Vol. 11(2), pp. 69-77, February 2019
DOI: 10.5897/IJBC2017.1096
Article Number: 1E2035660079
ISSN 2141-243X

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International Journal of Biodiversity and Conservation

Full Length Research Paper

Activity budget of captive Drill monkeys Mandrillus *leucophaeus* (Cuvier) in Limbe Wildlife Center, Southwest Region, Cameroon

Melle Ekane Maurice*, Nkwatoh Athanasius Fuashi, Tim Killian Lengha and Viku Bruno Agiamte-Mbom

Department of Environmental Science, Universitry of Buea, Cameroon.

Received 25 March, 2017; Accepted 21 June, 2017

Drill monkeys (*Mandrillus leucophaeus*) are known to be the most endangered species of primates in Africa. Hunting and habitat loss are believed to be the major causes of the species decline in Cameroon. It is for this reason that the study explored the behaviour of captive drills in Limbe Wildlife Centre (LWC) in line with reintroduction plan. Data collection started in May 15th 2016 and ended in August 15th 2016. Scan and focal samples were collected in mixed strategy, continuous sampling started from 6:00 am and ended at 6:30 pm, where the following behavioural categories were recorded: Feeding, foraging, movement, resting, socialization, grooming, play, aggression and vocalization. Simultaneously, data were recorded on weather changes. Data analysis comprised of descriptive and inferential statistics. The time budget was recorded as follows; 52.54% resting, 23.70% foraging, 10.0% feeding, 9.30% moving, 2.02% grooming,2.0% play, 0.40% aggression and 0.20% vocalization. There exist a significant difference between behaviours and age/sex classes, ($P<0.05$). Adult males spent more time resting than any age-sex class ($X^2=277.4$, df=1, $P<0.05$). Female adults spent most of their time foraging than any category ($X^2=93.4$, df=1, $P<0.05$). Female adults also dominated in grooming than any age/sex class ($X^2=118.5$, df=1, $P<0.05$). Male adults executed more aggressive behaviour than any other category ($X^2=28.7$, df=1, $P<0.05$), There is a significant difference for resting between adult males and juveniles ($X^2=273.2$ df=1 $P<0.05$), there is a significant difference for resting between female adults and juveniles ($X^2=27.58$ df=1 $P<0.05$). Also, there is a significant difference for resting female and male adults ($X^2=261.469$ df=1 $P<0.05$). The survey revealed a smooth interaction between the adult males, adult females, sub-adult males and sub-adult females, and the juveniles.

Key words: Drill monkeys, hunting, habitat loss, reintroduction, wildlife, behavior.

INTRODUCTION

Primates are among the most threatened mammals (IUCN, 1996), and many species threatened in their natural habitat have been the focus of translocation and reintroduction projects to augment their chances of restoration (Horwich et al., 1993). Drill monkeys (*Mandrillus leuciphaeus)* is one of the rare monkeys in

Africa and the world at large, Drill and their congener Mandrills (*Mandrillus sphinx*) are the only two species belonging to the genus Mandrillus found only in three African countries, the South West of Cameroon, South East of Nigeria and the Bioko Island of Equatorial Guinea. They are among the African most endangered primate species, being highest in conservation priority as listed by International Union for the Conservation of Nature (Oates and Butynski, 2008). They are forest floor dwelling, short tail monkeys which are sexually dimorphic both in size and in colour.

Drill population in the wild is currently running into extinction and estimated population is about 2,500 to 3000 in Korup National Park (KNP). Declining drill population remains a key threat to their survival; these threats are obviously hunting, forest fragmentation and illegal logging (Gadsby, 1990). The presence of drills in captivity is the possible means of bringing back or restoring the population of drills in the wild. Population increase and reintroduction programs depend on the ability of zoological gardens to breed species under good conditions of reproductive and behavioural repertoires (Carlstead, 1996). In line with conservational efforts, zoological gardens are now bent on breeding programs for reintroduction.

Drill survival in Cameroon and Nigeria does not depend only on captive breeding but this can be achieved if the surrounding neighbours to drill ecosystems are also key advocates to this species protection and the commitment of the host country Government to enforce existing laws. While other primate species have been highly protected and their number in the wild is a little higher, the drill population decline is a problem, and the solutions to increase it had been on going through the Pandrillus Foundation in Nigeria and in Cameroon. Many threats had led to the decrease of this species in the wild, illegal hunting with dogs and habitat fragmentations are the main threat to the survival of primates (Oates and Butynski, 2008). Drill activity budget, the time these individuals allocate to various activities such as resting, foraging, feeding, socializing, moving are key parameters for the quality of the enclosure and the living status of the group. Reintroduction programs are often used as a potential tool for ecological restoration and the recovery of endangered species (Macdonald et al., 2002). IUCN had defined reintroduction as an attempt to re-establish a species in an area which was once part of its historical range but from which it has been extirpated or become extinct (IUCN, 1998). Drills in captivity had shown successful reintroduction in a chosen site in Nigeria (Ijeomah and Choko, 2014).

According to some estimates, forest cover in Cameroon decreased from the period 1965 to 1995 by 30% (Gbetnkom, 2005). Habitat loss outside protected area is due to forest being either cleared for agriculture and human settlements or degraded from logging and mining. Although rates of deforestation may vary from period to period, as of 1998 approximately 23.950 km^2 of forest within the historical range of the Drill monkeys in Cameroon were classified as a logging concession or a forest reserve. The fundamental threats to drill monkey survival are hunting and habitats fragmentation, as is the case with most of the central Africa primates (IUCN, 2008). These threats are especially to Drill monkeys because of their limited distribution but high human population density within their range. In total, it is estimated that 12% of the remaining drill habitat is incorporated in strictly protected areas. Although there are reports of mandrills crossing small logging roads in Lope, Gabon (Rogers et al., 1996), both mandrill species are thought to be averse to open areas. It is unlikely that drills would cross large roads where overlying canopy and edge vegetation has been removed. The drills diurnal nature also means that such crossing would have to take place during periods of peak human use. Drill population is most affected by shrinking habitat of Douala-Edea, Mt Kupe, Mt.Cameroon, and Bioko Island protected areas. The expanding network of public and logging roads further fragments the drills habitat, limiting reproductive contact between sub-populations and increasing human presence in once remote area (Oates and Butynski, 2008). Also, the drills are vulnerable to hunting with the use of dogs (Wild et al., 2005). The common hunting techniques of night hunting and trapping are especially destructive for certain wildlife species but probably have only little impact on the drill monkeys.

The priority of zoo management organizations is to house animal in perfect and considerable conditions, in order to reduce stress and stereotype behaviours. In modern zoological parks, social behaviours of wildlife remain influential factors to conservation. The ability of these animals to live in good conditions can greatly interfere in their time budget on different activities, the environment in which species are been housed have proven to be a stressor to provoke abnormal behaviours in many animals and non-human primates (Poole, 2008).

Wildlife conservation in Cameroon and other countries in Sub-Saharan Africa is facing enormous challenges, mainly to rainforest fragmentation and poaching for bushmeat. For this reason so many wildlife species are highly threatened and are at the edge of regional extirpation. The Drill monkeys are known to be endemic

*Corresponding author. E-mail: melleekane@gmail.com.

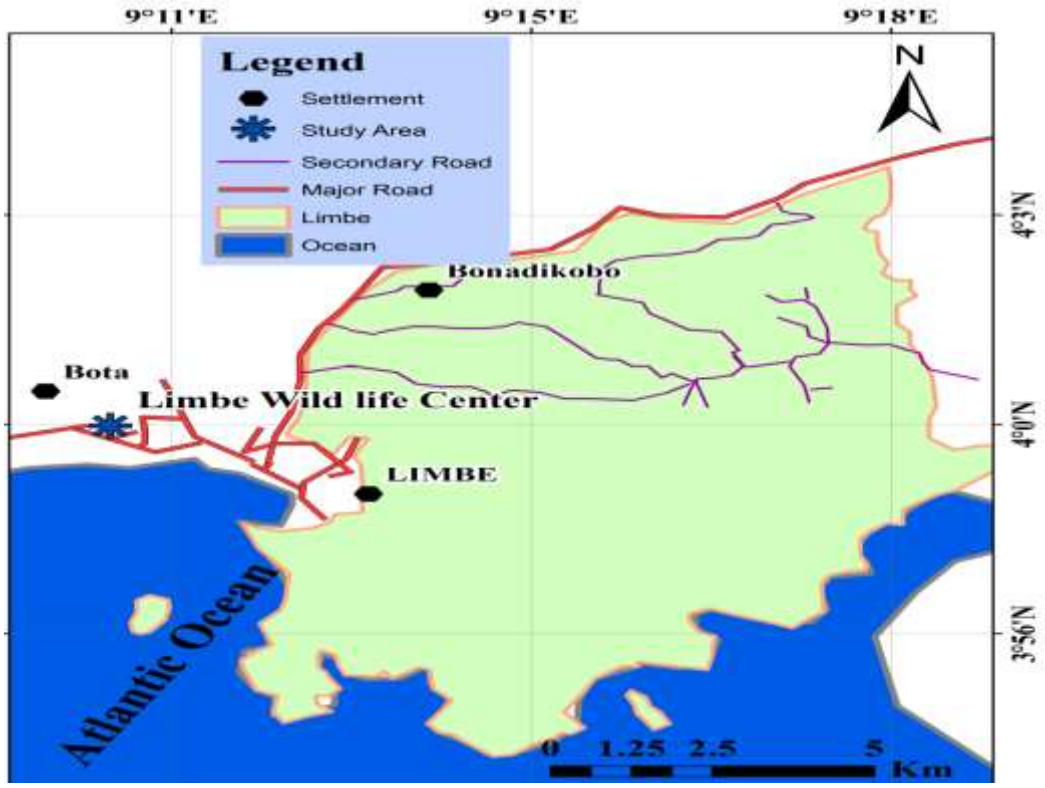

Figure 1. Map of Limbe City.

in Cameroon forest zone and neighbouring Nigeria, but its population is declining at alarming rate, creating a conservation research attraction. The main aim of this study is to assess the activity budget of the captive Drill monkeys preserved by the zoo management authorities for future reintroduction. Any behavioural study in a zoo setting will always improve or contribute to better management of the animals in question, considering the varying characteristics of individuals within a population. Conservation efforts and goals of reintroduction programs are only achieved when the release species prove to thrive in the release site with continuous monitoring before and after the reintroduction.

MATERIALS AND METHODS

Description of the study area

Limbe Wildlife Center (LWC) is found in the centre of the City of Limbe, located in the South West Region of Cameroon. It is located at latitude 4.1° 27.12' N and to longitude 9.12° 53.64' E (Figure 1). It was created in 1993 by the efforts of the Cameroon Government and the Pandrilus Foundation. The centre is bounded by roads within the town, just a stone throw from the Limbe City Council. All species of the centre had been donated or confiscated by the Government of Cameroon through the Ministry of Forestry and Wildlife (MINFOF) and the Pandriillus Foundation. The centre helps to rescue these species and later reintroduce them to natural environment in a protected area. The centre houses 15 Primates species in separate enclosures. The centre has a total of 21 cages; two cages house the western lowland gorillas (*Gorilla gorilla deihli*). The papionini section contains three small cages for the drills, two for the olive baboon (*Papio anubis*) and two for the mandrills. All the primate cages have an electric fence enclosure where they spend their time during the day. There are also separate cages for the guenons (*Cercopithecus* spp.*)*; mangabeys (*Cercocebus torquatus)* and other small enclosures contain the duikers (*Cephalophus* spp.*).* The quarantine section contain up to seven small cages housing different species of wildlife.

Data collection

The behavioural data collection started on the 15th May and ended on the 15th of August 2016. Six days of data collection was carried out each month and 4 months data was collected. The enclosure was divided into seven observational areas, called zones, each zone had its distinctive point for clear identification. The partitioning of the enclosure was based on the fact that these areas can be clearly visualized with or without a binocular at different relative positions around the enclosure. Behavioural observations began in the morning between 6:00 and 6:30 and ended at 12:30 every day, while in other days, observations started between 12:00 to 12:30 and ended at 6:30 in the evening. Data were collected using instantaneous scan sampling at predetermined intervals. Martin and Bateson (2007) define “instantaneous scan sampling” as when “a whole group of subjects is rapidly scanned, or “censused,” at regular intervals and the behaviour of each individual at that instant

Table 1. Behavioural categories and definitions used in the study.

Activity type	Behaviour	Description
Feeding	Drink or eat	Process of drinking water or eat food
Foraging	Search, dig, scratch, hunt, smell, turn	Process of looking for food ,insect by any means
Locomotion	Run, climb, walk, jump	Any locomotory process without a defined reason
Resting	Sitting, standing, selfgroom and play alone	The state of being inactive
Social (grooming, play, aggression)	Presentation, chases, groom, flee, smell mouth or vulva, play, volcalise.	Any positive and sexual interactions
Vocalisation	Alarm, grunt, song	The act of producing sound either for predators or aggression

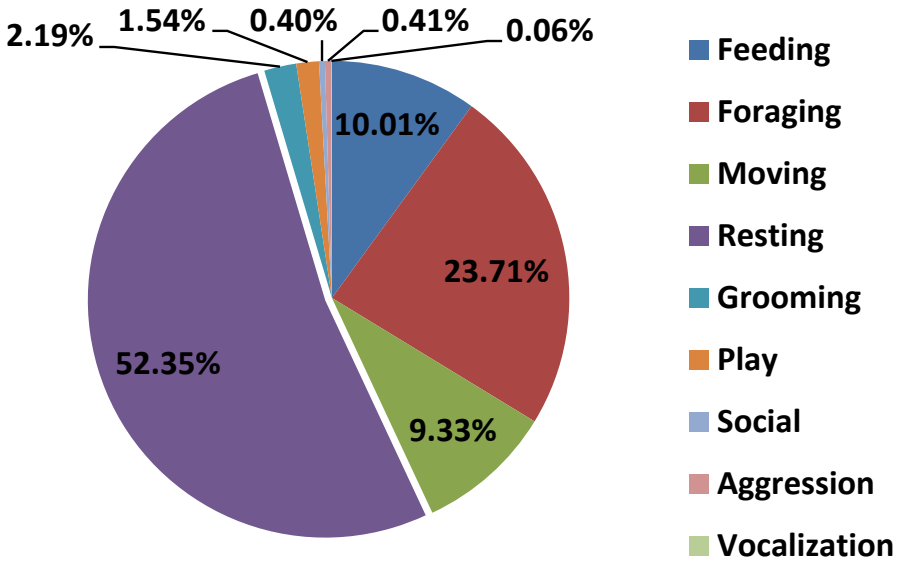

Figure 2. Activity budget of *Mandrillus leucophaeus.*

is recorded."Behavioral data can be collected in several ways (Altmann, 1974). In categorizing these methods, Martin and Bateson (1986) distinguish between sampling rules (whose behaviour is watched and when) and recording rules (how the behaviour is recorded). For this study two recording methods were simultaneously used because it was important to know both: First is how the animals spent their time (activity budgets); and, how social behaviours were patterned, that is, who does what to whom, and how often. Hence, the scan sample data for this survey was collected after every 10 min (Altmann et al., 1993). Between the 10 min of scan sampling a focal sample was conducted for 5 min. All the scan observations were done from right to left throughout the study. The focal animal was randomly selected for the day, based on the age-sex class. The drill behaviours were recorded during the scan and focal. The following behaviours were recorded; feeding, foraging, locomotion, social behaviours and resting (Table 1).

Data analyses

The data sheets were transcribed to Microsoft Excel spreadsheets for each data type (scan and all-occurrences) from the group. The frequency data generated were analysed by the use of exploratory statistical distribution tool for each observed behaviour in the study. Pearson chi-square was also used to compare the different activity budget for the behaviour of each sex-age class in the drill group.

RESULTS

Activity budget of drill monkeys

Drill time budget involves a spectrum of much behaviour; resting, foraging, movement, feeding and social behaviours. A total of 288 observational hours were made, and 7534 individuals' activities were recorded in the group of 95 drill monkeys. Figure 2 shows activity budget for the drill group. Resting was the most frequent behavior 52.54%, followed by foraging 23.70%, feeding 10.0%, movement 9.30%, grooming 3.70%, play 1.54%,

Table 2. Activity budget for each age-sex classes.

Age-sex class	Activity									
	Feeding	**Foraging**	**Moving**	**Resting**	**Grooming**	**Playing**	**Social**	**Aggression**	**Vocalization**	**Total**
Female adult	303	931	341	1443	138	11	9	6	1	3183
Activity budget (%)	9.52	29.25	10.71	45.33	4.34	0.35	0.28	0.19	0.03	100
Male adult	185	260	131	1342	6	3	8	21	2	1958
Activity budget (%)	9.45	13.28	6.69	68.54	0.31	0.15	0.41	1.07	0.10	100.00
Juvenile	110	265	97	312	11	84	2	-	1	882
Activity budget (%)	12.47	30.05	11.00	35.37	1.25	9.52	0.23	-	0.11	100
Mature Male	117	152	84	656	3	5	6	4	0	1027
Activity budget (%)	11.39	14.80	8.18	63.88	0.29	0.49	0.58	0.39	-	100
Sub-adults	39	179	50	193	7	13	5	-	-	486
Activity budget (%)	8.02	36.83	10.29	39.71	1.44	2.67	1.03	-	-	100.00
Total	754	1787	703	3946	165	116	30	31	4	7536
activity budget	10.01	23.71	9.33	52.36	2.19	1.54	0.40	0.4	0.05	100
Total (%)	100.	100	100	100	100	100	100	100	100.	100

Table 3. The age-sex class and behavioural relationship.

Activity	Age –Sex Classes			
	FA-MA	**FA-JU**	**MA-JU**	**FA-SA**
Foraging	X^2= 173 df=1 p=0.0000	X2=0.21 df=1 p=0.0000	X^2=113.4 df =1 P=0.0000	X^2=84.8 df=1 P=0.0000
Feeding	X^2=0.007 df=1 P=0.93	X^2=6.59 df=P=0.001	X^2=5.9 df=1 P=0.015	X^2=3.0 df=1 P=0.08
Resting	X^2=262.9 df=1 P=0.0000	X^2=27.9 df=1 P=0.0000	X^2=275 df =1 p=0.0000	X^2=106.7 df=1 P=0.0000
Moving	X^2=23.5 df=1 P=0.0000	X^2=0.058 df=1 P=0.001	X^2=15.3 df=1 P=0.0000	X^2=5.4 df=1 P=0.019
Grooming	X^2=72.2 df=1 P=0.0000	X^2=18.65 df=1 P=0.0000	X^2=9.04 df=1 P=0.003	X^2=39.2 df=1 p=0.0000
Playing	X^2=1.09 df=1 P=0.0000	X^2= 254.8 df=1 P=0.0000	X^2=179.8 df=1 P=0.0000	X^2=0.40 df=1 P=0.5
Social	X^2=0.58 df=1 P>0.445	X^2=0.08 df=1 P=0.77	X^2=9.5 df=1 P=0.002	X^2=0.3 df=1 P=0.159
Aggression	X^2=18.13 df=1 P<0.0000	X^2=1.66 df=1 P=0.197	X^2=0.573 df=1 P=0.444	X^2=1.32 df=1 P=0.250
vocalisation	X^2=1.04 df=1 P=0.308	X^2=0.943 df=1 P=0.331	X^2=0.007 df=1 P=0.931	X2=0.30 df=1 P=0.57

FA = Female adult; MA = Male adult; JU = Juvenile; SA = sub adult.

social 0.40%, Aggression 0.41%, and vocalization (Figure 2).

Table 2 gives the age-sex class activity budget for all behavioural categories. Female adults executed more grooming and foraging than any other age-sex class (N=138 and N=931) respectively. Adult male rested more than any other category (N=1342) and juvenile performed more playing than any category (N=84).

From Table 3 there is a significant difference for resting between adult male and juvenile (X^2=273.2 df=1 P<0.05), also there is a significant difference for resting between female adults and juveniles (X^2=27.58 df=1 P<0.05). In addition there is a significant difference for resting female and male adults (X^2=261.469 df=1 P<0.05). There exist a significant difference between behaviours executed and the different age-sex classes (X^2=262.9 df=1 P< 0.05). Male adult spent more time resting than any other categories (X^2=277.5 df=1 P<0.05). Female adults spent more time foraging than male adult (X^2=173.7 df=1 P<0.05) and there is no significant difference between female adults and male adults for feeding (X^2=0.007 df=1 P=0.9). Female adults spend more time grooming than other categories(X^2=72.3 df=1 P<0.05), juvenile spend more time playing than the other categories (X^2=420.2 df=1 P<0.05). Male adults spend more time on aggressive behaviour than any other age-sex class(X^2=28 df=1 P<0.05). Moreso, there is no significant difference between female adults and sub-adults on behaviours like socialization, movement, aggression and vocalization. Sub-adults spend more time playing than female adults There is a significant difference between male adults behaviours and all sex-age classes (X^2=30.1 df=1 P<0.05). There is a significant difference in feeding for juvenile and female adults (X^2=6.427 df=1 P=0.011),

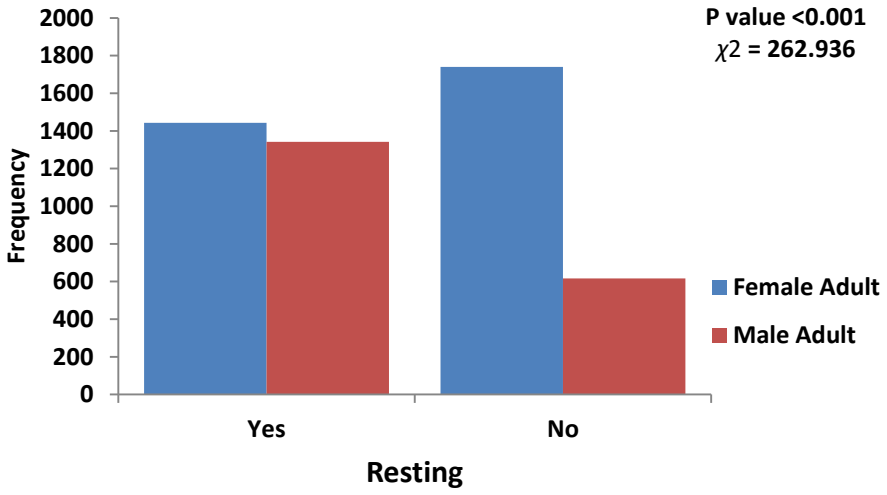

Figure 3. Adult male and female resting.

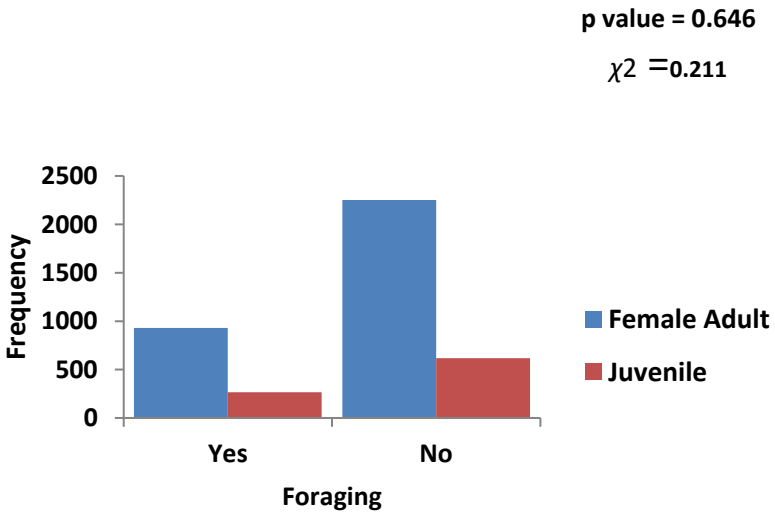

Figure 4. Adults females and juvenile foraging.

implying that male adults feed more frequently than juveniles.]

From Figure 3 male adults spend a significant time resting. “Yes” show bar chart counts for resting and “No” show bar chart counts for non-resting, male adult had “Yes” counts (N=1342) and No counts (N=616). Female adults registered Yes counts (N=1443) and no counts (N=1740). From these values it is clear that male adults spend more time resting than female adults.

From Figure 4, “Yes” represents bar charts counts for foraging and “No” show bar charts counts for non-foraging. Female adult had (N=931) for foraging and (N=2252) for non-foraging. Juvenile scored (N=265) for foraging and (N=617) for non-foraging.

From the Figure 5, female adults were mostly closest to juvenile and male adult; they spent most time at 0 to 1 m apart (53%). Adult males and juvenile were mostly at 2 to 3 m from each other (48.7%).

DISCUSSION

Studies of behavioral ecology can provide significant contributions to conservation through evolutionary and ecological perspectives of how animals adapt to their environment (Krebs and Davies, 1993). Zoos provide advantages to researchers by allowing for longitudinal studies of behavior and reproduction, as well as

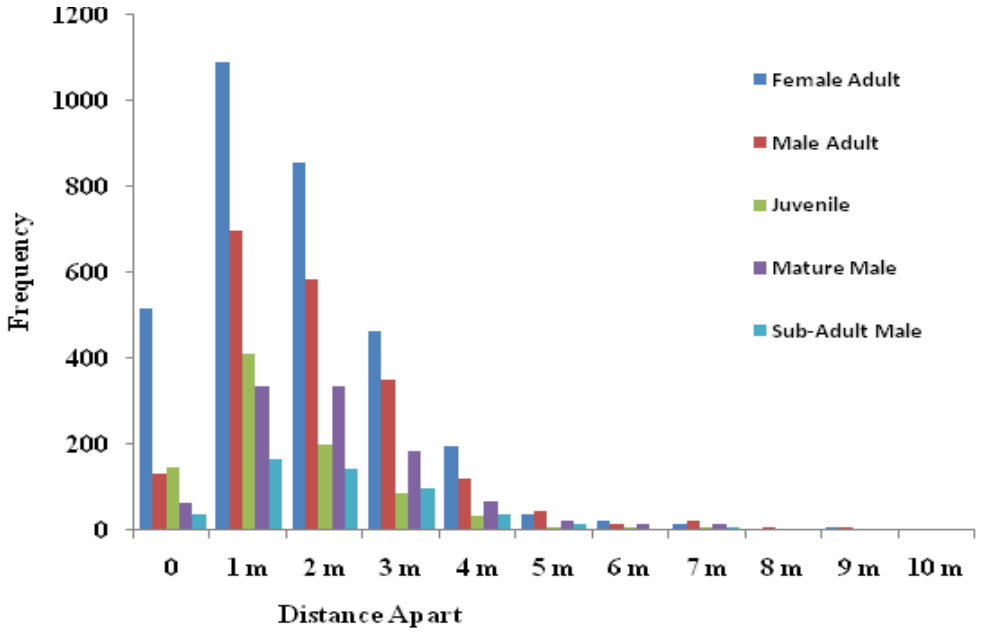

Figure 5. The mean distance between the age-sex category.

opportunities for gathering data on all aspects of life history (Hardy, 1996). Preserving the behavioral and developmental diversity of animals maintained in captivity allows for zoos to achieve their full potential in conservation. Captive propagation efforts and reintroduction programs are dependent on captive animals exhibiting normal reproductive and behavioral repertoires. To thrive in captivity, a species must adapt their behaviors to the altered environmental conditions (Carlstead, 1996). Zoos are typically underrated as research resources, although the amount of research conducted at zoos has increased over the past twenty years (Stoinski et al., 1998). They provide a key role in the conservation of species, specifically primates, and have become focal points for research by academic and zoological scientists. Researchers are able to study animals closely in zoological facilities as well as have control over environmental and social variables (Hosey, 1997; Stoinski et al., 1998). Improvements on animal management, including breeding, handling, transporting, and caring for animals, are developed usually in zoos before being applied in natural habitats. Much of the information acquired through zoo research is of great relevance to conservation generally and to the conservation of species and habitats in particular. Understanding how a species behaves in wild is important for the maintenance of natural behaviors and life history characteristics of those kept in captivity. An important advantage that primates have in the competition for survival is their practice of living in societies which have a constant close association of young and old through long life duration. The young learn survival skills from experienced, knowledgeable adults. The result is that by the time primates are grown, they are usually proficient in dealing with each other and the environment. While primate instinctive survival skills are minimal, their social skills are unusually effective. Acting together in groups, they often can avoid or intimidate predators. Groups of primates also have a greater opportunity in discovering and controlling food sources.

In captivity, Drill monkeys spent 23.5% of their time digging the soil, scratching the wall of the fence, turning stones, catching insects and arthropods. The environment in which drills are habituated can greatly affect their activity budget; food is provided two times a day only, protein is also added as a supplement to their diet. In a related study of drill in a semi-free area showed drill spend 50% of it time foraging (Terdal, 1996). Adult females foraged more than male adult, this agrees with Feistner (1988). Male adult were actively involved in aggressive activities than any age-sex class. The drill group was frequently masked with aggressive behaviour within the adult males, dominance in rank is believed to be the major cause of these aggressive interactions. Male adults were rarely found performing affiliative behaviours like grooming and playing, while the female adults spent more time grooming than any age-sex class. Sometime grooming of lactating mother by other adult females was used as a strategy to gain access to their infants that were newly born Feistner (1988). The juveniles spent most of their time playing than any age-sex class. They devoted little time on other activities but

they were often seen catching insects. From Table 3, 72.4% of playing was executed by juvenile. Shanee and Shanee (2011) stated that juveniles could be expected to feed more and play more since they are growing. Little time was spent moving, the fact that the enclosure size was small this might have affected the movement.

Although it is valuable for the zoo going public to see primates like drills surrounded by the native vegetation, it would be more beneficial for the public to see them engaged in natural activities that are more indicative of a wild state. Simulating natural behaviors involves providing the animal with an environment that mimics the wild habitat to encourage behavior expression while stimulation relies on environment enrichment to evoke the behavior regardless of the enclosure (Fábregas et al., 2011; Grandia et al., 2001). Zoos are particularly important component of the reintroduction process for animal species, as they are “pre-adapted” to maintain populations of threatened species due to their histories of keeping, breeding and transporting animals.

The low success rate of reintroductions (ranging from 11 to 54%) requires a reexamination of how we maintain species in captivity (Kleiman and Beck, 1994; Kleiman, 1989). Evidence suggests that reintroductions using wild stock are more successful than those use captive stock (Jule et al., 2008). Evaluating and meeting the behavioral needs of captive animals allows managers to fulfill their roles as stewards, and provide valuable educational opportunities for zoo visitors (McPhee, 2003). The lack of multi-institutional behavioral studies conducted in zoos does not allow animal keepers, administrators, or researchers to determine how the captive condition alters the behavioral profile of a population of captive animals. Single zoo studies are essential for establishing better husbandry protocols, breeding programs, and enclosures for individual institutions but do not address the role of the zoo in conservation or loss of behavior (Carlstead, 2002; Shepherdson and Carlstead, 2001). Animal welfare guidelines ensure that individuals are provided with stimulating environments, but these guidelines do not encourage behavior maintenance (AZA, 2009a, b).

Conclusion

Wildlife conservation in Cameroon and other countries in Sub-Saharan Africa is facing enormous challenges, mainly due to rainforest fragmentation and poaching for bushmeat. For this reason so many wildlife species are highly threatened and are at the edge of regional extirpation. The Drill monkeys are known to be endemic in Cameroon forest zone and neighbouring Nigeria, but its population is declining at alarming rate, creating a conservation research attraction. The Drill monkey population in LWC is the confiscations made by the Cameroon Government Forest and Wildlife authorities for preservation and future reintroduction programmes. The examination of activity budget of these monkeys was aimed at understanding the different interactions within members in the formation of sub-group associations. Through these group associations, their reintroduction into the wild would have a head way and limit rampant aggressions within the group caused by the adult males for dominance.

CONFLICTS OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Altmann J (1974). Observational study of behavior: sampling methods. Behaviour 49(3):227-266.

Altmann J, Schoeller D, Altmann SA, Muruthi P, Sapolsky RM (1993). Body size and fatness of free-living baboons reflect food availability and activity levels. American Journal of Primatology 30:149-161.

AZA (2009a). AZA Guidelines for Reintroduction of Animals. In: Aquariums AoZa, editor.

AZA (2009b). Special Survival Plan Programs. In: Aquariums AoZa, editor. Animal Care and Management

Carlstead K (1996). Effects of Captivity on the Behaviour of Wild Mammals. In: Wild Mammals in Captivity: Principles and Techniques. Pp. 317-333.

Carlstead K (2002). Using cross-institutional behavior surveys to study relationships between animal temperment and reproduction; 2002 28-29 September, 2002; Omaha, NE. pp. 54-62.

Feistner ATC (1988). Reproductive parameters in a semifree-ranging group of mandrills. In de Mello, M.T. (Ed.), Baboons: Selected Proceedings of the 12th Congress of the International Primatoloaical Society Meeting, (pp.77-88).

Fábregas MC, Guillén-Salazar F, Garcés-Narro C (2011). Do naturalistic enclosures provide suitable environments for zoo animals? Zoo Biology 30:1-12.

Gadsby EL (1990). The status and distribution of the Drill (Mandrillus leucophaeus) in Nigeria, A report focusing on hunters and hunting and their threat to remaining populations of drills and other forest primates in southeast Nigeria.

Gbetnkom D (2005). Deforestation in Cameroon: immediate causes and consequences. Environment and Development Economics10:557-572.

Grandia PA, van Dijk JJ, Koene P (2001). Stimulating natural behavior in captive bears. *Ursus* 12:199-202.

Hardy D (1996). Current Research Activities in Zoos.In: Kleiman D, Allen M, Thompson K, Lumpkin S, editors. Wild Mammals in Captivity: Principles and Techniques. Chicago: The University of Chicago Press. p 531-536.

Krebs J, Davies N (1993). *An Introduction to Behavioural Ecology. London:* Blackwell Publishing. 432 p.

Horwich RH, Koontz R, Saqui E, Saqui H, Glander KE (1993). A reintroduction program for the conservation of the black howler monkey (*Alouatta pigra*) in Belize.*Endangered Species UPDATE* 10:1-6

Hosey GR (1997). Behavioural research in zoos: academic perspectives. Applied Animal Behaviour Science 51:1 99-207.

Ijeomah HM, Choko OP (2014). Challenges of captive breeding and re-introduction of selected primate. Ethiopian Journal of Environmental Studies and Management 7(3): 218-234

IUCN (1996). The 1996 IUCN red list of threatened animals. IUCN, Gland, Switzerland and Cambridge, U.K

IUCN (1998). IUCN Guidelines for Re-introductions. Prepared by the

IUCN/SSC eintroductions Specialist Group. IUCN, Gland Switzerland and Cambridge, UK. (Available from IUCN Publications Services Unit or from http://iucn.org./themes/ssc/PUBS/POLICY/INDEX.HTM)

IUCN (2008). IUCN Red List of Threatened Species.International Union for Conservation of Nature (IUCN), Species Survival Commission (SSC), Gland, Switzerland and Cambridge, UK. Website: www.iucnredlist.org.

Jule KR, Leaver LA, Lea SEG (2008). The effects of captive experience on reintroduction survival in carnivores: A review and analysis. Biological Conservation 141(2):355-363.

Kleiman DG (1989). Reintroduction of captive mammals for conservation. Bioscience 39(3):152-161.

Kleiman D, Beck B (1994). Criteria for reintroductions. In: Olney P, Mace G, Feistner A, editors. Creative Conservation: interactive management of wild and captive animals. London: Chapman & Hall. Pp. 287-303.

Krebs JR, Davies NB (1993). An introduction to behavioral ecology. Blackwell Scientific Publications, London.

Macdonald DW, Moorhouse TP, Enck JW, Tattersall FH (2002). Mammals Handbook of Ecological Restoration:Principles of Restoration eds. M.R. Perrow

Martin P, Bateson P (1986). Measuring behavior: an introductory guide. Cambridge, United Kingdom: Cambridge University Press. 200 p.

Martin P, Bateson P (2007). Measuring Behavior: An Introductory Guide,3d ed. Cambridge: Cambridge University Press.

McPhee M (2003). Generations in captivity increases behavioral variance: considerations for captive breeding and reintroduction programs. Biological Conservation 115:71-77.

Oates JF, Butynski TM (2008). *Mandrillus leucophaeus*. IUCN Red List of threatened species. Online. URL: www.iucnredlist.org.

Poole J, Granli P (2008). Mind and movement:Meeting the interests of elephants. In: Forthman,D.L., Kane, L.F., Hancocks, D., Waldau, P.F.(eds). An elephant in the room: The science and well-being of elephants in captivity. North GraftonMA: Tufts University. Pp. 2-21.

Rogers ME, Abernethy KA, Fontaine B, Wickings EJ, White LJT, Tutin CEG (1996). Ten days in the life of a mandrill horde in the Lope Reserve, Gabon. American Journal of Primatology 40:297-313.

Shanee S, Shanee N (2011). Activity budget and behavioural patterns of free-ranging yellow-tailed woolly monkeys (*Oreonax flavicauda)*(Mammalia: Primates), at La Esperanza, northeastern Peru. Neotropical Primate Conservation Pp. 274-275.

Shepherdson D, Carlstead K (2001). New approaches to the evaluation of zoo animal well-being using multiple institutions, assessment of behavior and temperament, and non- invasive physiological measures. American Zoo and Aquarium Association Annual Conference pp.131-136.

Stoinski T, Lukas K, Maple T (1998). A survey of research in North American zoos and aquariums. Zoo Biology 17:167-180.

Terdal ES (1996). Captive environmental influences on behavior in zoo drills and mandrills (*Mandrillus*), a threatened genus of primate. Ph.D. dissertation. Portland State University, pp. 128.

Wild C, Morgan BJ, Dixson AF (2005). Conservation of drill (*Mandrillus leucophaeus*) populations in Bakossiland, Cameroon: historical trends and current status. International Journal of Primatology 26:759-773.