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**ENVIRONMENTAL ENRICHMENT OF ENDANGERED MANIPUR
BROW- ANTLERED DEER (*Rucervus eldii eldii*) FOR SUSTAINABLE
POPULATION MANAGEMENT UNDER THE EX SITU CONSERVATION
IN NATIONAL ZOOLOGICAL PARK, DELHI, INDIA**

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ABSTRACT

The Manipur Brow- antlered deer, which is under “Endangered” category of Wildlife Protection Act, 1972 has been listed by the Central Zoo Authority of India under Conservation Breeding Programme in National Zoological Park, Delhi along with two other participating zoos viz. Assam Zoo, Alipore Zoological Garden, Kolkata and the coordinating zoo, Manipur Zoological Garden. A detailed study has been carried out on Manipur Brow- antlered deer population in National Zoological Park, Delhi, India. Scientific observations were taken between 1000-1600 hours during summer, monsoon and winter seasons in 8006 square meters enclosure area from

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February 2016 to January 2018. Sampling occurrences of specific behavior method in captive herd was used to assess seasonal requirements as well as the behavioral responses toward the present environment inside the enclosure. The systematic observations on physical, social and behavioral enrichment factors like housing, ration and weather gear arrangement were carried out in every season. The findings of the present study was compared with the pilot studies conducted in Assam State Zoo cum Botanical Garden, Assam and Alipore Zoological Garden, Kolkata, Manipur Zoological Garden, Manipur and also with their natural habitat i.e., Keibul Lamjao National Park, Manipur India. Gap areas in existing environmental enrichment of the captive habitat were identified and the recommendations have been made in accordance with Central Zoo Authority guidelines to establish scientific enrichment techniques for sustainable growth and development of Manipur Brow- antlered deer irrespective of seasonal changes. An attempt also has been made to suggest incorporation of some components of the natural habitat into the existing captive environment. Moreover, improvement in existing environmental enrichment will also help Manipur Brow- antlered deer population to adapt well in the extreme weather condition as well as to cope up with captive environmental challenges in a more natural way in National Zoological Park, Delhi, India.

Keywords - Ex Situ Management, Manipur Brow- Antlered Deer, National Zoological Park, Season-Specific Environmental Enrichment

Introduction

Environmental enrichment plays a very important role in enhancing the welfare of the captive animals. Animals reared in an enriched environment have higher chances of reproducing successfully and exhibiting adequate behavioral activities (Carlstead, 1994). Zoological gardens have substantial opportunities to implement enrichment techniques as they house various wild species and moreover have the technical expertise on hand to develop and monitor new management practices and methods. Enrichment execution and husbandry training have become an integral part of the routine management of animals in captivity.

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Enriched environment is majorly required in terms of conservation and protection of endangered species by providing them more suitable environment in different seasons for increase of population in an *ex situ* condition and for successful re-introduction also. It is the process in which animals' captive environments are manipulated by providing appropriate space and various enriched factors to help them to exhibit their species-appropriate behavior and normal activity patterns irrespective of extreme weather condition. Captive enrichment thus provide favorable environment for the wellness of animal which lead to the elimination or reduction of abnormal or stereotypic behavior and other behavioral problems (Joshi, 2015).

Systematic observations and behavioral analysis in different seasons can help to better understand animal's complex behavior in zoos (Walker et al., 2017). For sustained growth and development, scientific enclosure enrichment is necessarily required regarding every weather change. The objective of this paper was to measure the seasonal behavioral responses of the Manipur Brow-antlered Deer (*Rucervus eldii edii*) herd in terms of season-specific environmental enrichment in National Zoological Park, Delhi. This study can lead to develop a more suitable and enriched environment essentially required in terms of *ex situ* environment management.

Materials and methods

STUDY AREA

The National Zoological Park is 188.62 acres large Zoo located near the Old Fort in Delhi, India between 28^o 36.456 ' North latitude and 077^o 14.532' East longitude. The zoo is part of Conservation Breeding Programme recognized by the Central Zoo Authority for the protection and management of endangered Manipur Brow-antlered deer with an enclosure area of 8006 square meters (Beat no. 05).

STUDY AREA MAP

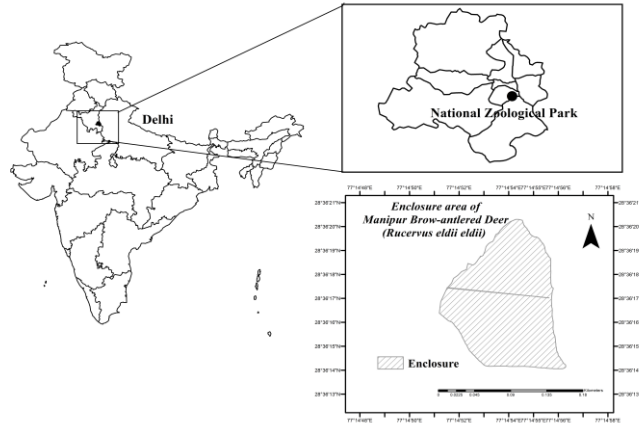


Figure 1 showing the map of study area

Methodology

Behavioral observations were carried out in N=2 herds of Manipur Brow- antlered Deer (Herd 1=24 individuals, Herd 2=27 individuals) for three seasons viz. winter, summer and monsoon from February 2016 to January 2018 (3 days/week) in the National Zoological Park, Delhi. Data were collected during the normal operating hours of the zoo, i.e., from 10:00 h to 16:00 h. Observation hours were equally distributed and collections of data were made using sampling occurrences of specific behavior method (Altmann, 1974).

The percentage time spent in various behavioral patterns was calculated by using a formula.

$$\text{Percentage of time} = (\text{Total duration of behavior} / \text{total duration of observation}) \times 100$$

Wilcoxon Signed-Rank test was used to measure the mean percentage of behavior differences between herds/groups (1&2) of February 2016 to January 2017 and of February 2017 to January 2018 of Manipur Brow-antlered deer in the National Zoological Park, Delhi. Data were analyzed using SPSS 22 statistical package with a significance level of $p = 0.05$.

Result and Discussion

Table 1 showing activity budget of Manipur Brow- antlered deer herd from February 2016 to January 2018 in the National Zoological Park, Delhi

Season	Behavioral pattern	Category	Abbreviation	Seasonal enrichment factors (housing, ration and weather gear arrangement)	Percentage of time spent (Mean \pm SE) of Herds 1&2 (February 2016 to January 2017)	Percentage of time spent (Mean \pm SE) of Herds 1&2 (February 2017 to January 2018)	Different time budget between herds/groups compared by Wilcoxon Signed-Rank Test
Winter	Resting	State	RE	Straw bed inside the enclosure	38.75 \pm 2.41	40.41 \pm 2.08	Z=-1.604, p=0.109
	Feeding	State	FE	Mesh, Indian gooseberry/ Carrot and Green Beans	12.96 \pm 4.12	11.89 \pm 3.86	Z=-1.633, p=0.102
Summer	Resting/Sitting	State	RE	Wet floor (sprinklers installed) inside the enclosure	19.86 \pm 2.89	17.21 \pm 3.01	Z=-1.604, p=0.109
	Feeding	State	FE	Mesh, Cucumber and Green Beans	8.43 \pm 5.16	8.06 \pm 4.81	Z=-1.069, p=0.285
Monsoon	Resting/Sitting	State	RE	Shed in the kraal	14.54 \pm 2.82	11.95 \pm 3.03	Z=-1.604, p=0.109
	Feeding	State	FE	Mesh, Cucumber and Green Beans	7.19 \pm 4.14	8.58 \pm 4.05	Z=-1.614, p=0.107

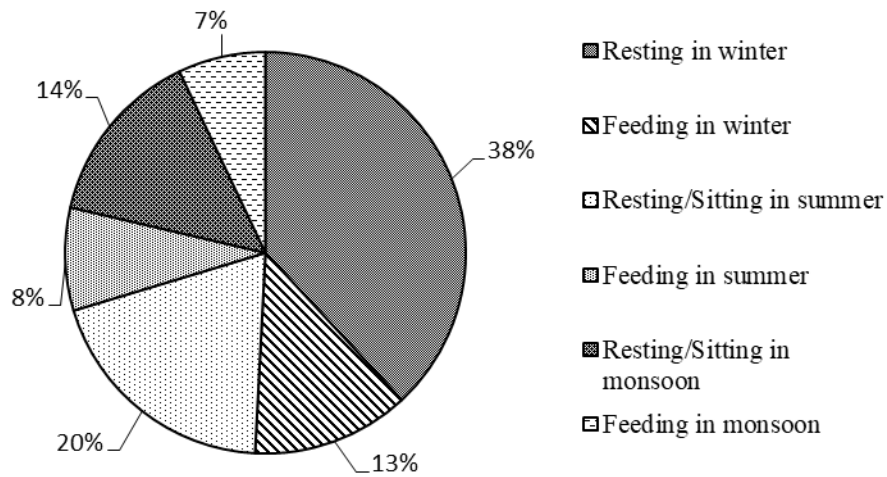


Figure 2 represents season-specific mean percentage distribution of behavioral patterns of herds 1 & 2 in terms of provided environmental enrichment from February 2016- January 2017

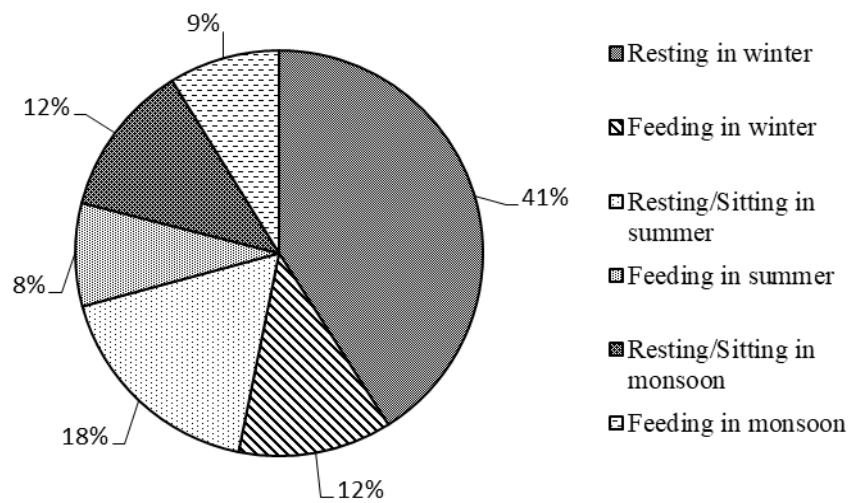


Figure 3 represents season-specific mean percentage distribution of behavioral patterns of herds 1 & 2 in terms of provided environmental enrichment from February 2017- January 2018

Behavioral observation and analysis has been done in the years of February 2016 to January 2017 and of February 2017 to January 2018 respectively.

Manipur Brow-antlered deer herd were found to spend more time in resting over the straw beds in winter season (38.75 ± 2.41 & 40.41 ± 2.08) respectively. While, the less resting behavior was observed over the wet floor caused by installation of sprinklers in the summer season (19.86 ± 2.89 & 17.21 ± 3.01) and in the shed area of the kraal in monsoon (14.54 ± 2.82 & 11.95 ± 3.03). The arena is full of stones, brick pieces, thorny shrubs and trees of *Prosopis juliflora*. Enormous trees inside the enclosure obstruct the sunlight during the winter. Uneven surface causes stumbling and injury in monsoon. Deer also suffered from heatstroke due to the absence of grass bed or marshy area in the arena. Injuries and heatstroke of Manipur Brow-antlered deer have been reported in captivity (PHVA 1992) for which uneven and rough arena surface, devoid of rich vegetation is one of the main reasons in an *ex situ* environment.

More feeding was observed during the winter season (12.96 ± 4.12 & 11.89 ± 3.86) when the enriched food including mesh, Indian gooseberry/carrot and green beans was additionally provided with ration and it was observed that there was comparatively less feeding during the summer (8.43 ± 5.16 & 8.06 ± 4.81) as well as in monsoon (7.19 ± 4.14 & 8.58 ± 4.05) when enrichment was with mesh, cucumber and green beans. Due to the presence of given feed in a single large of the kraal, dominance of adult individuals over sub-adults and fawns has been observed. Provision of spreading ration in a single area inside the enclosure often leads to the monopolization of food by the dominant individuals of a captive herd (PHVA, 1992).

There occurred no significant differences between the herds for all activities pattern (Wilcoxon Signed-Rank test, $p > 0.05$). Manipur Brow-antlered deer herd were found to exhibit normal behavioral pattern during utilization of provided seasonal enrichment factors inside the enclosure. Natural behaviors of captive animals can be maintained by enhancement of their enclosure's environment (Anderson et al., 2010). Naturalistic and favorable environment management would help to enrich an animal's psychological and physiological

state in the captive habitat. This would also results in normal behavioral activities, thus preventing aberrant behavioral display in different weather conditions. Thus, it is the essential requirement for the zoo to maintain natural behaviors under captivity with season-specific exhibit design, enriched food, husbandry, housing and enrichment programs.

Recommendations

The following recommendations have been made in terms of season-specific environmental enrichment of Manipur Brow-antlered deer in National Zoological Park, Delhi:

- a) A marshy area which can imitate their natural habitat (*ref.* Keibul Lamjao National Park and Manipur Zoo) or grass bed (*ref.* Alipore Zoo) should be developed to add more naturalistic and enriched environment in every season inside the enclosure. Development of wallowing area is suggested to keep the body of deer cool and comfortable during the summer season.
- b) Removal of stones and pebbles should be done in order to avoid injury especially in the monsoon, inside the enclosure.
- c) Removal of excessive *Prosopis juliflora* trees and shrubs should be done in order to make path for the sunlight during the winter season. This will provide warmth and favorable environment for the growth and development of newly born fawns inside the enclosure (*ref.* Assam Zoo).
- d) In every season, rather than providing ration in a single large area of the kraal, given feed should be sub-divided and placed in various locations as necessary to safeguard against weak and young animals remaining undernourished (*ref.* Central Zoo Authority Guidelines and Alipore Zoo).

Recommendations are based on the identified existing gap areas in National Zoological Park after taking into account the CZA Guidelines (CZA) as well as the pilot studies conducted in different zoos under Conservation Breeding Programme and also considering their natural habitat *i.e.*, Keibul Lamjao National Park, Manipur India.

Conclusion

Identification of existing gap areas have been done in terms of seasonal environmental enrichment by the assessment of behavioral responses for the period of February 2016 to

January 2018. Injuries, heatstroke and food monopolization by dominant individuals were found to have negative impact on the captive population. By examining the gaps areas between the existing enrichment practices and the standard CZA guidelines, recommendations were made to reduce or to eradicate inappropriate factors present inside the enclosure. This study will lead to the significance regarding requirement of scientific and season-specific enclosure enrichment for the sustainable population management of Manipur Brow-antlered deer in National Zoological Park, Delhi, India.

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