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Study of stress on caged phasianids in the national zoological park, New Delhi

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Abstract
With the increase in the rate of extinction and changing environmental conditions, the zoological parks around the globe face the pressure of successful breeding of their captive animal populations. The appraisal of stress on animals bred in captivity is important to ensure appropriate behavior and their successful breeding. High levels of stress not only pose threats to the well being of the animal but also decrease the viability of their offsprings. The study attempted to identify stress in the captive phasianids of the National Zoological Park, New Delhi. The study took into account the behavioral and breeding patterns of the phasianids, along with chick mortality and the visitor influence on these bird species. It was found that most of the phasianids face stress due to inadequate enclosure conditions and visitor pressure. Their behavior and breeding pattern was indicative of the same. Moreover, the chick mortality was also high. The study made an attempt to provide various enrichment techniques to reduce the stress in these captive phasianids. However, these measures will only prove to be successful if they are properly implemented and monitored.

Keywords: phasianids, stress, captivity, abnormal behavior, breeding, visitor pressure, enclosure enrichment

Introduction
Phasianids are small to large, blunt-winged terrestrial birds [1, 2]. In most species, the males have vibrantly colored plumage [3], while the females have less colorful, dull plumage. They inhabit a diversity of habitats including rainforests, deserts, woodlands, cultivated lands, forest edges and alpine meadows [1]. They are Asian in their native distribution, except for the Congo peafowl (*Afropavo congensis)* from central Africa [4].
Phasianids mainly perform locomotory behaviors (walking, running, hopping, flying, etc.), comfort behavior (grooming, scratching and dust bathing) and feeding behaviors (digging and scatching) [2]. Foraging is an important part of the daily routine of phasianids [3].
Their courtship displays are perhaps the most spectacular among all the birds in the world [3]. Females select the nest site which is often located on the ground. Clutch size varies with species, from 2 to 20 eggs [1, 3]. Incubation begins after the last egg is laid and lasts from 18 to 29 days, depending on the species.
The major threat faced by these birds is habitat loss and degradation resulting from conversion of forest land for agricultural purposes [3]. Hunting and illegal trade also pose danger to these birds. Harvesting activities other than hunting also affect phasianid populations as they are predominantly ground feeding and ground- nesting habits.

Stress in captivity
Stress is defined as an experience of having internal or external demands that exceeds an individual's resources for responding to those demands [6]. While acute stress responses can be considered adaptive, chronic stress responses may prove dangerous to the long term health of the captive animal [5-8].
Zoos work to improve their enclosures to make it fit for the animals. However, due to altered surrounding environment, a lot of animals show evidences of stress in captivity.
There are various stressors in captivity. Captive animals need to engage in a variety of species-specific behaviors such as nesting, mating and reproduction, foraging, defending territories etc. When an animal is unable to perform these behaviors, which normally allows it to control its environment, it is likely to be under stress [9, 10]. Another contributor to captivity induced stress is restricted movement [11, 12]. This may result in behavioral modifications and give rise to stereotypic behavior [13]. Increased proximity to humans may reduce the incidence of species typical behavior [10]. Moreover, disturbance caused by visitors often initiates stereotypical behavior [14, 15].
Therefore, in order to establish successful breeding populations, it is important to study the stressful conditions that the animals face, which could hinder the successful breeding of the species. Determining how captivity alters expression of species- specific behaviors is a component of building captive environments [16].

Ethology: The study of behavior
Ethology is the biological study of behavior [17]. Behavioral study is an important tool in the assessment of animal welfare [18].
In order to correctly record these behaviors, methods of

sampling the behaviors must be used. There are various sampling methods used in performing observational studies of behavior [19]. The behavioral sampling method used in this study was the focal-sampling method, which is one of the most common methods of behavior sampling. Focal-animal sampling involves recording all of the actions of one animal at intervals for a short pre-determined time period [19].

The study attempted to assess the causes and consequences of stress in captivity on the basis of the behavioral and breeding patterns of phasianids.

Method

Study Area

The study area was the National Zoological Park (NZP), which is a 176-acre zoo in Delhi, India. The National Zoological Park has two aviaries where various phasianid species are kept.

Sample Size

A sample size of two enclosures each were selected for every species from the off- display and the on- display aviary, that is, four enclosures per species.

Table 1

Species	No. of individuals off display		No. of individuals on display	
	Male	Female	Male	Female
Golden Pheasant	2	2	2	2
Silver Pheasant	2	4	1	2
Edward's Pheasant	2	1	2	1
Red Jungle Fowl	4	4	2	2

Collection of Data

The methodology adopted for the study involved the collection of primary data through direct observation of behavioral modifications and breeding pattern.

- **Behavioral Data:** Data was collected during the operational hours of the zoo between February and May 2016. Observations of behavior were made throughout the day in 2 minutes focal sampling per enclosure, four times a day. The frequency of occurrence of each behavior was calculated using the following formula:

$$\text{Frequency of behavior} = \frac{\text{Number of times a behavior was observed}}{\text{Total number of observations}} \times 100$$

- **Breeding *Pattern:*** The dates of egg laying, number of eggs laid, incubation period, number of chicks hatched and number of chicks survived was taken according to their respective occurrences. The breeding success was calculated using the standard formula for nesting success in birds [20].

$$\text{Breeding/Nest Success} = \frac{\text{No. of young that leave the nest}}{\text{Total no. of eggs}}$$

- **Parameters for identification of stress:** The stress on phasianids was determined on the basis on the following pre-defined parameters:
  a. Enclosure size,
  b. Behavioral modifications,
  c. Breeding success (Clutch size, incubation period and chick mortality), and
  d. Influence of visitors.

Study Limitations

There may be other parameters for stress assessment but this study was focused on the above mentioned stress parameters as it was time bound. The seasonal pattern was not observed in this study.

Result

The study was conducted in the National Zoological Park, New Delhi from February to July 2016 on four species of phasianids to assess stress with respect to the following parameters.

Enclosure Size. The enclosure size of the phasianids was approximately 36 m^2 for all the species under the study as compared to the standard size recommended by the Central Zoo Authority which is around 80 m^2 (Figure 1).

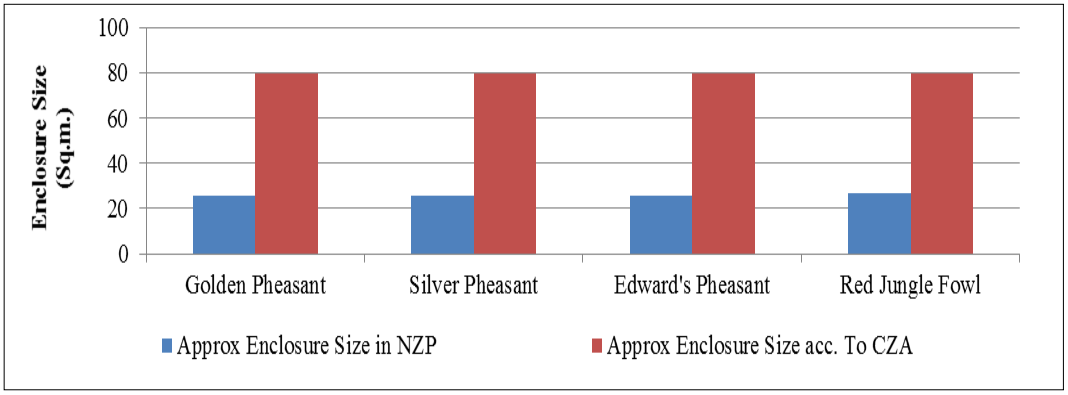

Fig 1: Comparison of enclosure sizes of Phasianids as designated by Central Zoo Authority with the enclosures of phasianids in the NZP.

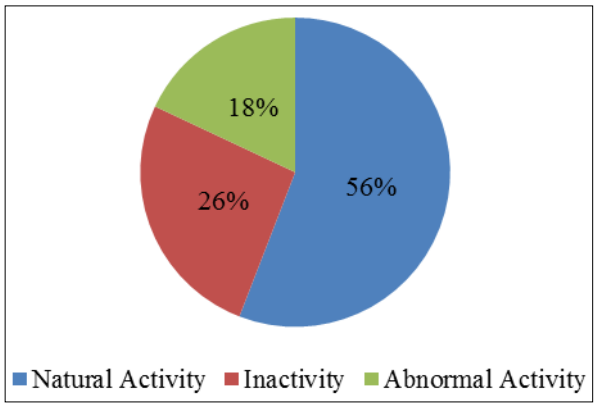

Fig 2: Behavior trend in off-display enclosures.

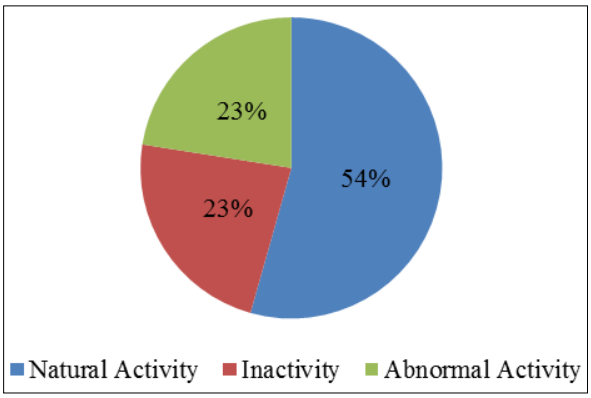

Fig 3: Behavior trend in on-display enclosures.

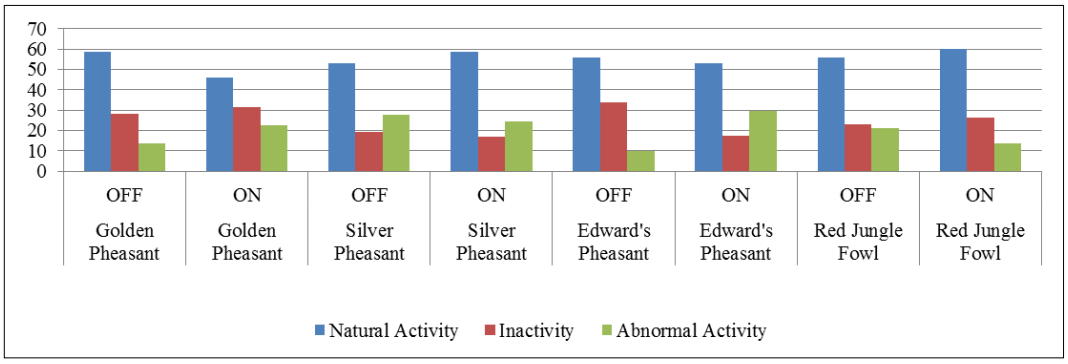

Fig 4: Species-wise behavioral trend in off-display and on-display enclosures.

Behavioral Modifications

For behavioral observations, a total of 238 observations were made for each individual and a total of 476 minutes were spent per enclosure. For assessment, behaviors were classified into three main categories: natural behavior, inactivity (standing, resting and remaining out of sight) and abnormal behavior (pacing, paying attention to adjacent cell, distracted by visitors and aggressive behavior). Moreover, comparison was also done between the off-display and the on-display enclosures.

The most frequently observed behaviors were the natural behaviors. However, significant levels of inactivity and abnormal behavior were also observed, as is apparent from figures 2 and 3. Further, on comparison of behaviors of off-display and on-display enclosures, it was found that natural behavior was predominant in both the aviaries but inactivity was higher in off-display enclosures and abnormal behavior was more frequently observed in on-display enclosures.

Breeding Success

It was found that breeding success was quite low in all the species. However, when compared to the on-display enclosures, the individuals in the off-display enclosures showed slightly higher rates of breeding success (Table 1).

Table 1: The breeding success of the phasianids.

Species	Total no. of eggs laid	Total no. of eggs hatched	Total no. of chicks survived	Breeding Success (%)
Off-Display				
Golden Pheasant	19	1	0	0
Silver Pheasant	32	14	5	15.63
Edward's Pheasant	6	0	0	0
Red Jungle Fowl	24	13	3	12.5
On- Display				
Golden Pheasant	5	0	0	0
Silver Pheasant	8	4	0	0
Edward's Pheasant	10	0	0	0
Red Jungle Fowl	11	0	0	0

Influence of Visitors

For every two minutes of observation, the approximate visitor number was counted per enclosure and the number of times the species was disturbed by the presence of visitors, that is, either staring at the visitors or moving towards/away from them, was also observed.

The correlation between the total number of visitors and the total number of times the species was distracted due to the presence of visitors was also calculated. The correlation coefficient was 0.85. This indicates that the more the number

of visitors, the more times the species got distracted.

Discussion

Stress is the body's reaction towards a challenging condition [21]. However, prolonged periods of stress may result in maladaptive changes. This study attempted to assess stress on the phasianids of the National Zoological Park, Delhi using various parameters, such as, enclosure size, behavioral modifications, breeding success and influence of visitors.

Phasianids are known to be terrestrial birds as they spend most of their time foraging. Therefore space restrictions may be a cause of stress in these species, as seen in the NZP, where the enclosures are much smaller than those recommended by the Central Zoo Authority.

The behavioral analysis illustrated a similar picture. Every species is known to perform certain "*species-specific behavior*". Such behaviors are largely internally motivated and occur without stimulation [10]. The major species-specific behavior of phasianids is "foraging". Other frequently occurring natural behaviors are comfort and grooming behavior, locomotion and vocalizations [3]. In case of the phasianids of NZP, natural behaviors were the most dominant. The abnormal behaviors were not as frequent as natural behaviors, but when observed, they were repetitive, and hence could be stereotypical behaviors [22]. Such stereotypical behaviors are indicative of stress.

Furthermore, the breeding success of the phasianids was found to be extremely low. The overall chick mortality was high. The major reasons for this high mortality were predation by mouse and snake and the lack of live insects in their diets [23].

In addition, the presence of visitors was found to be one of the major pressures to the phasianids in captivity. This can also be said as the occurrence of abnormal behavior and unsuccessful breeding was more often observed in the on-display enclosures.

Hence, it can be concluded that the phasianids in the NZP faced stress due to various factors like, space restrictions, visitor pressure, etc. and this was indicated in their behavior and breeding patterns. The individuals on-display were more prone to stress than the off-display ones.

Therefore, adequate habitat conditions and enclosure enrichment strategies must be applied to tackle the problem of stress these captive phasianids in order to facilitate natural behavior and successful breeding.

Newberry [24] has defined environmental enrichment as "*an improvement in the biological functioning of captive animals resulting from modifications to their environment*".

The following enrichment techniques could be implemented enhance behavior of phasianids as well as establish their successful breeding populations.

- For decreasing inactive behavior, adequate space is required for proper movement [25]. This would decrease boredom, stress and promote activity in phasianids. This can be done by decreasing the height of the enclosure and increasing the surface space [26], since the phasianids spend most of the time on the ground. Moreover, it is important to provide the phasianids with retreat spaces and hiding spaces within the enclosure in order to avoid extreme heat conditions and continuous exposure to visitors [10].
- To increase the breeding success, the authorities must ensure minimum levels of disturbance to phasianids during their breeding season. Therefore, if possible, the phasianid exhibits should be closed for visitors, atleast for the months of March and April. Moreover, adequate temperature and moisture conditions must be maintained for proper egg laying and successful hatching.
- For increasing chick survival, firstly, the enclosures should be made predator proof. Another very important measure for increasing chick survival rate is to provide the chicks live insects as food [3, 23]. This is very important for their healthy development.
- The Edward's pheasant is native to Vietnam. Therefore, it prefers exceedingly damp habitat conditions [27]. They also require dense vegetation cover [28]. Therefore, humidifiers could be installed in their enclosures to maintain high levels of humidity.

Conclusion

The study proved that the phasianids of the National Zoological Park, Delhi are under stress. The major causes of stress were found out to be space restrictions, visitor pressure, predator pressure and inappropriate enclosure conditions. The behavioral and breeding patterns were pointing towards the same. Therefore, appropriate enrichment for these phasianids is required to improve the environmental conditions and reduce the stress. Some of these methods have been suggested in this research.

However, these enrichment strategies would only be successful if they are properly implemented and monitored. It is imperative to assess the impacts these enrichment techniques on the behavior and breeding of phasianids.

Moreover, studies must be conducted periodically for few years to accurately establish the stressors which might have been missed during this short-term study. This would help the authorities take appropriate measures to ensure the absolute well-being of these phasianids.

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