



RESEARCH PAPER

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A study on diurnal activity pattern and time budget analysis of captive Indian peafowl (*Pavo cristatus*) in monsoon, winter and summer seasons at Alipore zoological garden, Kolkata, India

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Article published on September 06, 2024

Key words: Activity budget, Behavioural patterns, Focal sampling, High frequency behaviours, *Pavo cristatus*

Abstract

Animal in captivity can serve as ambassadors for the wild ones. As behavioural data can help address the specific needs of captive animals and can be used as a welfare indicator, a diurnal behavioural study and time budgeting of a male Indian peafowl, *Pavo cristatus* was carried out from June 2023 to May 2024, at Alipore Zoological Garden, Kolkata, India. The goal of this study was to explore the overall seasonal behavioural patterns and hourly activity budget from 10.00h to 17.00h by using focal sampling method with 33,600 minutes of observations. The present study identified total nine categories of behaviour including three types of feeding behaviours, one standing, three locomotion, four resting, one displaying, three grooming, one vocalization and excretory, and two other types of activities during the observation period. Significant variations in the behaviours of the studied peacock were noticed among the three different seasons, monsoon, winter and summer; as well as within the different hours of a day. The study revealed that the peacock was primarily engaged in high frequency behaviours through-out all of the seasons. When comparing the data of activity budget among the seasons, it was noticed that, among high frequency behaviours, feeding of offered feed (10.42%), standing (39.94%), roosting (6.37%) etc. was significantly higher in summer, while the peacock was predominantly engaged in foraging (8.37%), walking (14.09%), preening (30.32%) etc. in winter season. Displaying activity was the most frequent behaviour of the peacock during the rainy season, whereas, low frequency behaviour like yawning and animal interaction only occurred during the winter. Standing was significantly higher in summer (38.33%), while, displaying (40.84%) and preening (30.56%) reached peak during monsoon and winter respectively when the first hour (10:00h to 11:00h) of the observational period was considered. On the contrary, standing was prevalent in monsoon (23.47%) in the last hour (16:00h to 17:00h), while human interaction was detected solely during that particular hour in summer season (5.83%). This observational study will provide necessary information about the behavioural patterns of these majestic birds inside the enclosure which will act as an aiding tool in determining the alteration of their activity budget with respect to their wild conspecific that will ultimately help in adopting conservation efforts and ensure their welfare.

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Introduction

The Indian peafowl, *Pavo cristatus*, also called as the common peafowl or blue peafowl, belonging to the family Phasianidae (commonly called as pheasant) and order Galliformes (Ali and Ripley, 1989; Johnsgard, 1986), is a peafowl species native to the Indian subcontinent, inhabiting the scrub-jungles and forest edges as well as agricultural fields, along streams with proper vegetation and in close proximity to human habitations in a semi-feral condition (Johnsgard, 1986). Indian peafowl exhibits striking sexual dimorphism where, male peafowls, generally referred to as 'peacocks', have stunning, iridescent blue and green plumage, with a fan-like crest on top of their head and have worldwide fame for the large, elaborate train made up of elongated upper-tail covert feathers bearing vibrant eyespots. These captivating feathers, which are raised into a fan and trembled during a display, are the inseparable part of their courtship ritual. On the other hand, female peafowls, commonly known as 'peahens', lack the train and have a white face and iridescent green lower neck, with a comparatively smaller crest on top of their head and a dull brown plumage. This majestic bird was declared as National Bird of India in 1963 due to its worldwide distribution throughout the country and its glorious position in mythology (Kushwaha and Kumar, 2016). Peafowls are omnivorous, feeding on a wide range of diet that includes seeds, insects, fruits, small mammals, and reptiles, while, in rural areas, they willingly consume a range of cultivated crops such as groundnut, tomato, paddy, chilli, and even bananas (Johnsingh and Murali, 1978). This symbol of royalty is easy to detect for its loud calls, and often act as an indicator of the presence of a predator like tigers in wild.

Though in India, this elegantly exotic bird is given the utmost protection by including it under the Schedule I of Wildlife (Protection) Act, 1972, its population is still facing various threats to its survival and well-being, due to habitat loss and fragmentation, poaching, predation, human-peacock conflict, contamination of its food source etc. and in recent years, there has been a growing concern about their

declining status. Hence, it is very much essential to address these threats through conservation efforts and thorough research for their long-term survival, as they act as convenient bio indicators of healthiness of bionetwork. Thereby, for keeping their healthy population, proper management by taking conservation strategies, is of utmost importance (Fuller and Garson, 2000). Indian peafowls play a vital role in maintaining the ecological balance and ecosystem functioning by dispersal of seeds, insect control, territorial influence etc. Behavioural studies are the key components in understanding these ecological requirements of peafowl to protect these resplendent creatures and their habitat.

Animal behaviour refers to an organised action helping the animals to survive, through communication with the environment and with each other, as well as any kind of accomplishment exhibited by an animal with the help of Certain intrinsic stimuli such as craving, anxiety etc., and also extrinsic ones like resources, competitors, environmental factors and the obtainability of habitats (Gaulin, 1979; Zielinski *et al.*, 1983). Information about animal behaviour depicts about how the animals adapt and survive in nature and has been in the forefront of conservation initiatives ensuring their overall welfare.

Thus, a comprehensive understanding of the species' behaviour in captivity is crucial to confirm the findings in wild and for the ultimate enhancement of health of the animals (Sutherland and Gosling, 2000; Tanaka *et al.*, 2001). Animal behavioural pattern is species specific and depends on the amount of time and energy allocated in each activity by the animal (Adolfsson, 2009). Basically, activity pattern is the specific pattern of an animal's daily activities while, activity budget refers to the various behaviours displayed by the animal in a definite time period and is generally noted as the percentage of activity (Baskaran, 2013).

This acts as an important aiding tool for providing necessary baseline information about the animal and

differentiating between the behaviours of the species of interest in captivity and in wild. Overall, keeping peafowls in controlled environments can contribute to their conservation, reducing their risk of extinction; provide valuable insights about their behaviours; and protect from potential threats that they would face in the wild.

The continuous destruction of natural habitats has led to an urgent need to study the ecological and diurnal behaviours of Indian peafowl to know their overall behaviour and physical fitness for better understanding their requirements for the purpose of conservation.

Very few ecological studies have been conducted on the day long activities and different behaviours of Indian peafowls (Miazi *et al.*, 2020; Naseer *et al.*, 2018; Kaur and Kler, 2017).

For this reason, the present investigation was indent to study on diurnal activity budget of male Indian Blue Peafowl, *Pavo cristatus*, during monsoon, winter and summer season over a period of approximately 12 months in Alipore Zoological Garden, Kolkata, India. The primary objective of this study was to design an ethogram of the studied animal to measure the seasonal variation in behaviour during the observation days to fill the lacuna of data of the prior studies on peafowls.

Materials and methods

Study area

The Alipore Zoological Garden (22°32'9.29" N, 88°19'55.39" E), founded around 1800 by Richard Wellesley, the Governor-General of India holds the distinction of being one of the oldest zoological parks in India and continues to be a prominent tourist attraction. This zoological park occupies a total area of 18.811 hectares, which equates to almost 46.48 acres.

It is home to a diverse range of fauna, including approximately 108 species of mammals, birds, and reptiles, representing a total of nearly 1,266 animals.

The Alipore Zoological Garden plays a major role in supporting biodiversity, providing a habitat for several wintering migratory birds. This zoological garden experiences a moderate climate with summers from March to June. Temperatures can reach up to 40°C during this period, with an average of 36°C. During the winter months, from December to February, the region experiences a chill, with average temperatures hovering around 13°C. However, the temperature can drop as low as 10°C during this period. The rainy season lasts from July to September, when the city receives a substantial amount of rainfall, averaging 1641.4 mm annually.

Studied animal

The behavioural study was conducted upon an Indian Blue Peacock, *Pavo cristatus* of about 12 years old, with body length of 100-115 cm and body weight of about 7 kg. The zoo authority provided some specific healthy mixture of foods necessary for maintaining a good health including soaked gram (20g), soaked maize (20g), crushed maize (25gm), chattu (10g), minced meat (20g), ants egg (20g), boiled egg (1/2 piece), leafy vegetables (25g), pumpkin, onion, garlic (50g), in two separate food pots. The feed was given to the peacock once in a day before 9:30 am, every day of the week, as there was no fasting day for the peafowls.

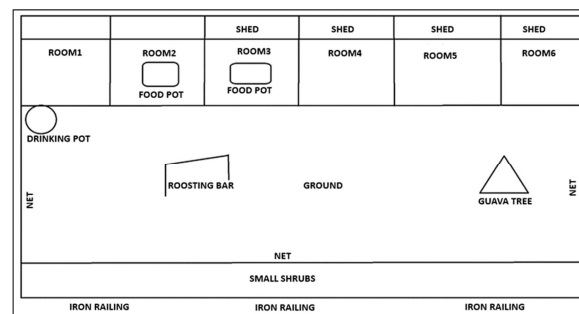


Fig. 1. Layout of peacock enclosure of Alipore Zoological Garden, Kolkata (based on visual observations during present study)

Enclosure of the animal

The Indian blue peafowl was kept in a large cage with the area of 756.51 sq.m. approximately. It is situated in the east side of the zoo. The frontside of the enclosure (Fig. 1) is covered top to bottom by two

layered netted fences. There is another layer of railing in the front, made of iron rods to protect the peafowls from the visitors. The other three sides of the cage are surrounded by single layer of netted fence. Some small to medium sized shrubs are present at the front side behind the iron railing. There are six separate rooms with concrete roofs in total, inside the enclosure for the shelter of the peafowls. There is another shelter on the top of that roof, which is covered with asbestos, where the peafowls take rest in their resting period. Two different food pots are kept in two different rooms and a drinking pot is also kept at the corner side of the enclosure. There is an open ground area inside the enclosure where two iron bars and a guava tree are present for roosting purpose.

Data collection

The study on the diurnal behavioural pattern of Indian blue peacock at Alipore Zoological Garden spanned around 12 months, encompassing 4 months from each of the three seasons monsoon, winter and summer. Primary observations were carried out on the Indian blue peacock for recognizing the behavioural patterns and then data were recorded during day time from 10 am to 5 pm twice in a week, through direct observation from a suitable, unobstructed view point without disturbing the animal or its environment, with unaided eye by using focal sampling methods (Altmann, 1974) and marked on excel sheet. A total of 33,600 minutes observations were recorded.

Table 1. Ethogram used for collecting behavioural data of peacock, *Pavo cristatus* in captivity at Alipore Zoological Garden, Kolkata (based on Miazzi *et al.*, 2020; Naseer *et al.*, 2018; Kaur and Kler, 2017)

Category	Type	Description
Feeding	Feeding offered	Mixture of foods offered by the zo authority.
	Foraging	Roaming in the ground for the search of food such as grain, insects, small reptiles, figs, leaves, seeds etc.
Standing	Drinking	Action or habit of consuming water from an offered pot.
	Standing	Still as a statue upon two legs, animal watched intently, its senses focused on the stimuli.
Locomotion	Walking	Movement without any additional behaviour with help of two legs.
	Running	With a powerful stride by help of two legs, bird shot forward, leaving a trail of dust in its wake.
Resting	Flying	Leaping into air, flapping wings briefly before landing with a soft thud.
	Sitting inside	Sitting inside a shade.
	Sitting outside	Sitting outside on ground.
	Roosting	Without any action sitting on a tree or column of stone.
Displaying	Yawning	Opening of mouth for 2-3 seconds.
	Displaying	Vibrating and spreading of train feathers by male.
	Grooming	Beaks at its feathers, sometimes standing, sometimes sitting.
	Body shaking	Shaking of total body for cleaning dust particles.
Vocalization	Head shaking	Shaking head while preening.
	Calling	Emitting sound for communicate with others.
Excretory	Excretion	Eliminating or expelling waste matter from body.
Others	Animal interaction	Showing any manner of behaviour or interacting with another animal.
	Human interaction	Showing any manner of behaviour or interacting with people.

Ethogram

An ethogram is a comprehensive inventory of behaviours displayed by an animal, serving as a tool for understanding and analysing its actions. The behaviours of the studied animal were categorized and an apt name was denoted to each behaviour with an accurate description. Based on previous behavioural studies on Indian Peafowl (Miazzi *et al.*, 2020; Naseer *et al.*, 2018; Kaur and Kler, 2017) a proper ethogram was created. Total 19 behaviours

including feeding offered feed, foraging, drinking, standing, walking, running, flying, sitting inside, sitting outside, roosting, yawning, displaying, preening, body shaking, head shaking, calling, excretion, animal interaction and human interaction were identified for the blue peacock in Alipore Zoological Garden. The time budgeting of diverse activities showed by the studied Indian blue peacock in a definite time span provided an opportunity for making evaluations between the behaviours

expressed by wild and captive peacock as well as pointing out the alterations observed and finding out the causes of such differences.

Data analysis

For the determination of diurnal activity time budget, initially the activities exhibited by the studied peacock were differentiated into various behavioural categories and then duration for each activity was recorded. The obtained data from simple observation on the studied Indian peafowl were analyzed and calculated respectively as mean percentage of time, engaged in each behaviour (Crockett and Ha, 2010). All the necessary graphical representations for the study were constructed using MS-Excel software and the observational data were presented as mean percentage \pm standard error (SE). One-way analysis of variance (ANOVA), followed by Duncan’s multiple range tests (DMRT) was performed for multiple comparisons at the significance level of 0.05 to compare the different diurnal activity patterns among the three different seasons as well as within the studied hours.

Results

A total of 33,600 minutes of diurnal behavioural data of *Pavo cristatus* were obtained for the current study from each of the three studied seasons. Analysed data were presented as a percentage of time spent by the peacock.

Diurnal activity budget of peacock during monsoon, winter and summer season

Through-out the monsoon season (Fig. 2), the peacock spent maximum amount of the time in high frequency behaviours (97.24%) and remaining time in low frequency activities (2.76%). Among high frequency behaviours, the studied peacock primarily exhibited displaying, accounting for 42.74% of its time, followed by preening (18.37%), standing (15.81%), walking (5.71%), foraging (4.35%), Feeding of offered feed (4.17%) and roosting (3.47%). Human interaction only constituted 1.59% of the observation period.

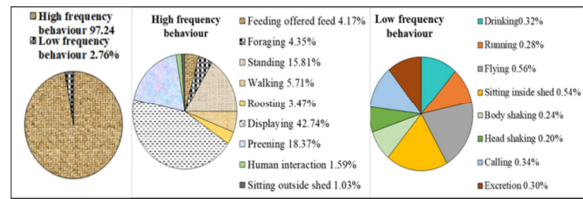


Fig. 2. Percentage of time spent in different behavioural categories by peacock, *Pavo cristatus* during monsoon season at Alipore Zoological Garden, Kolkata

When considering the low frequency behaviours, the peacock was predominantly engaged in flying (0.56%) followed by sitting inside the shed (0.54%), calling (0.34%), drinking (0.32%), excretion (0.30%), running (0.28%), body shaking (0.24%) and head shaking (0.20%).

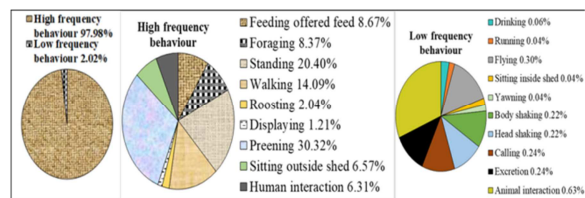


Fig. 3. Percentage of time spent in different behavioural categories by peacock, *Pavo cristatus* during winter season at Alipore Zoological Garden, Kolkata

During the months of winter (Fig. 3), the studied peacock dedicated maximal time in high frequency behaviours (97.98%), whereas, the low frequency behaviours were noted to be accounted for only 2.02% of its time. When considering the high frequency behaviours, the peacock was mostly involved in preening (30.32%) followed by standing (20.40%), walking (14.09%), feeding of offered feed (8.67%), foraging (8.37%), sitting outside the shed (6.57%), human interaction (6.31%), roosting (2.04%) and displaying (1.21%) activities.

When considering the low frequency activities, the studied peacock interacted with other animals (0.63%) most of the time of the observation period, followed by flying (0.30%). The studied animal spent equal amount of time for the calling and excretion activity (0.24%), and also for the body shaking and

head shaking activity (0.22%). Drinking behaviour was accounted for only 0.06% of its time, while, running, sitting inside the shed and yawning, each of the behaviour was found to occur with 0.04% of the study period.

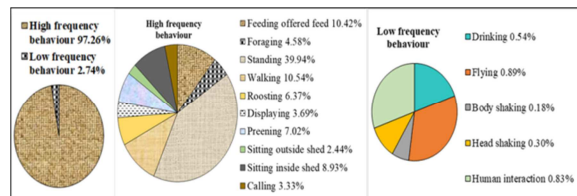


Fig. 4. Percentage of time spent in different behavioural categories by peacock, *Pavo cristatus* during summer season at Alipore Zoological Garden, Kolkata

During the summer season (Fig. 4), the peacock was predominantly engaged in high frequency behaviours (97.26%) and spent only 2.74% of its time in low frequency activities. Among the high frequency activities, the peacock primarily displayed standing (39.94%) followed by walking (10.54%), feeding of offered feed (10.42%), sitting inside the shade (8.93%), preening (7.02%), roosting (6.37%), foraging (4.58%), displaying (3.69%) and calling (3.33%). Sitting outside the shade was recorded for only 2.44% of its diurnal hours during summer.

When the low frequency behaviours were taken under consideration, it was observed that, the peacock dedicated 0.89% of its diurnal time in flying activity followed by human interaction (0.83%), drinking (0.54%), head shaking (0.30%) and body shaking (0.18%) of its diurnal time.

Comparison of diurnal activity budget of the peacock among three seasons

When comparing the data of activity budget among the three studied seasons, it was noticed that, among high frequency behaviours, feeding of offered feed and foraging was significantly higher in summer and winter season respectively ($P < 0.05$; DMRT), whereas, displaying was the most frequent behaviour of the monsoon season ($P < 0.05$; DMRT). Standing, roosting, sitting inside shed and calling was

significantly higher during summer ($P < 0.05$; DMRT), while, the peacock was predominantly engaged in activities like walking, preening, sitting outside the shed and human interaction in winter ($P < 0.05$; DMRT) (Fig. 5).

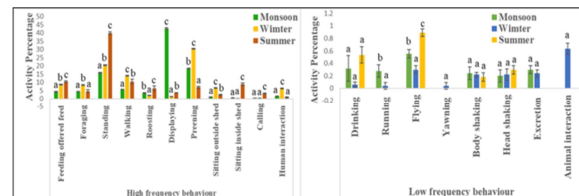


Fig. 5. Percentage of time spent in different activities under the high frequency and low frequency behavioural category by peacock, *Pavo cristatus* in three different seasons at Alipore Zoological Garden, Kolkata. Values are mean \pm SE. Bars with different letters are significantly different ($P < 0.05$) using DMRT after two-way ANOVA

Regarding low frequency behaviours of the studied peacock, it was observed that drinking and flying reached peak during summer ($P < 0.05$; DMRT). On the contrary, behaviours like running and excretion was noted to be absent during that particular season. When considering the behaviours, body shaking and head shaking, it was noticed that, there were no significant variations among the three seasons (DMRT). The study also revealed that yawning and animal interaction only occurred during the winter season.

Hourly activity time budget of peacock during monsoon season

The findings from the hourly activity budget during the monsoon season showed that, among high frequency behaviours, feeding of offered feed, foraging and displaying occurred through-out the day but was predominant from 12:00h to 13:00h, whereas, behaviours like standing, preening, sitting outside the shed and human interaction reached peak during the final hour (16:00h to 17:00h) of the observational period. Walking and roosting was notably higher during the first (10:00h to 11:00h) and second hour (11:00h to 12:00h) of the observation period respectively (Table 2).

Table 2. Mean percentage of hourly activity pattern of peacock, *Pavo cristatus* from 10:00h to 17:00h during monsoon season at Alipore Zoological Garden, Kolkata

Behavioural category	Behaviours	Hours							
		10.00-11.00	11.00-12.00	12.00-13.00	13.00-14.00	14.00-15.00	15.00-16.00	16.00-17.00	
High frequency behaviour	Feeding offered feed	3.47	3.61	5.56	3.75	3.19	5.14	4.44	
	Foraging	2.64	2.78	7.08	3.33	4.72	4.58	5.28	
	Standing	14.86	11.11	12.78	13.06	17.22	18.19	23.47	
	Walking	8.61	4.72	3.89	5.97	3.89	6.25	6.67	
	Roosting	2.64	6.25	2.22	4.03	4.31	3.06	1.81	
	Displaying	40.83	50.14	51.94	47.08	47.78	41.94	19.44	
	Preening	24.03	16.25	13.75	18.61	15.97	15.83	24.17	
	Sitting outside shed	0.69	0.56	1.53	0.97	0.83	0.83	1.81	
Low frequency behaviour	Human interaction	0.00	0.28	0.00	0.00	0.00	0.56	10.28	
	Drinking	0.42	0.69	0.00	0.28	0.00	0.56	0.28	
	Running	0.00	0.42	0.28	0.42	0.14	0.28	0.42	
	Flying	0.69	0.97	0.28	0.56	0.56	0.56	0.28	
	Sitting inside shed	0.28	0.69	0.14	0.42	0.28	0.83	1.11	
	Body shaking	0.28	0.00	0.00	0.42	0.28	0.56	0.14	
	Head shaking	0.14	0.42	0.00	0.28	0.14	0.28	0.14	
	Calling	0.00	0.56	0.42	0.28	0.69	0.42	0.00	
Excretion	0.42	0.56	0.14	0.56	0.00	0.14	0.28		

When the low frequency behaviours were considered, it was observed that, the peacock was predominantly engaged in drinking, flying and head shaking during the second hour (11:00h to 12:00h), whereas, body shaking and sitting inside shed peaked during the second last (15:00h to 16:00h) and the final diurnal hour (16:00h to 17:00h) respectively. Activity like calling was noted to be absent during the initial (10:00h to 11:00h) and final hour (16:00h to 17:00h) of the study period and was significantly higher from 14:00h to 15:00h, whereas, absence of running and excretion was noticed in the first (10.00h to 11.00h) and fifth hour (14:00h to 15:00h) respectively.

The comparison of data within the hours during monsoon revealed that, under high frequency behaviours, displaying activity dominated all the hours except the final one (16:00h to 17:00h) when significantly higher value was found for preening. The second highest value from 10:00h to 14:00h was observed for preening, whereas, for the rest of the hours standing remained as the second highest activity performed by the studied peacock. Flying was notably higher during first (10:00h to 11:00h), second (11:00h to 12:00h) and fourth hour (13:00h to 14:00h) (along with excretion), while, calling remained dominant during the third (12:00h to 13:00h) and fifth hour (14:00h to 15:00h) of the

observational period. The peacock was predominantly engaged in sitting inside shed for the last two diurnal hours (15:00h to 17:00h).

Hourly activity time budget of peacock during winter season

During the winter season, the peacock showed a definite behavioural for the high frequency behaviours. Feeding of offered feed was found to be dominant during the second last hour (15:00h to 16:00h), while, the lowest value for sitting outside shed was observed in that particular hour during this season. Foraging was significantly higher during third hour (12:00h to 13:00h) whereas; activities such as standing and preening peaked from 13:00h to 14:00h. Value for walking reached peak from 14:00h to 15:00h, while, the studied bird was mainly engaged in human interaction during the final hour (16:00h to 17:00h) of the observational period. Behaviours like roosting and displaying was prevalent from 11:00h to 12:00h (Table 3).

Among low frequency behaviours, drinking, running and sitting inside shed occurred at a lower rate during this season. Flying was observed to be significantly higher for the first two hours (10:00h to 12:00h) and second last hour (15:00h to 16:00h), while, yawning was noticed only from 14.00h to 15.00h and 15.00h to

16.00h. Body shaking and calling reached peak during the second hour (11:00h to 12:00h), whereas, the peacock was primarily engaged in head shaking, excretion and animal interaction during the third hour (12:00h to 13:00h) of the observation period.

When the activity budget data were compared within the different hours of the day, the result indicated that, among high frequency activities, preening

dominated all of the hours, followed by standing. However, under low frequency behaviours, animal interaction was noted to be significantly higher through-out the day except the third (12:00h to 13:00h) and second last hour (15:00h to 16:00h) when excretion and flying reached peak respectively. Behaviours like body shaking and calling were also at their highest level from 11:00h to 12:00h along with animal interaction.

Table 3. Mean percentage of hourly activity pattern of peacock, *Pavo cristatus* from 10:00h to 17:00h during winter season at Alipore Zoological Garden, Kolkata

Behavioural category	Behaviours	Hours							
		10.00-11.00	11.00-12.00	12.00-13.00	13.00-14.00	14.00-15.00	15.00-16.00	16.00-17.00	
High frequency behaviour	Feeding offered feed	11.39	7.50	4.17	4.58	6.39	14.31	12.36	
	Foraging	8.47	8.89	10.14	6.25	7.64	9.03	8.19	
	Standing	22.22	16.25	20.97	26.25	24.03	16.11	16.94	
	Walking	13.33	13.06	14.31	13.47	17.92	14.31	12.22	
	Roosting	2.50	4.03	0.69	0.83	1.94	1.94	2.36	
	Displaying	1.81	4.72	0.69	0.56	0.00	0.69	0.00	
	Preening	30.56	29.31	29.72	33.19	29.03	30.69	29.72	
	Sitting outside shed	7.64	8.33	8.33	7.92	5.28	2.22	6.25	
Low frequency behaviour	Human interaction	0.28	5.14	7.78	4.58	5.97	9.44	10.97	
	Drinking	0.00	0.14	0.00	0.00	0.00	0.14	0.14	
	Running	0.14	0.00	0.00	0.14	0.00	0.00	0.00	
	Flying	0.42	0.42	0.14	0.14	0.28	0.42	0.28	
	Sitting inside shed	0.14	0.14	0.00	0.00	0.00	0.00	0.00	
	Yawning	0.00	0.00	0.00	0.00	0.14	0.14	0.00	
	Body shaking	0.14	0.56	0.14	0.42	0.28	0.00	0.00	
	Head shaking	0.28	0.00	0.56	0.42	0.14	0.14	0.00	
	Calling	0.14	0.56	0.28	0.28	0.14	0.14	0.14	
	Excretion	0.00	0.42	1.11	0.14	0.00	0.00	0.00	
Animal interaction	0.56	0.56	0.97	0.83	0.83	0.28	0.42		

Hourly activity time budget of peacock during summer season

When the result of hourly activity budget of summer season was considered, among high frequency behaviours, the peacock did not feed on offered feed from 12:00h to 14:00h, while, the highest value for that particular activity was found during the second last hour (15:00h to 16:00h). Foraging and sitting outside shed was significantly higher from 14:00h to 15:00h, whereas, the studied animal was predominantly engaged in standing from 13:00h to 14:00h. Walking and displaying dominated the initial hour (10:00h to 11:00h) of the observation period, while, preening and roosting was prevalent during the third (12:00h to 13:00h) and final hour (16:00h to 17:00h). Behaviour like human interaction was solely detected from 16:00h to 17:00h.

In case of low frequency behaviours, it was observed that drinking was predominantly high in the first hour (10:00h to 11:00h), whereas, the peacock spent most of its time by sitting inside the shed and head shaking from 12.00h to 13.00h. Body shaking occurred at higher rate from 15.00h 16.00h, while, calling was recorded to be dominant in the second hour (11.00h to 12.00h) (Table 4).

When comparing the data within the different observational hours, it was noticed that, among high frequency activities, standing was highest showed behaviour for all the observational hours except the last two hours (15.00h to 16.00h, 16.00h to 17.00h) when feeding and roosting had the highest mean value respectively. In the initial two hours (10:00h to 12:00h), walking had the second

highest value after standing, while, feeding was the second highest behaviour exhibited by the studied bird from 14.00h to 15.00h. Human interaction was only observed in the last hour (16.00h to 17.00h). During the first hour (10.00h to 11.00h), low frequency behaviours like sitting inside shed, body shaking and head shaking were totally absent. In the second (11:00h to 12:00h), third (12:00h to

13:00h) and fourth hour (13:00h to 14:00h) of the observational period, sitting inside shed occurred at a higher rate, whereas, during the fifth hour (14:00h to 15:00h) flying and calling was in peak. Calling was highest showed behaviour during the second last hour (15:00h to 16:00h) but in the final hour (16:00h to 17:00h), the peacock spent most of its time again by sitting inside the shed.

Table 4. Mean percentage of hourly activity pattern of peacock, *Pavo cristatus* from 10:00h to 17:00h during summer season at Alipore Zoological Garden, Kolkata

Behavioural category	Behaviours	Hours							
		10.00-11.00	11.00-12.00	12.00-13.00	13.00-14.00	14.00-15.00	15.00-16.00	16.00-17.00	
High frequency behaviour	Feeding offered feed	10.83	5.42	0.00	0.00	16.67	26.67	13.33	
	Foraging	7.50	2.92	1.67	0.00	8.33	4.17	7.50	
	Standing	38.33	48.33	39.58	63.75	47.50	25.42	16.67	
	Walking	22.50	10.83	6.25	7.08	9.17	7.92	10.00	
	Roosting	0.42	4.58	0.00	0.00	3.33	16.67	19.58	
	Displaying	10.83	3.33	0.00	0.00	0.00	0.00	11.67	
	Preening	7.08	9.17	14.17	7.92	0.00	5.42	5.42	
	Sitting outside shed	0.00	0.00	0.00	2.50	6.25	5.83	2.50	
Low frequency behaviour	Human interaction	0.00	0.00	0.00	0.00	0.00	0.00	5.83	
	Drinking	1.67	0.00	0.00	0.00	1.25	0.42	0.42	
	Flying	0.42	1.67	0.00	0.00	2.92	1.25	0.00	
	Sitting inside shed	0.00	8.33	32.50	13.33	1.67	1.67	5.00	
	Body shaking	0.00	0.00	0.00	0.42	0.00	0.83	0.00	
	Head shaking	0.00	0.00	1.25	0.83	0.00	0.00	0.00	
	Calling	0.42	5.42	4.58	4.17	2.92	3.75	2.08	

Activity budget of peacock in different seasons

From 10:00 to 11:00 hour

When comparing the data among the three seasons, it was observed that, in the first hour of observation period, within the high frequency behaviours, standing was significantly higher in summer (38.33%) followed by winter and monsoon, while, displaying (40.84%) and preening (30.56%) reached peak during monsoon and winter respectively. On the other hand, low frequency behaviours like flying (0.69%), body shaking (0.27%) and excretion (0.41%) was notably higher in monsoon, whereas, head shaking (0.27%) and calling (0.42%) dominated the winter and summer season respectively (Fig. 6).

From 11:00 to 12:00 hour

During the second hour of observation, it was noticed that, the peacock was predominantly

engaged in standing during summer (48.33%), whereas, displaying (50.14%) and preening (29.31%) was more prevalent during monsoon and winter respectively under high frequency behaviours. When low frequency behaviours were considered, both sitting (8.34%) and calling (5.42%) occurred at higher rate during summer season from 11:00h to 12:00h.

From 12:00 to 13:00 hour

During the third hour of observation, it was recorded that high frequency behaviour like standing was notably higher in summer (39.58%) followed by winter and monsoon. Displaying occurred at higher rate in monsoon (51.94%) but preening dominated the winter (29.72%). In case of low frequency behaviours, sitting (32.5%) and calling (4.58%) was found to be significantly higher in summer.

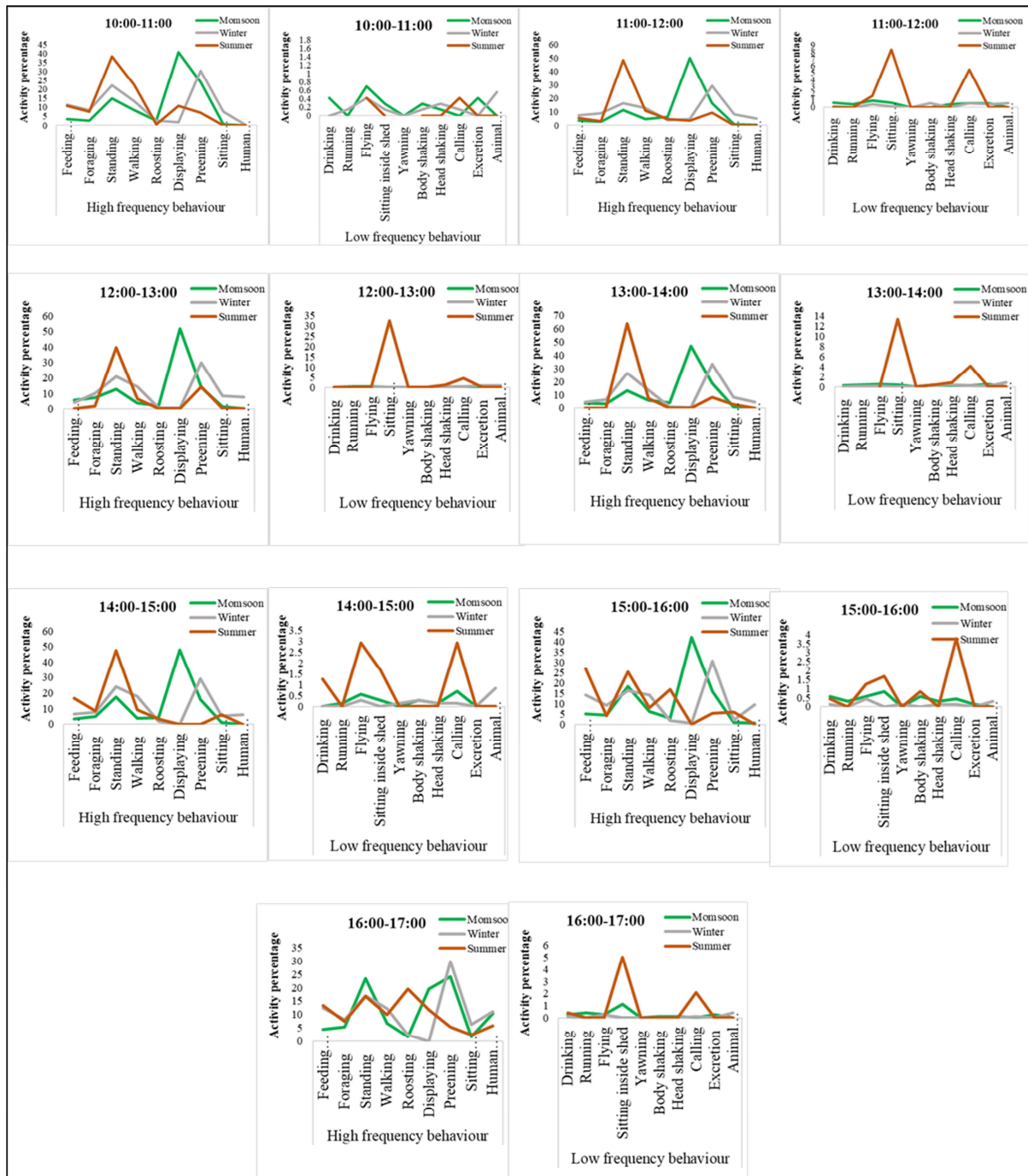


Fig. 6. Activity budget of peacock, *Pavo cristatus* in different seasons from 10:00h to 17:00h at Alipore Zoological Garden, Kolkata

From 13:00 to 14:00 hour

Among high frequency behaviours, the graph revealed that the studied peacock was predominantly engaged in standing during summer (63.75%) compared to the other two seasons, during the fourth hour of observational period. Displaying was still highest in monsoon (47.08%) and lowest in summer. Preening was at a higher rate in winter (33.19%) followed by

summer. In case of low frequency behaviours, sitting and calling reached peak again during the summer.

From 14:00 to 15:00 hour

In the fifth hour of the observation period, among the high frequency behaviours, the higher occurrence rate for standing was noticed during summer (47.50%), followed by winter and monsoon.

Preening was noted to be highest in winter (29.03%) while displaying had significantly higher value during the monsoon season (47.78%). Under the low frequency behaviours, flying (2.92%) and calling (2.92%) was predominantly high in summer, while, animal interaction reached peak in winter (0.83%) during this particular hour.

From 15:00 to 16:00 hour

The peacock spent most of its time in standing during summer (25.42%) followed by monsoon and winter from 15.00h to 16.00h, while, feeding (26.67%) and roosting (16.67%) was at its peak in summer among high frequency behaviours. Displaying dominated the other activities during the monsoon season (41.94%) while preening had significantly higher value during the winter season (30.69%). In case of low frequency behaviours, the studied bird was predominantly engaged in sitting inside shed during the summer (1.67%), whereas, in this season, calling (3.75%) reached the highest mean value.

From 16:00 to 17:00 hour

When analyzing the behaviours of the peacock in the final hour, it was noted that standing reached its peak in monsoon (23.47%), while roosting was very dominating during summer (19.58%) within high frequency activities. Preening showed considerably higher value in winter (29.72%) and moderate in the monsoon. In case of low frequency behaviours, both sitting inside shed (5%) and calling (2.08%) was notably higher in summer.

Discussion

The current case study was conducted on male Indian blue peafowl, *Pavo cristatus* for observing the changes in their behavioural pattern during three different seasons inside the enclosure. Observational studies on captive populations of this species have suggestively advanced our understanding of the subtle behavioural changes of peacocks inside the zoo, as well as the knowledge about the required necessary arrangements for the best management of peacocks in captivity.

Male Indian peafowl remain engaged for most of their time in displaying compared to other activities during the monsoon season, though age and sex of the species had an impact on their behaviour pattern (Dookia, 2015). Similarly, the present study also revealed that, the studied peacock devoted most of the time of monsoon in displaying (42.74%). Usually in wild, in the rainy season, peacocks spent maximum time in mating behaviours and for that reason displaying might occur more prominently during this season compared to other activities in order to attract the females. According to a prior study, there were no recordings of displaying activity during the hottest hours of the day, as it would be energetically costly to perform in the scorching heat (Gokula and Muthukrishnan, 2015). The present study also supported the findings that the studied peacock performed the displaying activity in very low frequency or not when the weather was too hot during the summer season. The displaying activity of feral peacocks were found to occur during the morning and late afternoon in summer (Petrie *et al.*, 1991; Walther, 2003). Here in captivity too, the studied bird was predominantly engaged in displaying during the first hour (10:00h to 11:00h) and the last hour (16:00h to 17:00h) of the day during summer season probably due to comfortable environmental temperature or might be due to the perfect angular light maximizing the reflecting value of iridescent plumage towards the target female.

Wild Indian peafowls have been known to spend less time in preening their train compared to those in captivity (Harikrishnan *et al.*, 2010). In a study, adult males were found devoting significantly more time in preening than sub-adult males and females, indicating a high maintenance cost associated with their elaborate trait feathers (Walther and Clayton, 2005). In the current study too, preening was notably higher in the captive male peafowl. So far, no specific reason has been found to explain why the peacock shows increased preening behaviour during the winter months. But the possible reason behind it might be to keep the feathers clean and oiled to stay dry and warm in cold weather.

Prior behavioural study on peafowl depicted that the Indian peafowl's standing behaviour is very much essential in aiding the bird to survive, by enabling it to watch the potential threats, survey its territory, and maintain a high level of alertness (Galusha and Hill, 1996). Here, in zoo also, standing was mostly observed during the summer season (39.94%), which might also be a significant strategy to mitigate energy loss and to avoid the scorching heat by taking it as a form of rest.

According to a study by Galusha and Hill (1996) peafowl spent most of their time in feeding and the standing and walking was noted as the next most common activities. Similarly, feeding was commonly observed for the studied peacock during the summer season. A prior report revealed that the peafowls' roosting habit was closely associated with the timing of sunset, but was not influenced by the temperature fluctuations (Navaneethakannan, 1984). In the current study, the roosting was also notably higher during the final two hours of the day of summer season (6.37%), most probably to restore its energy. The captive peacock increased water consumption in the hot summer season (0.54%), maybe due to mitigate the effects of extreme heat and to maintain its optimal hydration levels.

The peafowl in captivity was primarily engaged in calling in summer (3.33%) during the mid-day possibly due to the continuous disturbance created by the visitors and the sound of horn of the summer-special-tourist-cars. Sitting outside the shed was found to be significantly higher in winter (6.57%), probably to maintain its body heat by sunbathing, during the cold temperature. On the contrary, sitting inside shade was greatly observed during summer (8.93%) to protect itself from the burning heat. The current study indicated increased human interaction during winter (6.31%) probably because of tourist pressure. Activity like running is found to be a common behaviour in wild peacocks and it was also observed in captivity as well. Peacocks, whether in their natural habitat or in captivity, display similar behaviours such as body shaking, head shaking and

excretion, indicating a consistent aspect of their behaviours. According to a study, peafowls usually fly when threatened by a predator or when returning to their roosting site in the evening hours (Veeramani *et al.*, 2019). Despite being in a controlled environment, flying behaviour was also found to occur at high frequency in case of the studied captive peacock in summer followed by monsoon and winter season.

Conclusion

Studied Indian blue peacock, *Pavo cristatus*, showed considerable seasonal as well as hourly variations in its activity time budgets. Among the various high frequency and low frequency behaviours, the peacock spent maximum time in displaying activity during the monsoon season. Preening was highest time spent behaviour in winter, whereas, activities like standing, sitting dominated the summer. Though the insights gained from this behavioural study can help address environmental and behavioural challenges faced by captive Indian blue peacocks, additional research is required to elucidate the behavioural differences between captive and wild peacocks, for the overall development of management strategies that address the specific needs of captive Indian blue peacocks and promote their welfare.

Acknowledgements

The authors are grateful to Alipore Zoological Garden authority for providing the permission to conduct the present study and also grateful to the staffs of zoo for their cooperation.

References

- Adolfsson UG.** 2009. Diurnal behaviour and utilization of shade in Masai giraffes (*Giraffa camelopardalis tippelskirchi*). Swedish University of Agricultural Sciences **1**, 4-19.
- Ali S, Ripley SD.** 1989. Handbook of the birds of India and Pakistan, Second edition. Oxford University Press, New Delhi.
- Altmann J.** 1974. Observational study of behavior: sampling methods. Behaviour **49**, 227-267.

- Baskaran N.** 2013. An overview of Asian Elephants in the Western Ghats, southern India: Implications for the conservation of Western Ghats ecology. *Journal of Threatened Taxa* **5(14)**, 4854-4870.
- Crockett CM, Ha RR.** 2010. Data collection in the zoo setting, emphasizing behaviour. In: "Wild Animals in Captivity: Principles and Techniques for Zoo Management." University of Chicago Press, Chicago, 386-405.
- Dookia S.** 2015. Ecology and behaviour of Indian Peafowl (*Pavo cristatus*) in Keoladeo National Park, Bharatpur, Rajasthan, India. *International Journal of Fauna and Biological Studies* **2(4)**, 97-103.
- Fuller RA, Garson PJ.** 2000. Pheasants: Status Survey and Conservation Action Plan 2000–2004. WPA/Birdlife/SSC Pheasant Specialist Group, IUCN, Gland, Switzerland, and Cambridge, UK, and the World Pheasant Association, Reading, UK.
- Galusha J, Hill JA.** 1996. Study of the behavior of Indian Peacocks (*Pavo cristatus*) on Protection Island, Jefferson County, Washington, USA. *Pavo* **34**, 23-31.
- Gaulin S.** 1979. A Jarman/Bell model of primate feeding niches. *Human Ecology* **7**, 1-20.
- Gokula V, Muthukrishnan V.** 2015. Display behaviour of Indian Peafowl *Pavo cristatus* (Aves: Galliformes) during the mating season in Viralmalai, Tamilnadu, India. *Taprobanica* **7(1)**, 8-13.
- Harikrishnan S, Vasudevan K, Sivakumar K.** 2010. Behavior of Indian Peafowl *Pavo cristatus* Linn. 1758 during the mating period in a natural population. *Open Ornithology Journal* **3(1)**, 13-19.
- Johnsgard PA.** 1986. The pheasants of the world. Oxford University Press, Oxford.
- Johnsingh AJT, Murali S.** 1978. The ecology and behaviour of the Indian Peafowl (*Pavo cristatus*) Linn. of Injar. *Journal of the Bombay Natural History Society* **75(4)**, 1069-1079.
- Kaur S, Kler TK.** 2017. Feeding habits and roosting preferences of Indian Peafowl (*Pavo cristatus*) in Ludhiana district (Punjab). *Journal of Entomology and Zoology Studies* **5(4)**, 1693-1696.
- Kushwaha S, Kumar AA.** 2016. Review on Indian Peafowl (*Pavo cristatus*) Linnaeus, 1758. *Journal of Wildlife and Research* **4**, 42-59.
- Miazi OF, Miah G, Hassan MM, Jalil MA, Khan MMH.** 2020. Day long activities of Indian blue peafowl in Bangladesh National Zoo. *Bangladesh Journal of Veterinary and Animal Sciences* **8(2)**, 55-59.
- Naseer J, Anjum KM, Khan WA, Imran M, Yaqub A, Munir MA, Nazeer A.** 2018. Observations on the reproductive behavior of Indian Peafowl (*Pavo cristatus* Linn.) under captivity. *The Journal of Animal & Plant Sciences* **28(2)**, 515-519.
- Navaneethakannan K.** 1984. Activity patterns in a colony of peafowls (*Pavo cristatus*) in nature. *Journal of the Bombay Natural History Society* **81**, 387-393.
- Petrie M, Halliday T, Sanders C.** 1991. Peahens prefer peacocks with elaborate trains. *Animal Behaviour* **41**, 323-331.
- Sutherland WJ, Gosling LM.** 2000. Advances in the study of behaviour and their role in conservation. In: *Behaviour and Conservation*, Cambridge University Press, Cambridge, UK, 3-9.
- Tanaka H, Tagaki Y, Naito Y.** 2001. Swimming speeds and buoyancy compensation of migrating adult chum salmon *Oncorhynchus keta* revealed by speed/depth/acceleration data logger. *Journal of Experimental Biology* **204**, 3895-3904.

Veeramani A, Dalson MJ, Vinoth B, Mohanakrishnan H, Ramakrishnan B. 2019. Government Arts College (Autonomous), Kumbakonam, Tamil Nadu, India 2 Biologist, Mudumalai Tiger Reserve, The Nilgiris, Tamil Nadu, India 3 Government Arts College, Udhamandalam, Tamil Nadu, India.

Walther BA. 2003. Do peacocks devote maintenance time to their ornamental plumage? Time budget of male blue peafowl *Pavo cristatus*. *Lundiana* **4**, 149-154.

Walther BA, Clayton DH. 2005. Elaborate ornaments are costly to maintain: evidence for high maintenance handicaps. *Behavioral Ecology* **16(1)**, 89-95.

Zielinski WJ, Spencer WD, Barrett RH. 1983. Relationship between food habit and activity patterns of pine martens. *Journal of Mammalogy* **64**, 387-396.