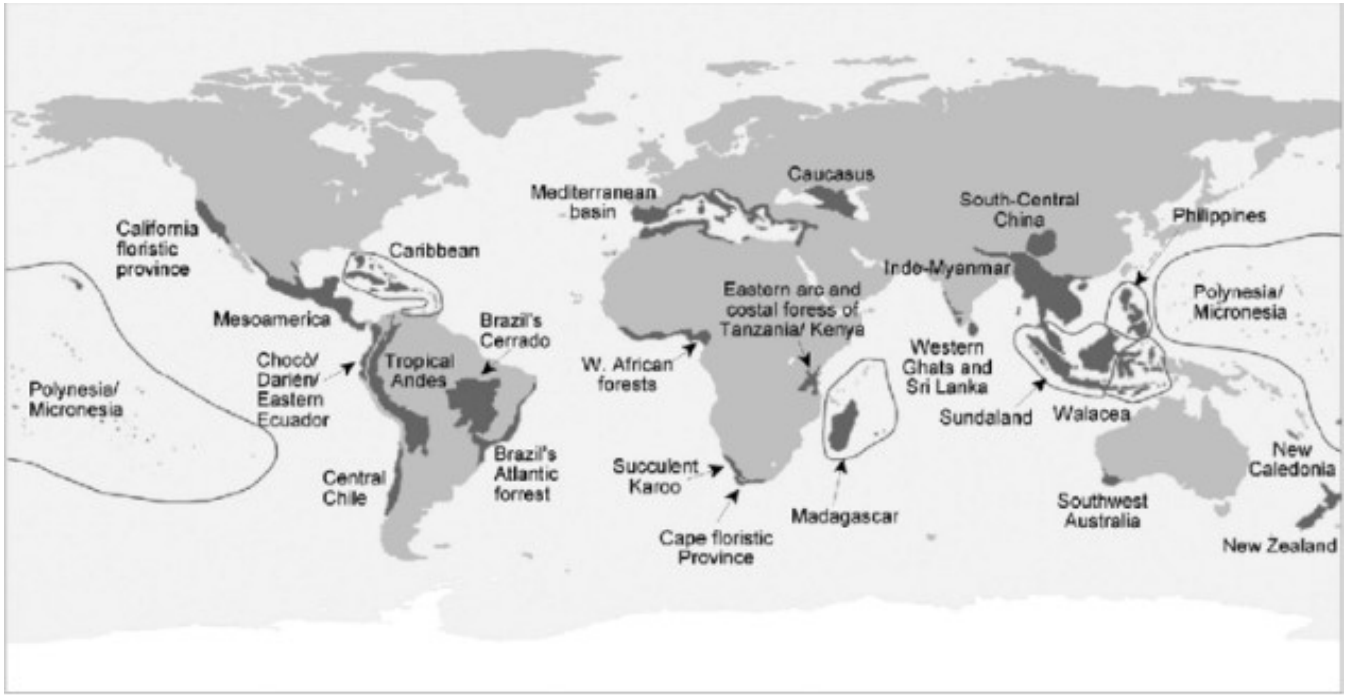


Fig. 1. Global Biodiversity hotspots (Myers et al., 2000)

1.2.2 Threats to Biodiversity

Biodiversity is under threat as a result of a multitude of factors, both anthropogenic and natural; Habitat loss, climate change, exploitation of natural resources and invasive species are all contributing to the decline of both species and habitats, though other factors are also influential (Table I). As many of the biodiversity hotspots occur in developing countries, there is often systematic degradation and overexploitation as a result of the development of the areas (Wood et al., 2000). The disparity of wealth and lack of basic living conditions in these areas results in local people having little choice but to utilize resources from the natural environment (Dietz and Adger, 2003), and as a result habitat is lost through conversion to agriculture and housing, and species are hunted for food.

Table I: Threats to global biodiversity

Threat	Reference
Habitat loss, conversion, degradation and fragmentation	St Laurent et al., 2009
Population growth	Dietz and Adger, 2003
Over exploitation of natural resources	Schindler and Lee, 2010
Invasive species	Burgiel and Muir, 2010
Climate change	Fischlin et al., 2007
Pollution	Wood et al., 2000
Disease	Lips et al., 2006
Lack of protection/weak law enforcement	Wood et al., 2000
Poverty	Gaveau et al., 2009
Background extinction	Brook et al., 2008
Stochastic events	Wood et al., 2000

1.2.3 Need for Conservation

Biodiversity is highly important to both humans and the planet as a whole since they provide us with services, provisions, functioning processes and hold intrinsic value (Norton, 1987). Habitats and biodiversity need to be handled with care due to their great importance for the services they provide such as food for humans where plants and animals turn into sustenance (Costanza et al., 1997). Ecosystems provide more subtle, but equally integral services to humans via ecosystem services (Fischlin et al., 2007), with services such as climate regulation, groundwater supply, pollination and natural resources. Ecosystem services are the processes and resources provided by natural systems, which have value to humans (de Groot et al., 2002).

Functioning of these processes is driven by environmental health (Rapport et al., 1998), with more resilient habitats providing more economic functions. Ecosystem services are considered to be worth in excess of $16 trillion dollars per annum (Costanza et al., 1997) though the services provided cannot be replaced at any monetary cost.

In-situ and ex-situ approaches for the conservation of biota are the most used techniques for conservation even though the genetic conservation of animals and vascular plant are increasingly being used (Gonzalez-Perez et al., 2009).

1.2.4. Conservation and Protection of Species (In-situ and Ex-situ)

The future will require us to adapt some conservation strategies in order not to leave some species go instinct. New conservation approaches are beginning to come to the fore, with the "ecosystem approach" the primary practice for conservation management (Anonymous, 2012). Early research suggested that the coincidence of rare species from different taxa in a given area would lead to a reductionist approach, with sites being managed specific species (Prendergast et al., 1993). According to Simberloff (1998), a good ecosystem will favour the species living within.

1.2.4.1 In-situ Conservation

In-situ conservation is the keeping and caring of the plants and animals in the environment that favours them such as their natural environment (Greenwood, 1996). Some species are very sensitive to disturbance and direct contact with humans beings (Bell and Merton, 2002) as such this method is best in managing their stress level since they are being maintained in their natural habitat (Anonymous, 1995). This practice is also beneficial as it allows species to remain in the environment to which they are accustomed, and when used over a long temporal scale, it allows the species to maintain its evolutionary traits and adapt naturally (Anonymous, 1995).

These areas provide a form of in-situ conservation, as they are protecting particular species within their natural range. Shaffer (1981) identified four major categories of natural risk associated with in-situ conservation as follows:

- demographic uncertainty, which refers to the result of random events associated with the species such as reproduction rate, number of availability and the rate of surviving;
- environmental uncertainty, here we refer to the unforeseen circumstances such as disease, food supply and predation.
- natural catastrophes which refers to the effect of stochastic events such as flooding/fire/droughts within the habitat;

- genetic uncertainty which refers to the result of genetic divergence which may lead to inbreeding.

In addition to these naturally and uncontrollable occurring risks, there are the anthropogenic influences, such as hunting and persecution, which are detrimental to in-situ approaches.

1.2.4.2 Ex-situ Conservation

Ex-situ conservation is the preservation of components of biological diversity outside their natural habitats (Engelmann and Engels, 2002). This is the conservation of genetic resources of wild and cultivated species. Some of these include:

- gene banks, such as sperm, seed and ova banks;
- in vitro plant tissue;
- artificial propagation of plants and animals with end goal of reintroduction it to the wild;
- collecting living organisms for zoos, aquaria, and botanic gardens for research and public awareness.

Ex-situ and in-situ conservation ensure the survival of particular species against extinction and do play a great role in the recovery programs of such species which are endangered.

1.2.5 Legal Framework for Biodiversity Conservation in Cameroon

About 90% of African ecosystems are found in Cameroon. They include the sahelian, sudanian, tropical rainforest, afromontane, coastal and marine ecoregions. Thus, the presence of a diversity of plants and wildlife that ranks Cameroon 5th in Africa after the Democratic Republic of Congo, South Africa, Madagascar and Tanzania. This wealth of biological diversity constitutes an enormous reservoir of genetic material.

The biodiversity (all living organisms in both terrestrial and aquatic ecosystems) managed in protected areas and on state land is threatened by poor knowledge of the resource potential, unsustainable exploitation by the local populations and economic operators, inadequate institutional arrangement by the administration and insufficient financial and material resources.

State institutions managed these resources in a conservatory manner until 1980, after which date, positive change started with the designation of the Benue and Waza National Parks and the Dja Wildlife Reserve as biosphere reserves. The creation in April 1992 of the Ministry of the Environment and Forestry (MINEF) by the Government was a great step forward. Also in 1992, the "Earth Summit" was held in Rio de Janeiro, of which one of the outputs was "Agenda 21". Within the framework of this action plan that aimed at reconciling sustainable use of natural resources with poverty alleviation, western nations promised to provide technical and financial assistance to countries endowed with a great wealth in biodiversity in order to conserve it. It is for this purpose that the Global Environment Facility (GEF) was created.

Thereafter, as concepts and orientations evolved, protected area management became less conservatory and bipartisan, but more participatory. This participatory approach required that the concerns of all stakeholders be taken into consideration (the Administration, funding partners, NGOs, local populations and economic operators). It is in a bid to further develop and test this new conservation approach, that the Government of Cameroon together with its partners designed the Cameroon Biodiversity Conservation and Management Programme.

Following the Rio de Janeiro Conference of 1992, the Government of Cameroon signed the Convention on Biological Diversity in 1993.

A new forestry law was promulgated in January 1994 to lay down forestry and wildlife regulations. This law is based on the principle that Cameroon's forest resources are unique and that they should be managed and exploited sustainably. Moreover, the new forestry policy explicitly recognizes the unique importance of biodiversity for Cameroon and for the world as a whole and thus gives a high priority to the conservation of this heritage.

The new forestry law acknowledges the existence of two forest categories: permanent forests and non-permanent forests. It also allows for the creation of communal forests and community forests & wildlife management areas, that belong to the first category (gazetted forests) and to the second category (non-gazetted forests), respectively.

According to this law, traditional hunting can be carried out in the national territory except in classified forests such as National Parks, Wildlife reserves, Wildlife sanctuaries, amongst others. Hunting tools permitted by the law include traditional tools such as cutlasses, sticks and spears.

Guns can only be used with a permit or license from the administration to own one. This law also prohibits some methods of hunting such as:

- night hunting using headlamps;
- use of fire;
- chemical poisoning for example using Gamalin;
- hunting with Dane guns;
- hunting and fishing with modern nets;
- use of explosives (small bombs);
- shooting from a vehicle;
- any hunting method that threatens the conservation of animals.

The law has also divided wild animals into three classes, namely; Class A, B and C.

Class A animals are animals that are totally protected by law and should never be killed. Some examples include: Gorillas, Chimpanzees, Drills, elephants, the giant pangolin, lions. The law allows only three conditions under which class A animals can be shot or killed:

- when a special authorization is given by the authority in charge of forest and wildlife;
- for self-defense when the animals attack an individual or community showing proof within 72 hours or 3 days of killing:
- when animals destroy livestock and crops in farms after complaining and given authorization by the MINFOF.

Class B animals are animals that are also protected, but we can hunt them only when we have a permit or a special authorization from the Minister of Forestry and Wildlife. Examples include: Pythons, Hippopotamus, Hyenas, eagles, crocodiles, Beecroft Flying Squirrel, some monkeys.

Class C animals are animals that are partially protected by law but can be hunted by local populations with a permit. They include all other animals except those of Class A and B. Examples are moles, cutting grass, porcupines, dwarf pangolin, small reptiles.

1.2.6 Description of Primate Species

1.2.6.1 Chimpanzee

Chimpanzees (*Pan troglodytes*) are found across the west-east belt in equatorial Africa. Their range spans 22 countries: Angola, Burkina Faso, Burundi, Cameroon, Central African Republic (CAR), Congo, Ivory Coast, Democratic Republic of Congo (DRC), Equatorial Guinea, Gabon, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Nigeria, Rwanda, Senegal, Sierra Leone, Sudan, Tanzania, and Uganda (Nishida et al., 2001). This represents a total area of about 2.5 million km2 though the majority (about 77%) of the total estimated population can be found in only two countries, Gabon and Congo (Cowlishaw and Dunbar, 2000).

Chimpanzee lives mostly in tropical rainforest, savannas and dry woodland even in montane forest (Poulsen and Clark, 2004). Locomotion patterns include quadrupedal knuckle walking and occasional bipedalism. They are both terrestrial and arboreal, with the amount of time spent on the ground varying between study sites and between sexes (Doran, 1996). All chimpanzees build sleeping nests in trees at night (Rowe, 1996).

The chimpanzee diet consists of mostly fruit, vegetables and insects but they also eat bird, eggs, honey and even the soil. They spend more of their time moving from one food area to another (Goodall, 1986). Chimpanzees have excellent retentive memory and equally us tools to obtain their food such as sticks, rocks, grass, and leaves are all commonly used materials that are modified into tools and used to acquire food and at times to defend themselves. Long thought to be free of natural predators because of their large body size, leopard (*Pantherapardus*) attacks can be a significant cause of mortality in chimpanzees (Boesch and Boesch-Achermann, 2000).

Chimpanzee lives in groups of up to a few hundred individuals thereby reducing their predators attack hence defense and feeding efficiency and higher copulatory success because of access to mates (Boesch, 1996). Males remain in their natal communities while females, in general, emigrate at adolescence, between nine and 14 years old (Nishida et al., 2003). For female chimpanzees that do emigrate, though, they are not likely to be related to other adult females in their new community, the dominance hierarchy is linked to age (Nishida, 1989).

Mating occurs throughout the year and there is no evidence of a birth season, female chimpanzees do exhibit seasonality in the number of estrous females within a group (Boesch and Boesch-Achermann, 2000; Wallis, 2002).

In chimpanzees, mother cares for their infants for four to five years and the majority of parental care is also the sole responsibility of the mother which is very important for the survival of the infant (Goodall, 1986). There is also some evidence that a young chimpanzee achieves rank according to his or her mother's status (Boesch and Boesch-Achermann, 2000).

Visual and vocal communications are important to chimpanzee society. A suite of facial expressions, postures, and sounds function as signals during interactions between individuals and groups. For example, a "full closed grin" is in response to an unexpected and frightening stimulus and evokes an instant fear response in others. Body position and stance also convey information to other individuals. Adult chimpanzees drum on the trunks of trees as a dramatic display and it can be heard in multiple contexts including while traveling, during displays, encounters with other chimpanzee communities, and when arriving at large food sources (Crockford and Boesch, 2005). One of the best ways to assess dominance rank is to listen for "pant-grunts," which are directed towards dominant individuals by submissive individuals to inform them about food discovery (Pusey et al., 1997).

With only 100,000 to 200,000 left in the wild, chimpanzees are among the most threatened primates in Africa (Goodall, 2001). They are on Appendix I of CITES and according to the IUCN Red List, they are endangered species. In Cameroon, they are classified as class A animals.

1.2.6.2 De Brazza's Monkey

De Brazza's monkeys (*Ceropithecus neglectu*) are found in Eastern to Central Africa in countries ranging from Cameroon, Ethiopia, Kenya to Angola. (Anonymous, 2003). They are found in forests, swamps, and seasonally flooded areas. They exist predominantly in the closed canopy, preferring dense vegetation, and are generally found within 1 km of rivers in humid forests. (Anonymous, 2005).De Brazza's monkeys are arboreal, territorial, and terrestrial. They take shelter in trees and freeze when alarmed. They are diurnal hand gatherers, foraging in the early

morning and evening. Unlike some monkeys, they move around on all four feet. They are excellent swimmers.

These monkeys are omnivorous, but primarily eat fruit. Other items in their diet include leaves, flowers, mushrooms, beetles, termites, and worms. While foraging, the monkeys store food in their cheek pouches and then eat it later when they are in a safer area. Like other small forest monkeys, it is likely that De Brazza's monkeys fall prey to chimpanzees, leopards, humans, various avian predators, and snakes. (Anonymous, 2003; Anonymous, 2005).

De Brazza's are social animals and often live in small groups of 4-10 individuals, though sometimes up to 35 individuals. Groups generally consist of one dominant male and many females. A female monkey will often live in her mother's group for life; however, young males leave the group as soon as they are sexually mature. Young males spend much of their time practicing being dominant by strutting around with arched tails and slamming branches, apparently imitating their father. While not always successful, the dominance of the resident male is sometimes challenged by another male monkey. Unlike some other species of guenons, Debrazza's monkeys are rarely found associating with other monkeys. However, in captivity, they associate more freely.

They communicate through three main ways which are visual, vocal, and tactile. Visual communication often occurs between males, especially in conflict situations. Some types of visual communication are staring or yawning to show teeth. Vocal communication can include low frequency boom calls made by males to indicate territory or isolation calls made by youth when they become separated from the group. Tactile communication is important during mating as well as between mothers and offspring.

Males typically compete to control access to a group of females (Nowak, 1999) and breeding is mostly polygamous. However, this species is reported to sometimes be found in pairs with young, indicating that there may be some monogamy (Anonymous, 2005). De Brazza's monkeys reach sexual maturity at 5 to 6 years of age. The breeding interval is long, but the gestation period is 5 to 6 months. Single births are normal, although twins are produced on rare occasions. The breeding season is usually from February to March and/or otherwise, breeding occurs when food is available.

Because females nurse their young for a year, it is utility that females are able to produce more than one young per year, even under good conditions. Young begin to eat solid food around the age of 2 months. (Anonymous, 2003; Anonymous, 2005)

The longevity of *C. neglectus* shows that there can live in captivity within 22 to 24 years (MBZBG 2019). Lifespan in the wild are likely to be somewhat shorter. It is reasonable to assume that De Brazza's monkeys are like the other members of their genus in regard to lifespan. (Nowak, 1999).

The greatest threat to De Brazza's monkeys is from pet trade, habitat destruction from deforestation, range fragmentation from increasing human populations, and cultivation. However, they are not considered threatened or endangered. These monkeys can be found protected on the Dja Reserve in Cameroon. Classified as Least Concern by the IUCN Red List, on Appendix II of CITES and in class C by the Cameroon wildlife law.

1.2.6.3 Drill and Mandrill

The ranges of Mandrills (*Mandrillus sphinx*) and Drills (*Mandrillus.leucophaeus*) are incompletely known, but span the region between southern Congo and eastern Nigeria, separated by the Sanaga River in Cameroon, with *M. leucophaeus* North of this barrier and M. sphinx south of it (Harrison, 1988). The largest protected population is found in the Korup National Park in the northern part of Cameroon

Mandrillus sp inhabits mainly tropical rain forests (including semi-deciduous lowland rainforest, closed-canopy lowland moist forest, and other primary and secondary rainforests often with very dense vegetation) and forest-savannah mosaic forests (never moving far into pure savannah), but also Marantaceae and rocky forest, as well as gallery forest within savannah areas, riparian forests, agricultural areas and even inundated forests and stream beds (Astaras et al., 2008).

Locomotion patterns include quadrupedal walking through the forest floor. *M. leucophaeiis* and M. sphinx have similar omnivorous diets (Astaras et al., 2008), predominantly fruits, but also leaves, lianas, bark, stems, fibers, animal foods, mushrooms, soils and other foods (Rogers et al., 1996). Leopards (*Pantherapardus*) are known predators of *M. sphinx* and crowned eagles (*Stephanoaetus coronatus*) and various snakes probably also pray on the species (Henschel et al., 2005).

The mandrillus has a unimale social system, with the leader male receiving most of the copulations. Rogers et al. (1996) found that in Lope Reserve, Gabon, the social system was multimale-multifemale. Hoshino et al. (1984) found that multi-male groups are found during the minor fruiting season and one-male groups are found during the major fruiting season. During the major fruiting season the fruiting trees are patchily distributed in the forest and it might be easier for mandrills to move in smaller groups. In multi-male groups, there tends to be one or a few more dominant males, with a hierarchy existing amongst the males (Wickings et al., 1993). Solitary males also occur in this species and groups are made up of adult males, sub-adult males, adult females, and juveniles, with immature members comprising more than 50% of the group population (Hoshino et al., 1984). Males disperse from their natal group (Harrison, 1988). There are not territorial species since they easily accommodate other groups and during the day they are seen closed to each other. It has been suggested that, "the integration of a group of mandrills may be maintained by the members of a group focusing attention on adult males". Adult males initiate movement of the group (Hoshino et al., 1984).

Much of the communication among mandrillus is visual, with displays of brightly colored posteriors and markings bordering their nasal passages. They are noisy creatures, regularly emitting grunts and screams, but the purpose of these sounds is not yet known. In addition to these forms of communication, it is likely that tactile communication is important, both between mothers and their offspring, and between mates. Most primates spend significant amounts of time grooming their allys, and grooming can be used to maintain social bonding. Both drills and mandrills possess scent glands on the chest which are used for marking branches. This scent marking is a form of chemical communication.

These species give birth to a single offspring. During estrus the perineum of the female swells up. Mothers provide the bulk of the care and protection for their offspring. Maternal kin, brothers and sisters, may also help in carrying, grooming, and playing with young.

Destruction of the mature forest in Cameroon is the primary factor in the decline of mandrillus species over the last twenty years. They are also hunted extensively for their meat, which is considered sweet. Unfortunately, since they form huge aggregations, hunters easily slaughter up to twenty individuals in one expedition. It is essential that hunting and logging restrictions be placed in the areas where the drill lives or the species will surely not survive. The Drill is classified

as Endangered and the Mandrill as vulnerable by the IUCN Red list, in Appendix I and in class A by the Cameroon forestry law.

1.2.6.4 Gray checked Mangabey

Grey-cheeked mangabeys (*Lophocebus albigena*) are primarily found in central Africa, from the Cross River, Nigeria, through to the Nile, North of the Congo River and the Lualaba River, Democratic Republic of the Congo. Its range encompasses South-East Nigeria, Cameroon, Congo, Gabon, mainland Equatorial Guinea, South-Western Central African Republic, Democratic Republic of Congo, Burundi, Uganda, western Kenya, and extreme North-Western Tanzania. Although primarily a lowland species, it can be found up to 1,600 m in strictly equatorial zones.

This species is found in both primary and secondary forest. It is arboreal, spending most of the time in the upper canopy (Shah, 2003). Its diet consists mainly of fruit and seeds; preferred plant species include false nutmeg (*Pycnanthus*), breadfruit (*Treculia*), dwarf dates (*Phoenix*), Erythrophleum fruit and seeds, and oil palm (*Elaeis*) (Poulson et al., 2001).

Mangabeys live in social troops usually led by a single dominant male, though some larger groups may have multiple dominant males that disperse into smaller groups for foraging. Troops range in size, but average around 15 individuals. Females tend to remain with their natal groups, while males typically leave upon maturity to join another troop. Troops have home ranges between 1.2 and 2.4 square miles (2-4 km2) that greatly overlap both with other mangabeys, as well as other primate species.

Mating in this species occurs all year round. Females exhibit tumescence on the fleshy, pink pads (*ischial callosities*) below their tails when they are receptive for mating. Generally, one offspring is born after a gestation period of six months.

The greatest threats to their survival include being hunted for bushmeat and habitat loss, primarily to agricultural development. They are listed in the African Convention on the Conservation of Nature and Natural Resources, as well as CITES appendix II classified as Least Concern by the IUCN with a down trending population and in class B by the Cameroon law.

1.2.6.5 Olive Baboons

Olive or Anubis baboon (*Papio anubis*) is widespread throughout equatorial Africa and are found in 25 countries. From the west coast of Africa moving eastward, olive baboons are found in Guinea, Mali, Mauritania, Sierra Leone, Côte d'Ivoire, Burkina Faso, Ghana, Togo, Benin, Nigeria, Niger, Chad, Central African Republic, Cameroon, Sudan, Ethiopia, Eritrea, and Somalia. The range of olive baboons extends southward into Uganda, Kenya, Tanzania, Rwanda, Burundi, Democratic Republic of Congo, and Congo (Groves, 2001).

Anubis baboons are found in savannah, grassland steppe, and rainforest habitats (Anonymous, 2000). They are omnivores and consume a huge variety of items including roots, tubers, corms, fruits, leaves, flowers, buds, seeds, bark, exudates, cacti, grasses, insects, birds, bird eggs, and vertebrates (including other primates) up to the size of a small antelope (Shefferly, 2004). Leopards and chimpanzees have been known to kill these animals. Anubis baboons have been reported to mob leopards, often with adult males leading the attack, in the Gombe reserve in Tanzania, an estimated one percent of the population fall victim to predators annually. Of these, about 3/4 are infants, and 1/4 are juveniles. (Nowak, 1999). Locomotion patterns include quadrupedal walking and are mainly terrestrial primates

Olive baboons are highly social animals, with a complex multi-male, multi-female social structure living in groups or "troops" as they are often called, ranging in size from 15 to 150 individuals (Ray and Sapolsky, 1992). The movements of a troop may be limited by the availability of appropriate sleeping locations (Nowak, 1999). All males emigrate from their natal troops, with 85 per cent of males emigrating prior to the time that they reach full adult size. An interesting phenomenon in *P. anubis* is the secondary transfer of aged adult males from their troops. Because the ability of a male to compete for mates is related to youth and vigour, or to long-term social relationships with females, transfer to a new troop in old age can only reduce a male's opportunities to mate (Sapolsky, 1996). Because males do not maintain life-long social ties with their kin, it is female kinship that forms the core and dominance hierarchy immediately below her mother and her younger sister. Anubis baboons utilize visual signals and gestures, vocalizations, and tactile communication. (Anonymous, 2000).

Reproduction in *P. anubis* is related to the social structure of this species. Anubis baboons live in multi-male, multi-female troops. Mating is polygynandrous, with both males and females mating with multiple partners. Most mating occur during consortships. Most parental behavior is performed by the female. Females nurse, groom, and play with their offspring.

Anubis baboons are not considered threatened or endangered. The IUCN Red list rates them as Least Concern Like most primates, they are included in Appendix II of the CITES, so international trade in the animals or their parts requires government approval. In Cameroon, put in class B of the forestry law.

MATERIALS AND METHODS

2.1. Experimental site

The study was carried out in two ex-situ conservation sites. The MvogBetsi Zoo Botanic Garden situated in the centre region of Cameroon in the Mfoudi Division, Yaounde IV subdivision and the Mefou proposed national park situated at Metet, a locality in the Mefou and Afamba division, Cameroon.

2.2 Materials

The following materials were used in the accomplishment of this project:

- appropriate and comfortable cloths; file and a form for data collection;
- writing implements, i.e., pencil or pen;
- watch with a second hand and/or a stop watch;
- digital camera for taking pictures of samples of interest;
- measuring tape for measuring enclosure sizes.

2.3 Method

2.3.1 Study Population

A total of 71 primate individuals were studied, made up of 49 males and 22 females. This sample population was made up of 6 species of primates living in captive environments were studied. The primates were housed in diverse group sizes and compositions in different enclosures types, which varied in their degree of complexity (Table 2).

The various species used in this study included:

- Chimpanzee (*Pan troglodytes*);
- De Brazza'smonkey (*Cercopithecus neglectus*);
- Drill (*Mandrillus leucophaeus*);
- Gray-cheeked Mangabey (*Lophocebus albigena*);
- Mandrill (*Mandrillus sphinx*);
- Olive baboon (*Papio anubis*).

2.3.2 Sampling Methods

To carry out this study, the convenience sampling method was used in which the primates to be observed were selected on the basis of their availability, proximity, and/or the ease by which they might be studied (Black, 1999). Sampling was also done by intervals, that is from 10a.m. to 3p.m, using instantaneous scans in which the observer recorded simultaneously the current activities of a subgroup of individuals after every 15 minutes (Altmann, 1974).

2.3.3 Data Collection

2.3.3.1 Primary data

Abnormal behaviours were those behaviours that are rarely seen in wild populations and do not promote the success and the survival of the individual or its close relatives. It appears not to be goal-oriented, so that its function is not apparent. Added to these are some normal activities which are not carried out in the appropriate way (Poole, 1988). For example, the following abnormal behaviours were observed in a study of behavioural abnormalities in captive non human primates (Mallapur and Choudhury, 2003):

- floating limb defined as the unusual movement pattern of a limb;
- self-clasping defined as the use of hands or feet to hold onto part of the body by oneself
- self-biting in which hands, legs, arms and/or torso bitten in a stereotyped fashion by oneself;
- stereotypic pacing referring to the repetitive pacing along the same path.

Data was collected by direct observation in which the observer was positioned at a distance of about 4m from the subjects to be observed in order not to influence their behaviour with his presence. Behaviour was sampled using instantaneous scans every 15 minutes during the sampling period (Altmann, 1974; Martin and Bateson, 1986). Any abnormalities occurring at the sampling point was recorded and described on prepared data sheets and an ethogram of abnormal hehavoiurs was established for each species.

11.3.3.2 Secondary Data

Published materials on behaviour in primates were used to assist in the identification and definition of abnormal behaviour, and in the production of an ethogram of abnormal behaviours in the various primate species.

11.3.4 Statistical Analysis

From the data collected, three measures of abnormal behaviour was constructed (Birkett and

Newton-Fisher, 2011) as follows:

- prevalence which is the proportion of individuals in a group who show a type of behavior;
- diversity which refers to the number of types of behavior observed in the various groups;

– frequency which is the number of bouts of behavior during the sampling period, and duration (amount of time spent performing a behaviour).

Table II: Factor categories used to compare behavioural data of NHPs (Mallapur, 2005):

Group size and composition	– Singly housed – Male- female pairs – Single sex Groups
Enclosure complexity and substrate	– Barren but enriched enclosures with hard substrate: enclosures with four walls, hard floor such as cement or concrete and the roof that have been structurally enriched. – Complex enclosure with soft substrate: enclosures that possess several natural features such as trees, bushes, water body, etc. that resemble the animal's natural habitat with soft substrate such as grass
Enclosure size	- 11 enclosures with different sizes
Sex	– Males – Females

These measures of behaviour were analyzed with respect to factor categories used in data analyses (Table 2). Since the behavioural data was not normally distributed, nonparametric statistical tests were used. The Kruskal Wallis (H) test was used to analyse the differences with group sizes and compositions, and the enclosure sizes while the Mann-Whitney U-Wilcoxon Rank Sum U test was used to test the differences among the sexes and the enclosure complexity and substrate. It was also used to test the differences within the group sizes and composition. Spearman's correlation test was used to examine the relationship between the diversity of behaviour and the sexes. All tests were two-tailed, and following convention, p value was set at 0.05. Data were analyzed using SPSS Statistics 16 statistics software.

RESULTS AND DISCUSSION

3.1. Identification and description of abnormal behaviors

In this study, a total of 27 abnormal behaviors were observed (Table 3). After studying all the individuals in the study population (71 individuals), it was observed that 67% of them showed some behavioral abnormalities with the most prevalent abnormal behaviour being genital display (54.9%) (Fig 2).

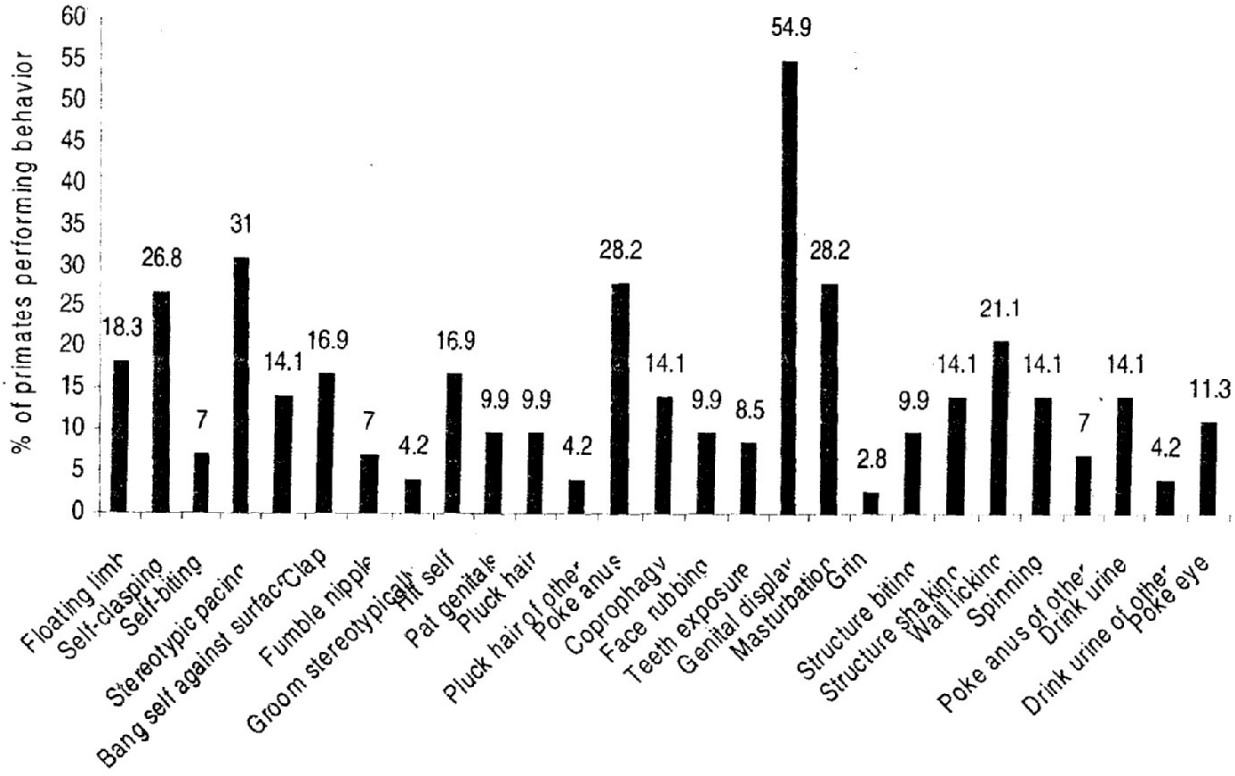


Fig. 2: Percentage of primates displaying each of the indicated abnormal behaviors.

Table 3: Abnormal behaviours observed in this study.

Abnormal Behavioral Patterns	Description of Abnormal Behavior (Source of Definition)
Floating limb	Entire limb (not just fingers or toes) appears to move independently, as if it does not belong to individual. (1, 3)

Self-clasping	Body is embraced while sitting, with apathic or fearful facial expression. 6
Self-biting	bite own body-part. (1)
Stereotypic pacing	locomote, usually quadrupedally, on substrate, covering and then re-covering route in stylized fashion, with no clear objective. (2)
Bang self against surface	hit own body-part against solid surface.(l)
Clap	slap palm of hand or sole of foot, making noise.(l)
Fumble nipple	Manipulate own nipple(s) with thumb or fingers. May suck on nipple if breast or nipple is extended. (4, 5)
Groom stereotypically	Repetitively groom self on specific body part, seemingly without goal. (5)
Hit self	hit own body-part with hand. (1)
Pat genitals	repetitively touch own genitals, then often lick hand. (1)
Pluck hair	pull out own hair. (I)
Pluck hair of other	pull out another's hair. (1)
Poke anus	insert finger into own anus. (5)
Poke anus of other	Insert finger into another's anus. (7)
Poke eye	poke one or more fingers into own eye. (1)
Coprophagy	ingest own faeces, both matrix and undigested items. (I)
Face rubbing	Individual rubs any part of its face (usually chin or cheeks) to any part of the enclosure. (6)
Teeth exposure	Lips are moved to expose teeth partially or totally. (6)
Genital display	The male's penis is erect and highly visible. Several exposure positions are recorded. Females were not seen exposing an erect clitoris. (6)
Masturbation	Rubbing of genitals either with one's own hands (male) or on the floor or other surface (female). (6)
Grin	Mouth arching with closed lips. (6)
Structure-biting	Biting of any part of the enclosure, such as bars, chains, locks, perches and others. (6)
Structure-shaking	Shaking of any enclosure structure, by securing it with hands and using body as propulsion.(6)
Wall licking	Licking of the enclosure walls. (7)
Spinning	Swirl performed with either the scapular or pelvic waists, with feet fixed on the ground. (6)
Drink urine	Drink own urine. (1)
Drink urine of other	Drink another's urine. (1)

Sources: 1. Walsh et al. (1982); 2. Bloomsmith and Lambert (1995); 3. Bradshaw et al. (2008); 4. Nishida et al. (2010); 5. Birkett et al. (2011); 6. Fragaszy et al. (2004); 7. This study.

3.2. Vulnerability of sexes to the development and performance of behaviour expressed in diversity, prevalence and frequency.

The observed population was made up of 49 males and 22 females. All 27 abnormal behaviors were observed among males with 75.5% presenting abnormalities meanwhile 'Pat genital, genital display and masturbation' were absent in the female population with 72.7% showing abnormalities. It was observed that the number of abnormal behaviours exhibited differed significantly between males (27 behaviours) and females (25 behaviours). Using Mann-Whitney U-Wilcoxon Rank Sum U test (U= 373, p= 0.03) (Fig 3).The number of different abnormal behaviours (diversity) displayed by individuals was highly variable and ranged from 0 - 8 behaviours for males and from 0 - 5 behaviours for females (Table 4), and was highly correlated to the number of individuals in the groups (rho =0.25; n r=71, p= 0.03).

In contrast, no significant difference was recorded in the levels of abnormal behavior exhibited by male and female primates whether measured by prevalence (U294; n= 27, 24; p= 0.57) or frequency (U= 227; n= 27, 21; p= 0.23) (Fig 3). However, the most prevalent and frequent behavior in males was 'genital display' while in females, the most prevalent abnormal behavior was recorded as 'poke anus' and the most frequent being 'wall licking' (Fig 7;Table 5).

Table 4: Effect of factor categories on the diversity of abnormal behaviours

Categories	N	Mean	Median	Range
Male	49	3.56	4	0 - 8
Female	22	2.19	3	0 - 5
Single house	3	6	6	4 - 8
Male-Female pair	8	4.38	4	2 – 7
Single sex	4	4.5	4.5	4 – 5
Groups	56	2.57	3	0 - 8
BES	9	5.78	6	3 – 8
CES	62	2.73	3	0 - 8

BEH= Baren enriched enclosure with hard substrate, CES= Complex enclosure with soft substrate

Table 5: Effect of sex on prevalence and frequency of each abnormal behavior.

Behavioral patterns	Prevalence		Frequency	
	Male(49)	Female(22)	Male(140hrs)	Female(80hrs)
Floating limb	0.22	0.09	0.19	0.03
Self-clasping	0.31	0.18	0.35	0.1
Self-biting	0.08	0.05	0.03	0.01
Stereotypic pacing	0.33	0.27	0.36	0.48
Bang self against surface	0.14	0.14	0.04	0.05
Clap	0.02	0.05	0.01	-
Fumble nipple	0.02	0.18	0.04	0.04
Groom stereotypically	0.04	0.05	0.01	0.01
Hit self	0.16	0.18	0.08	0.01
Pat genitals	0.14	-	0.05	0.08
Pluck hair	0.06	0.18	0.04	0.03
Pluck hair of other	0.04	0.05	0.01	0.01
Poke anus	0.16	0.55	0.12	0.24
Coprophagy	0.12	0.18	0.04	0.05
Face rubbing	0.1	0.09	0.06	-
Teeth exposure	0.1	0.05	0.05	-
Genital display	0.8	-	0.84	-
Masturbation	0.41	-	0.31	-
Grin	0.02	0.05	0.01	0.01
Structure biting	0.1	0.09	0.06	0.04
Structure shaking	0.16	0.09	0.05	0.04
Wall licking	0.14	0.36	0.28	0.61
Spinning	0.14	0.14	0.06	0.03
Poke anus of other	0.08	0.05	0.03	0.01
Drink urine	0.12	0.18	0.04	0.05
Drink urine of other	0.02	0.09	0.02	-
Poke eye	0.08	0.18	0.04	0.04

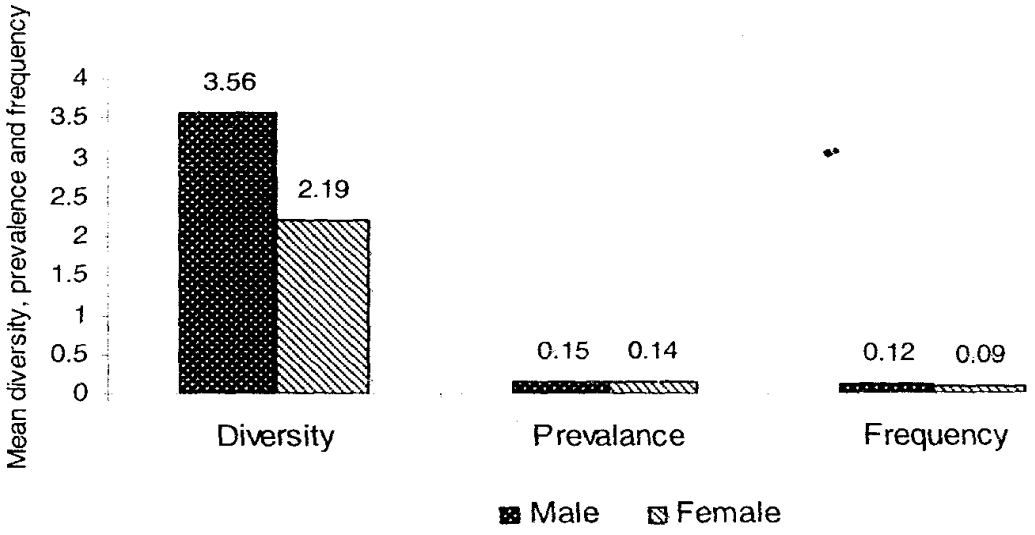


Fig. 3: Effect of sex on mean diversity, prevalence and frequency of abnormal behavior

3.3. Effect of group size and composition on the diversity, prevalence and frequency of abnormal behaviours exhibited by captive primates.

The influence of group size and composition on the proportions of abnormal behaviors exhibited by captive primates was evaluated. The primates were divided into four different groups; Singly-housed (3 individuals), male-female pair (8 individuals), single sex (4 individuals) and Groups (56 individuals). The proportion of individuals with abnormalities was higher in the singly-housed, male-female pair and the single sex groups (100%), while only 67.9% of individuals housed in groups showed abnormalities. The number of different abnormal behaviours per individual (diversity) varied significantly across the four groups (using Kruskal Wallis H Test) ($H= 10.97$; $p= 0.01$), with the highest-scoring group being the singly housed primates (Fig 4), scoring a median diversity of 6 with each individual performing at least 4 different abnormal behaviours, and the lowest-scoring group being grouped primates with a median diversity of 3 where individuals were observed without abnormalities (Table 4). Similarly, the prevalence of abnormal behaviour differed significantly across groups ($H= 29.9$; $p< 0.0001$) with the singly housed scoring highest (Fig 4; Table 6).

Comparing prevalence of behaviours within groups, it was noticed that the only group within which no significant difference was recorded was between primates housed singly and single sex

(U= 27; p= 0.37). On the other hand, there was no significant difference observed in the frequency of behaviours across groups (U= 27.0; p= 0.36).

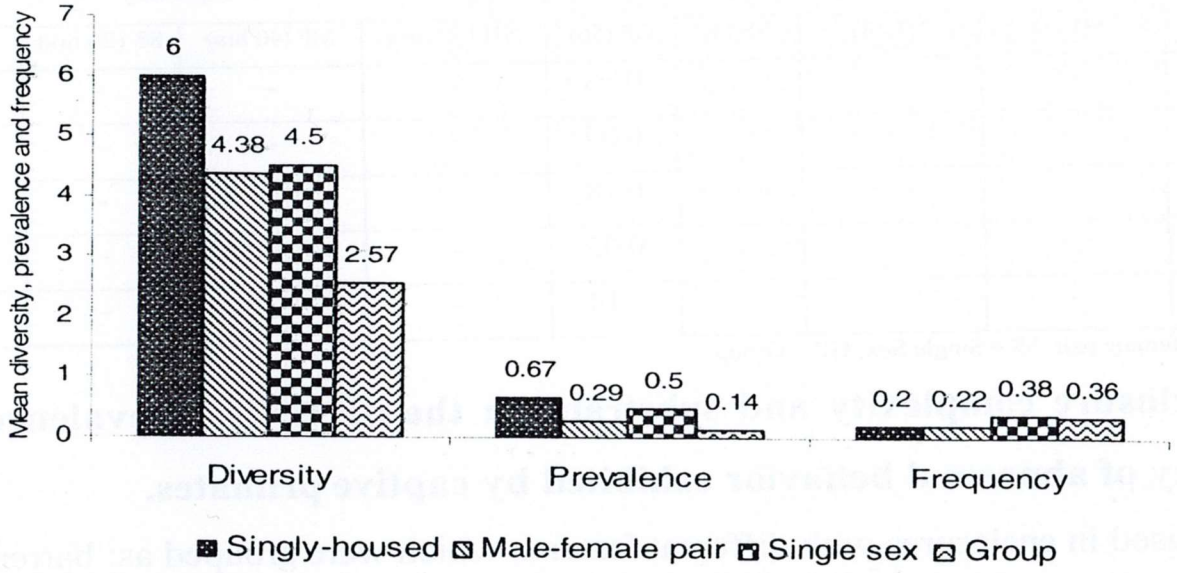


Fig. 4: Effect of group size and composition on mean diversity, prevalence and frequency of abnormal behavior.

Table 6: Effect of group size and composition on prevalence and frequency of each abnormal behavior.

Behavoiral patterns	Prevalence				Frequency			
	SH(3)	Mf (8)	SS (4)	GP (56)	SH (30hrs)	MF (40hrs)	SS (20hrs)	GP (40hrs)
Floating limb	0.33	0.25	0.75	0.13	0.07	0.05	0.4	0.4
Self clasping	0.67	0.75	0.5	0.16	0.13	0.43	0.35	0.73
Self biting	-	0.13	-	0.07	-	0.03	-	0.1
Stereotypic spacing	1	0.63	1	.0.17	0.73	1	0.2	0.55
Bang self against suface	-	-	0.25	0.16	-	-	-	0.23
Clap	-	-	-	0.04	-	-	-	0.05
Fumble nipple	-	0.13	-	0.07	-	0.03	-	0.18

Groom stereotypically	0.33	0.25	-	-	0.03	0.05	-	-
Hit self	-	-	-	0.27	-	-	-	0.3
Pat genital	0.33	0.13	-	0.09	0.1	0.1	-	0.15
Pluck hair	-	0.25	-	0.09	-	0.08	-	0.13
Pluck hair of other	-	-	-	0.05	-	-	-	0.08
Poke anus	-	0.25	0.25	0.3	-	0.23	0.05	0.65
Coprophagy	-	--	-	0.18	-	-	-	0.25
Face rubbing	-	0.25	-	0.09	-	0.1	-	0.13
Teeth exposure	0.67	-	0.5	0/04	0.07	-	0.15	0.05
Genital display	1	0.25	1	0.54	0.43	0.33	1.6	1.48
Masturbation	1	-	0.25	0.29	0.17	-	0.1	0.9
Grin	-	0.13	-	0.02	-	0.03	-	0.03
Structure biting	-	0.5	-	0.05	-	0.18	-	0.1
Structure shaking	-	0.5	-	0.18	-	-	-	0.25
Spinning	-	-	-	0.18	-	-	-	0.25
Poke anus of other	-	-	-	0.09	-	-	-	0.13
Drink urine	-	-	-	0.18	-	-	-	0.25
Drink urine of other	-	-	-	0.05	-	-	-	0.08
Poke eye	-	-	-	0.14	-	-	-	0.2

SH= Singly housed, MF= Male-female pair, SS= Single Sex, GP= Group

3.4. Effect of abnormal behavior exhibited by captive primates.of enclosure complexity and substrate on the diversity, prevalence and frequency

The primates were housed in enclosures with different features which were grouped as: barren enriched enclosures with hard substrate (9 individuals) and complex enclosures with soft substrate (62 individuals). From the results obtained, it indicates that individuals housed in barren enriched enclosures with hard substrate exhibited higher levels (100%) of abnormal behavior than those housed in complex enclosures with soft substrate (79%) expressed in diversity, prevalence and frequency (Fig 5), though no significant difference was recorded in the frequency of abnormal behaviours ($U= 178.5$; $p= 0.77$) However, a significant difference was observed in the diversity ($U= 93.5$; $p= 0.001$) and the prevalence ($U= 69$; $p= 0.000$) with the most prevalent behaviors

'genital display and self-clasping' for those housed in barren enriched enclosure, and 'genital display' for those housed in complex enclosures. (Table 7)

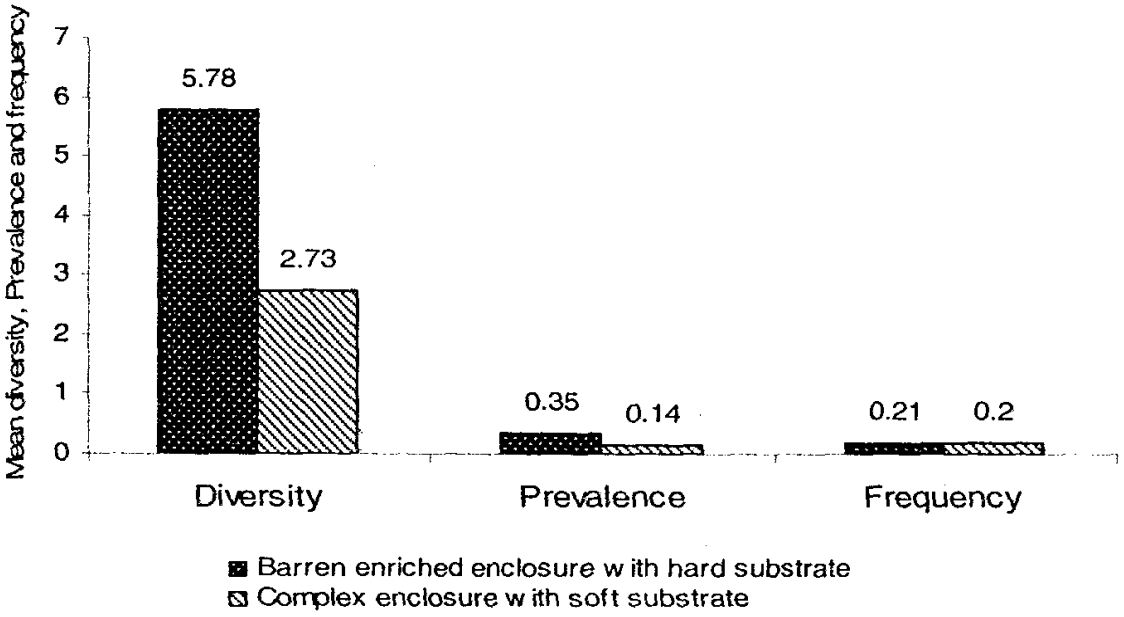


Fig. 5: Effect of enclosure complexity and substrate on mean diversity, prevalence and frequency of abnormal behavior

Table 7: Effect of enclosure complexity and substrate on prevalence and frequency of each abnormal behaviour

Behavoiral patterns	Prevalence		Frequency	
	BEH (9)	CES (62)	BEH (60hrs)	CES (80hrs)
Floating limb	0.33	0.16	0.15	0.24
Self-clasping	0.75	0.19	0.32	0.48
Self-biting	0.11	0.06	0.02	0.05
Stereotypic pacing	0.67	0.26	0.88	0.44
Bang self against surface	-	0.16	-	0.14
Clap	-	0.03	-	0.03
Fumble nipple	0.11	0.06	-	0.1

Groom stereotypically	0.22	0.02	0.03	0.01
Hit self	-	0.19	-	0.15
Pat genitals	0.22	0.08	0.12	0.08
Pluck hair	0.22	0,08	0.05	0.06
Pluck hair of other	-	0.05	-	0.04
Poke anus	0.22	0.29	0.17	0.33
Coprophagy	-	0.16	-	0.13
Face rubbing	0.11	0.1	0.05	0.08
Teeth exposure	0.33	0.05	0.05	0.05
Genital display	0.78	0.52	0.08	0.86
Masturbation	0.33	0.27	0.12	0.45
Grin	-	0.03	-	0.03
Structure biting	0.22	0.08	0.09	0.09
Structure shaking	0.22	0.13	-	0.13
Wall licking	0.67	0.15	0.07	0.99
Spinning	-	0.16	-	0.13
Poke anus of other	-	0.08	-	0.06
Drink urine	-	0.16	-	0.13
Drink urine of other	-	0.05	-	0.04
Poke eye	-	0.13	-	0.1

3.5. Effect of enclosure size on the diversity, prevalence and frequency of abnormal behavior exhibited by captive primates.

The enclosures in which the primates were housed were of different sizes (Table 8). It was expected that the smaller area offered by the enc1osurs would increase overall levels of abnormal behaviour. But this was not the case as the highest number of abnormal behaviours (diversity) were recorded in E4, the enclosures with the most prevalent behaviours being E3,E4 and E5 while the enclosure that recorded the most frequent behaviour was E8 (Fig 6). However, a significant difference was seen across enclosure sizes ($H= 48.24$, $p< 0.0001$).

Table 8: Enclosure sizes of 11 different enclosures indicating the number of individuals per enclosure.

Enclosures	N	Area /m2	% of individuals with abnormalities
E1	2	13.5	100
E2	2	13.8	62.5
E3	1	13.9	100
E4	1	15.2	100
E5	1	23.2	100
E6	2	136.5	100
E7	2	171.5	100
E8	5	476.4	100
E9	2	523.9	100
E10	8	755.3	100
E11	12	761.6	58.3

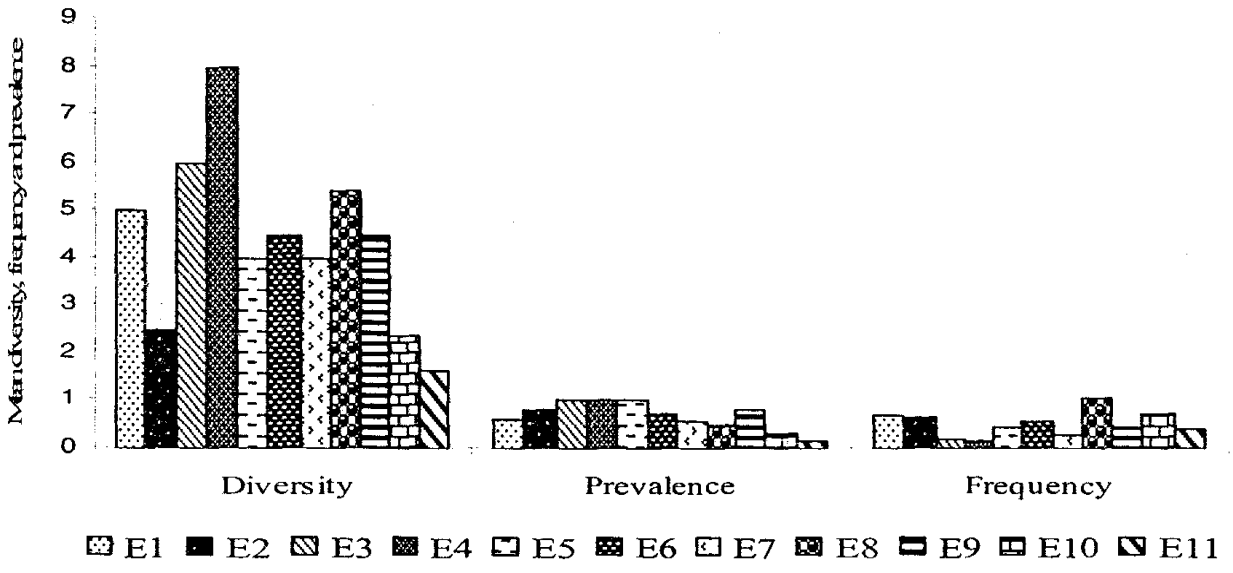


Fig. 6: Effect of enclosure complexity and substrate on mean diversity, prevalence and frequency of abnormal behavior.

3. 6. Discussion

Across the primate study population, a total of 27 behavioural abnormalities were identified and defined of which more than half (65%) of the individuals behaved abnormally. A high incidence of abnormal behaviour such as this in the captive NHP population, suggests that the husbandry and management protocols followed should be carefully scrutinized and probably revised. Animal behaviour studies such as these provide information on an individual's needs, preferences and internal states (Siegal and Castellan, 1988). Changes in the natural pattern of behaviour to an out-of-context exhibition of behaviour such as the abnormal behaviours listed above provide cues that the individual in question is under stress. Captive environments impose on wild animals a setting that differs vastly from that in which they have evolved. To thrive in captivity, a species must accommodate these differences. A species ability to respond to captive conditions with behaviour from its normal behavioural repertoire depends on the degree to which the particular captive condition resembles its natural environment (Mench and Mason, 2000). In order to reduce the levels of stress in a captive population of NHPs, scientists conduct applied behavioural studies to identify the environmental factors that influence the behaviour of these individuals (Mallapur and Choudhury, 2003; Caristead, 1998). Several factors influence the behaviour, reproduction and health of NHPs in captivity. Some such factors identified were group composition and size, enclosure complexity and substrate, sex and Enclosure size.

Results obtained from our study showed that abnormal behaviour and the proportion to which they were exhibited was higher in males. In males, the number of different abnormal behaviours ranged from 0 — 8 while in females, it ranged from 0 — 5, with an overall mean diversity value of 3.56 and 2.19 for males and females respectively. Also the mean prevalence of overall abnormal behaviours was recorded as 0.15 and 0.14, and the mean frequency as 0.12 and 0.09 for males and females respectively, with no significant difference. We can deduce from these results that, captivity affects the development of abnormal behaviours in males than females. Our result fit in with report of Mallapur and Choudhury (2003) who obtained similar results in which the diversity of abnormal and undesirable behavior of males deprived of early nonspecific contact who were then housed with normal females and the proportion to which they were exhibited was higher than in females. Also, a study (Mitchell, 1979) on early social restriction in captive rhesus monkeys showed that males exhibited higher levels of undesirable behavior than did females.

Housing primates singly, in pairs or in single sex groups was found to be inappropriate in this study, where singly-housed, male—female pairs and single sex grouped individuals exhibited significantly higher levels of abnormal behaviour than did group-housed individuals. These results are similar to those obtained by Mallapur (2005) who showed that macaques housed singly or in pairs exhibited significantly higher levels of abnormal behaviour than did group housed macaques and mother—offspring pairs. Several other studies have also suggested that housing NHPs in pairs or in isolation or even in species-inappropriate groupings gives rise to abnormalities in their behavioural repertoire (Mootnick and Baker, 1994; Coe, 1991).

NHPs are also sensitive to the enclosures in which they are housed and enclosure features such as enclosure complexity and enclosure substrate tend to influence their behavioural repertoire (Reinhardt, 1997). From our results obtained, it was observed that individuals housed in barren enriched enclosures with hard substrates exhibited higher levels of abnormal behaviour compared to individuals housed in complex enclosures with soft substrates with a mean diversity of 5.78 and 2.73, a mean prevalence of 0.35 and 0.14, and a mean frequency of 0.21 and 0.2 respectively. Similar results demonstrating that individuals housed in barren enclosures with hard substrates exhibits higher levels of abnormal behaviour than those housed in complex enclosures with soft substrates has been publish earlier by Mailapur (2005). Most outdoor enclosures are naturalistic with trees and shrubs, and usually have a soft substrate of grass, sand or soil. Enclosures such as these provide the appropriate environmental stimuli, which in turn promote the exhibition of exploratory, foraging, and other natural behaviour patterns. On the contrary, barren enclosures usually have concrete floors, with no greenery. The lack of sensory input from these enclosures hinders the development of a natural behavioural repertoire. In the absence of environmental stimuli from their relatively stark environments, NHPs housed in cages and barren enclosures tend to develop behavioural abnormalities (Mallapur and Choudhury, 2003; Mason, 1991).

Evaluating the effect of enclosure size on the proportions of abnormal behaviour exhibited showed that although there was a significant difference in abnormal behaviour exhibited across the various enclosures, levels of behaviour were not relative to the sizes of the enclosures. It was expected that the smaller area offered by the enclosures would increase overall levels of abnormal behaviour. But this was not the case as the highest number of abnormal behaviours (diversity) was recorded in E4, the enclosures with the most prevalent behaviours being E3, E4 and E5 while the enclosure

that recorded the most frequent behaviour was E8. However, it seems that quality of the environment is what matters, not only available space (Box, 2007). A similar effect was observed by Aluaneet at. (2013) who worked on captive Capuchin Monkeys and observed that even though there was less space for animals to move in cages of phase 1 of his research, they were placed in open environments containing vegetation and natural elements, where they had visual contact with all animals and interaction with the surrounding nature and as a result had lower levels of abnormal behaviour.

Also recorded was the fact that, the frequency of abnormal behaviours was not significantly affected by all the factor categories used. This results correlates with that of Birkett and Newton-Fisher (2011) who worked on 'How Abnormal Is the Behaviour of Captive, Zoo-Living Chimpanzees' and reported that there was no effect of sex on the occurrence of abnormal behaviour measured by frequency. However, this observation is contrary to that recorded by Mallapur (2005) in which the group size and composition, and the enclosure complexity and substrate significantly affected the overall frequencies of abnormal behaviours.

In the wild, primate communities have a fluid social structure in which individuals are free to choose associates, mates, and ranging area (although all of these are subject to competitive effects). Their daily activities vary accordingly, and they range widely over varied landscapes and habitat types (Goodall, 1986; Boesch and Boesch-Achermaim, 2000; Reynolds, 2005) In comparison, captive-living primates have little opportunity to adjust association patterns, occupy restricted and barren spaces compared to the natural habitat, and have large parts of their lives substantially managed by humans (Hosey and Skyner, 2007). Providing captive primates with more naturalistic enclosures, unpredictable feeding schedules and extractive foraging opportunities, as well as the opportunity to interact with nonspecific through housing in social groups, all appear to decrease the performance of abnormal behaviours (Lukas et al., 2005). Even the best captive environments are limited, however, in what they can provide (Clarke et al., 1982).

CONCLUSION AND RECOMMENDATION

4.1. Conclusion

From this study whose main objective was to evaluate the development and performance of abnormal behaviour in captive primates, the following conclusions can be made.

A total of 27 behavioural abnormalities were identified with more than half (65%) of the individuals behaving abnormally probably from stress and sub-optimal environments in captivity. A high incidence of abnormal behaviour such as this in the captive NHP population, suggests that the husbandry and management protocols followed should be carefully scrutinized and probably revised.

The overall levels of abnormal behaviour was higher in males than in females, implying that, males are more vulnerable to develop abnormal behaviour in captivity than females and therefore should be provided with a more naturalistic environment.

Captive environmental features such as the enclosure size, enclosure complexity and substrate, and the group size and composition greatly influence the exhibition of abnormal behaviour in captivity. Results show that primates housed in groups, in larger enclosures with complex environments and soft substrate demonstrated relatively low levels of abnormal behaviour. This suggests that more attention should be paid to the captive environment to encourage naturalistic behavior in captive animals, which is also tied to psychological wellbeing (Novak et al., 1 994).It would be imperative to take these factors into consideration while building new exhibits or forming new groups of any given primate species.

4.2. Perspectives

The following findings will go a long way to ameliorate this work;

- A long-term evaluation of abnormal behaviour of captive primates, studied for each species and with an increased population size, taking into consideration the amount of time spent in performing abnormal behaviour.
- Research on preventative or remedial actions to abnormal behavioural performances, whether intervention is best aimed at the environment and/or the individual, and how to best monitor recovery of primates performing abnormal behaviour.
- Understanding how the primate mind copes with captivity, an issue with both scientific and welfare implications that will impact potential discussions concerning whether such species should be kept in captivity at all.

REFERENCES

Altmann, J. 1974. Observational study of behaviour: Sampling methods. Behaviour, 49:

227—267.

Aluane S. F., Rafaela N. A. and Roman A. M. (2013). Management strategies and Animal welfare of Captive Capuchin Monkeys Genus cebusErxleben 1777 (primates:

Cebidae) WoridApplied Sciences Journal 21(1): 42-48, ISSN 18 18-4952. Anonymous, 1995.Conservation of Biodiversity and the new Regional planning.

Edited by Richard, E., Saunier and Richard, A., and Meganck.ISBN 0-8270-3592-6.Astaras, C., Muhlenberg, M., Waltert, M. 2008. Note on drill (Mandrillusleucophaeus)

ecology and conservation status in Korup National Park, southwest Cameroon. Am J Frimatol 70(3):306-10.

Bell, B. D. and Merton, D. V. 2002.Critically endangered bird populations and their Management. In: Norris, K. and Pain, D.J. (Eds). Conserving bird biodiversity. Cambridge University Press, UK

Birkett, L.P. and Newton-Fisher, N.E. 2011. PLoS ONE 6(6): e20 101. doi: 10.137 1/journal.pone.0020 101.

Black, T. R. 1999. Thousand Oaks, CA: SAGE Publications, Inc. (p. 118) Neuroscience & Biobehavioral Reviews, 30: 1246—1259.

Bloomsmith, M.A. and Lambeth, S.P. 1995. Applied Animal Behaviour Science 44: 65—74

Boesch, C. 1996. Social grouping in TaI chimpanzees. In: McGrew, W. C., Marchant, L. F. and Nishida, T.(Eds). Great ape societies. Cambridge, England: Cambridge UnivPr, pp. 101-13.

Boesch, C. and Boesch, H. 1993. In: Berthelet, A. and Chavaillon, J. (Eds). The use of tools by human and non-human primates. Oxford, England: Oxford UnivPr, pp. 158-87.

Boesch, C. and Boesch-Achermami, H. 2000. The chimpanzees of the TaI Forest: behavioral ecology and evolution. Oxford, England: Oxford Univ Pr. 316 p. Box, H. 0. 2007. Bem-estar animal. In: Eds M.E. Yamamoto and G.L. Volpato,

ComportamentoAnimal.Editora da UFRN, Natal, Brazil, pp: 270-283 Bradshaw, G.A., Capaldo, T., Lindner, L. and Grow, G. 2008. Journal of Trauma and Dissociation 9: 9—34.

Brooks, T. M., Mittermeier, R. A., da Fonseca, G. F., Mittermeier, C.G., Pilgrim, J.D. and Rodrigues, A.S.L. 2008.Global biodiversity conservation priorities. Science, 313: 58-61.

Burgiel, S.W. and Muir, A.A. 2010. How invasive species adapt due to changes in climatic condition. Accessed via http://moodle. writtle.ac.uk/file.php/729/Burgiel_Muir2O I 0.pdf date accessed 1/1 1/11.

Caristead, K. 1998. Determining the causes of stereotypic behaviour in zoo carnivores: Towards developing appropriate enrichment. In Environmental Enrichment for Captive Animals (eds Shepherdson, D. J., Mellen, J. and Hutchins, M.), Smithsonian. Institute Press, Washington DC, 1998, pp. 285—297

Chapman, P.M. 1992. Journal of Aquatic Ecosystem Stress and Recovery, 1: 69-79.

Chapman, C. A., White, F. J. and Wrangham, R. W. 1993.Defining subgroup size in fission fusion societies. Folia Prim 61: 31-34.

Clarke, A. S., Juno, C. J. and Maple T. L. 1982. Behavioral effect due to environmental changes. Zoo Biology, 1: 37 1—380

Coe, C. L. 1991. Issues of Psychological Well-Being in Captive Nonhuman Primates (eds Novak, M. A. and Petto, A. I.), American Psychological Association, Washington, 1991, pp. 78—92.

Costanza, K, d'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, and Van Der Belt, M. 1997. The value of the world's ecosystem services and natural capital. Nature, 387: 253-260.

Cowlishaw, G. and Dunbar, R. 2000. Primate conservation biology. Chicago: Univ Chicago Pr. 498 p.

Crockford , C. and Boesch, C. 2005. Call combinations in wild chimpanzees. Behaviour 142(4): 397-421.

De Groot, R.S. Wilson, M.A. and Boumans, R.M.J. 2002.A typology for the classification, description and valuation of ecosystem function, good and services. Ecological Economics 41, 393-408.

Dietz, S. and Adger, W.N. 2003.Economic growth, biodiversity loss and conservation effort.Journal of Environmental Management, 68: 23-3 5.

Doran, D.M. 1996.Comparative positional behavior of the African apes. In: McGrew W.C., Marchant, L.F., Nishida, T., (Eds). Great ape societies. Cambridge (England): Cambridge Unive Pr. p 2 13-24.

Duncan, I. J. H. and Fraser, D. 2000.Understanding animal welfare. In Animal Welfare (eds Appleby, M. C. and Hughes, B. 0.), CAB International, Oxon, pp. 19—32.

Erwin, J. and Deni, R. 1979. In Captivity and Behavior: Primates in Breeding Colonies, Laboratories and Zoos (eds Maple, T. L., Erwin, J. and Mitchell, G.), Van Nostrand Reinhold, New York, pp. 1—28.

Turley, C., Rounsevell, M.D.A. Dube, O.P. Tarazona, J. and Velichko, A.A. 2007. Ecosystems, their properties, goods, and services. Climate Change 2007: Impacts, Adaptation and Vulnerability. Canziani, 0.F. Palutikof, J.P. Van der Linden, P.J. and Hanson, C.E. (Eds). Cambridge University Press, Cambridge, pp. 2 11-272.

Fragaszy, D.M., E. Visalberghi and L. Fedigan, 2004.The complete capuchin-the biology of the genus Cebus.Cambridge University Press. Cambridge, UK. 339pp.

Gaveau, D.L.A. Linkie, M. Suyadi, (no forename). Levang, P. Leader-Williams, N. 2009. Biological Conservation 142, 597-605.

Gonzalez-Perez, M.A. Sosa, P.A. and Batista, F.J. 2009.Genetic variation and conservation of the endangered endemic Anagyrislatifolia from the Canary Islands. Plant System Evolution 279, 59-68.

Goodall, J. 1986. The chimpanzees of Gombe. Cambridge (MS): Belknap Pr. 673 p. Goodall, J. 2001. Problems faced by wild and captive chimpanzees: finding solutions. In:

Beck B.B., Stoinski T.S., Hutchins M., Maple T.L., Norton B, Rowan A, Stevens

E.F., Arluke A, (Eds). Great apes & humans: the ethics of coexistence. Washington

DC: Smithsonian InstPr; p xii-xxiv.

Greenwood, A. G. 1996. Veterinary support for in situ avian conservation programs. Bird Conservation International, 6: 285-292.

Groves, C. 2001. Primate taxonomy. Washington DC : Smithsonian Inst Pr. 350 p.

1-larrison, M.J.S., 1988.The mandrill in Gabon's rain forest-ecology, distribution and status. Oryx 22(4):218-28.

Hoshino, J., Mori, A., Kudo H. and Kawai M. 1984. Grouping of mandrills (Mandrillus sphinx) in Cameroon. Primates 25(3):295-307.

Linder, J.M. and Oates, J.F. 2011.Differentif impact of bushmeat hunting on monkey species and implications for primate conservation in Korup National Park, Cameroon. Biological Conservation 144: 738-745.

Lips, K.R. Brem, F. l3renes, R. Reeve, J.D. Alford, R.A. Voyles, J. Carey, C. Livo, L. Pessier, A.P. and Collins, J.P. 2006. Loss of Biodiversity and a rise in contaminating desease. PNAS 103, 3165-3 170.

Mailapur, A. 2005.Managing Primates in Zoos: Lessons from Animal Behavoiur.Current Science.Vol. 89.No. 7.

Mallapur, A. and Choudhury, B. C. (2003).Behavioral abnormalities in captive nonhuman primates. Journal ofAppliedAnimal Welfare Science,6(4): 275 — 284.

Martin, P. and Bateson, P. 1986. Measuring behaviour. Cambridge, England: Cambridge University Press.

Mason, G. and Rushen, J. 2006. Stereotypic Animal Behaviour, 2nd ed.; CAB International:

Wallingford, UK, pp. 1015—1037

Mason, G. J. 1991. Stereotypies: A critical review. Anim. Behav., 41: 1015—1037.

May, R.M. 1992. How many species inhabit the earth? Scientjfic American 10: 18-24.

Mench, J. A. and Mason, G. J. 2000.Behaviour in Animal Welfare (ed Appleby, M. C. And Hughes, B. 0., CAB International, Oxon, pp. 127—142

Mitchell, G. 1979. Behavioral sex differences in nonhuman primates. New York: Van Nostrand Reinhold.

Mooney, H., Larigauderie, A., Cesario, M., Elmquist,T., Guldberg, O.H., Lavorel, S., Mace, G.M. Palmer, M. Scholes, R. and Yahara, T. 2009. Biodiversity, climate change and ecosystem services. Current opinion in Environmental Sustainability 1: 46-54.

Mootnick, A. R. and Baker, E. 1987.Masturbation in captive Hylobates (gibbons). Zoo Biol., 13: 345—353.,

Mora, C., Tittensor, D.P., Adi, S., Simpson, A.G.B. and Worm, B. 2011. Total species on earth. PLoS Biology 9: 1-8

Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B. and Kent, J. 2000. Biodiversity hotspots for conservation priorities. Nature 403: 853-858.

Matsumoto, Oda, A. 2003. Demography, female life history and reproductive profiles among the chimpanzees of Mahale.Am J Prim 59(3): 99-12 1.

Norton, B.G. 1987. Why preserve natural variety? Princeton University Press, USA.

Nowak, R. 1999. Walker's Mammals of the World, Sixth Edition.

Poole, T.B. 1988. Normal and abnormal behaviour in captive primates.Primate Rep. 22: 3-12.

Poulsen, J.R., Clark, C.J. and Smith, T.B. 2001. Seasonal variation in the feeding ecology of the grey-checked mangabey (Lophocebusalbigena) in Cameroon. American Journal of Primatology, 54: 91 - 105.

Prendergast, J.R., Quinn, R.M., Lawton, J.H., Eversham, B.C. and Gibbons, D.W. 1993 Rare species, the coincidence of diversity hotspots and conservation strategies. Nature 365:335-337.

Rapport, D.J. Costanza, R. and McMichael, A.J. 1998.Assessing ecosystem health.Trends in Ecology & Evolution 13: 397 -402.

Ray, J. and Sapoisky, R. 1992. Styles of dominance and their endocrine correlates among wild olive baboons (Papioanubis). American Journal of Primatology, 18: 1-13.

Reid, W.V. 1998. Biodiversity hotspots. Trends in Ecology and Evolution 7: 275-280. Reinhardt, V. 1997. Refining the traditional housing and harnliing of research macaques in Monograph online available at http://pantheon.yale.edukseelig/pef/new/new.html. 1997, 1—9.

Remade, B. 1981. Ecologie des populations et des peuplements. Masson, Paris 200 p. Reynolds, V. 2005. New York: Oxford University Press. xv, 297 p.

Rollin, B, 2006. Science and ethics. Cambridge, UK: Cambridge University Press. 304 p.

Rowe, N. (1996). The Pictorial Guide to the Living Primates. East Hampton (NY): Pogonias Press. ISBN 0-9648825-0-7.

Rowe, N. 1996.The pictorial guide to the living primates. East Hampton (NY): Pogonias Pr. 263 p.

Sapolsky, R. 1996. Why should an aged male baboon ever transfer troops?. American Journal of Primatology, 39: 149-157.

Schindler, D.W. and Lee, P.G. 2010. Comprehensive conservation planning to protect biodiversity and ecosystem services in Canadian boreal regions under a warming climate and increased exploitation. Biological Conservation 143: 1571-1586.

Shah, N. F. 2003.Foraging strategies in two sympatric mangabey species (Cercocebusagilis and Lophocebusalbigena).Ph.D. Thesis, Stony Brook University.

Shefferly, N. 2004.“Papioanubis” (On-line), Animal Diversity Web. Accessed August 28, 2013 at http://animaldiversity.ummz.umich.edu/accounts/Papio_anubis/

Siegal, S. and Castellan, N. J. 1988. In Nonparametric Statistics for the Behavioral Sciences, McGraw-Hill, New York, 1988, pp. 170

St-Laurent, M.H., Dussault, C., Ferron, J. and Gagnon, R. 2009. Biological Conservation 142: 2240-2249.

Stork, N.E. 1993. How many species are there? Biodiversity Conservation 2: 2 15-232.

Boesch C., Hohmann G., Marchant L.F. (Eds) 2002. Behavioural diversity in chimpanzees and bonobos. Cambridge (England): Cambridge Univ P;.Pp. l81-1.

Walsh, S., Bramblett, C.A.and Alford, P.L. 1982. A vocabulary of abnormal behaviors in restrictively reared chimpanzees. Am J Primatol 3:315—319.

Wood, A., Stedman-Edwards, P. and Mang, J. 2000. The root causes of biodiversity loss. Earthscan Publications, London, UK.

APPENDIX 1

Statistical analysis on prevalence of abnormal behavior

Mann-Whtney U-Wilcoxon Rank Sum U test

Source of Variation	P value	P value summary	Significant?
Sex	P= 0.57	ns	No
Enclosre complexity and substrate	P<0.0001	***	Yes

Kruskal Wallis H test

Group size and composition	P<0.0001	***	Yes
Enclosure size	P<0.0001	***	Yes

APPENDIX 2.

Statistical analysis on frequancy of abnormal behavior

Mann-Whitney U-Wilcoxon Rank Sum U Test

Source of Variation	P value	P value summary	Significant?
Sex	P= 0.23	ns	No
Enclosure complexity and substrate	P= 0.77	ns	No

Kruskal Wallis H Test

Group size and composition	P 0.36	ns	No
Enclosure size	P= 0.45	ns	No

APPENDIX 3.

Statistical analysis on diversity of abnormal behaviour

Mann-Whitney U-Wilcoxon Rank Sum U Test

Source of Variation	P value	P value summary	Significant?
Sex	P<O.03	***	Yes
Enclosure complexity and substrate	P<O.OO1	***	Yes

Kruskal Wallis H Test

Group size and composition	P<O.O1	***	Yes
Enclosure size	P<O.O1	***	Yes