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Study of diurnal activity pattern and time budget of captive royal bengal tiger (*Panthera tigris tigris*) in Alipore zoological garden, Kolkata

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Key words: Alipore zoological garden, Diurnal activity pattern, Focal sampling, *Panthera tigris tigris*, Stereotypic behaviours

Abstract

A study on diurnal activity pattern and time budgeting of female Royal Bengal tiger (*Panthera tigris tigris*) was conducted at Alipore Zoological Garden, Kolkata, India, for seven hours observation period from 10.00h to 17.00h between June, 2023 to May, 2024 by using focal sampling method with 33,600 minutes of observations. The study revealed twelve active behaviours, eight types of resting, five territorial, four exploration, five maintenance, two social, five vocalization and three stereotypic behaviours of the tigress during the observation period. The female Bengal tiger exhibited significant variations in activities among the seasons and in the different hours within a day. The study indicated that the tigress was predominantly engaged in resting behaviours through-out all of the three seasons. Among active behaviours, it was observed that the tiger exhibited walking behaviour (4.26 ± 0.28) significantly higher in winter than the other two seasons, whereas, behaviours like drinking, bathing and panting peaked during summer. Resting activities such as sitting (10.65 ± 0.26), head down (3.71 ± 0.10) and belly up (2.79 ± 0.22); and territorial behaviours like urination (0.33 ± 0.01) were notably higher in the rainy season. When comparing the data among three seasons, in the first hour of observation, panting (4.08%) and walking (10.28%) under the active behavioural category was found to be higher during the summer season, while during the winter season lay down (57.22%) occurred more frequently. Higher incidences of lay down (68.89%) activity was observed during the monsoon while exhibiting resting behaviour from 12:00 h to 13:00 h, whereas, grooming (2.08%) reached its highest point during this season between 15:00 h and 16:00 h. When the stereotypic behaviours were considered, pacing was found to be highest (6.94 ± 0.20) during monsoon, while, circling (26.96 ± 0.33) dominated the winter. The presence of stereotypic activities indicates its possible psychological stress and demands further research on the feasible cause of this problem. Moreover, further studies on captive tiger will identify the effect of enrichment tools on its behaviour which will ensure healthier lifestyle for that animal.

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Introduction

Animal behaviour refers to the reaction to an animal's surroundings in its natural habitat as well as in captivity. It is an organized action aiding in animals' survival by communicating with the surroundings, the environment and with each other. Behavioural studies can be a valuable approach for conserving animals (Sutherland, 1996) as behaviour reveals about how they evolve and adapt in the wild and respond to stress when they are confined. Besides these, studying of animal behaviour depicts about various aspects of conservation and plays a vital role in determination of anthropogenic effects on wildlife. Hence in order to maintain the ecosystem balance, behavioural studies have been considered at the forefront of conservation efforts since the past few decades, as a means of evaluating animal welfare.

Understanding behaviour of captive animals is of utmost importance for proper conservation management as they help in maintaining the existing population in the wild. Zoological parks are the key components to carry out conservation of wildlife through captive breeding, research and recreation (Mench and Kreger, 1996; Shettel-Neuber, 1988). Zoo plays crucial role in fulfilling the purpose of providing education and awareness amongst public. About 26 billion animals are kept in captivity across the world, in zoos, conservation breeding centres, farms, research laboratories etc. and as pets (Mason, 2010) among which in zoos, large felid species like Royal Bengal tiger has been the main centre of attraction to the visitors for being a charismatic megafauna.

Royal Bengal tiger (*Panthera tigris tigris*) is the second largest majestic subspecies of tiger, native to the Indian subcontinent, inhabiting a variety of habitats including tropical forests, mangrove swamps, grasslands etc. and known for its incredible striped beauty. This awe-inspiring animal has distinctive stripes of dark brown to black on its yellow to light orange body coat, with its belly and interior parts of the limbs white and orange tail with black rings. These striking stripes aid this ferocious apex predator in ambush while hunting, by providing them a perfect camouflage like any other big cats. Their powerful legs with sharp claws also ensure their skillful hunting. The tigers have thick and dense fur working as an insulator to protect itself from harsh weather conditions. They are also quite adept at swimming and are known to cool off in lakes or rivers during intolerable heat of summer. This symbol of royalty roar to communicate over long distances, whereas moan, when tensed. The Royal Bengal tiger is considered the national animal of India and admired worldwide for its majesty and mesmerizing beauty. Though the tiger's population trend is increasing, it currently falls under 'endangered' category of IUCN status. About a century ago, there were over 100,000 tigers in wild across Asia, but there has been a major change in their numbers. According to the World Wildlife Fund, nearly 97% of the world's tigers have been lost to illegal hunting, poaching, habitat loss and fragmentation etc. This alarming decline in their population has led to conserve and protect this keystone species especially by introducing this endangered species to the public through captivity in zoo.

However, animals in captivity are subjected to man-made environment unsuitable for carrying out their natural behaviour (Carlstead, 1996) where they cannot perform many instinctive behaviours like 'hide, stalk and chase' hunting behaviour causing a risk of reduced welfare (Carlstead, 1996). As a result of this, abnormal, stereotypic activities may develop as a coping mechanism (Mason, 1991). Stereotypic behaviours are repetitive and apparently purposeless behaviours which can rise as a form of frustration and stress due to confined space, exposure to unfamiliar humans, high levels of noise etc. Zoochotic behaviours like pacing, tail sucking, overgrooming has been observed in the captive tigers to deal with chronic anxiety. This growing concern has led to the study of activity patterns of tigers in order to improve their captive life.

Activity pattern refers to the pattern of an animal's regular activities whereas, activity budget is the amount of time spent in particular behaviour

exhibited by the animal and is usually noted as the percentage of activity. This is critical for providing baseline data of the species of interest and plays a major role in distinguishing between its behaviour in wild and captive world. Observing animal behaviour in captivity can act as an aiding tool in many ways such as providing necessary information for their physiological as well as psychological well-being and early diagnosing of changes in behaviour before the damage is permanent.

The data of previous studies on behaviours of captive Royal Bengal tigers have a huge impact on improving their life in captive world (Vashisth *et al.*, 2023; Mohapatra and Sethy, 2020; Rofiqoh *et al.,* 2022; Szokalski *et al.,* 2012; Mohapatra *et al.,* 2014; Mishra *et al.,* 2013). Likewise, the present study also was designed to monitor and investigate the different factors affecting the proper management of female Royal Bengal tiger, Payel of Alipore Zoological Garden, Kolkata, India. There is still a lacuna in gaining valuable insights about the extent to which captivity and visitation have impacts on the tigress of Alipore Zoo. Hence the current study was designed to prepare a diurnal activity time budget of the female tiger focusing on the seasonal variations of its behaviours.

Materials and methods

Study area

The present study was carried out at Alipore Zoological Garden (22◦32'9.29" N, 88◦19'55.39" E), Kolkata, West Bengal, which is one of the oldest zoological parks of India as well as the busiest tourist attraction point. The zoo, covering about 18.811 ha area, was established around 1800 by Governor General of India, Richard Wellesley and was inaugurated on 1st January, 1876. The hot and humid summer season begins in March and ends with the onset of the rainy season in July with an average temperature of 35℃. On the other hand, the winter season starts right after rainy season and lasts until the month of February. The minimum temperature of this season is around 8℃, with a mean temperature of 13℃. The monsoon begins in July and concludes in the month of September with a yearly rainfall of about 1641.4 mm.

Study animal

The studied animal is an almost 13 years old female Royal Bengal tiger (*Panthera tigris tigris*) named Payel. Her diet basically contains 8.5 kg and 11.5 kg of buffalo meat per day in summer and winter respectively, except the fasting day, Thursday. The food is provided once every day after 4:30pm, in a food container.

Enclosure of the animal

The studied Royal Bengal tiger was kept in an open-air moated enclosure, situated at the south-east of the Alipore zoo. The enclosure covers the area of about 2764 sq.m. In the middle of the enclosure there is a large bathing area for the tiger to help her to cool off in the scorching heat. The whole premise of the enclosure is covered with grasses and small plants, planted in equal interval. The semicircular enclosure is surrounded by a narrow water canal on the three sides. From outside to inside, the enclosure is guarded by the steel railing, followed by a layer of small trees and netted fence. On the eastward corner of the enclosure, there is a cemented shelter having a feed container, where the meat is given (Fig. 1). Visitor can see the Royal Bengal tiger from the north and west side of the enclosure.

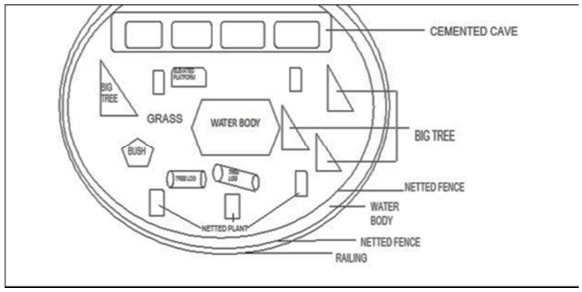

Fig. 1. Layout of tiger enclosure of Alipore Zoological Garden, Kolkata (based on visual observations during present study)

Data collection

The study on activity pattern of Royal Bengal tiger was carried out for twelve-months in the Alipore

Zoological Garden, covering monsoon to summer seasons (four months each). The focal sampling method utilized in this study was adopted from Altmann (1974). The behavioural patterns were recorded and marked on a sheet between 10 am to 5 pm twice in a week through simple observation with unaided eye. All the activities were recorded in each minute with a gap of 1 minute in every 5 minutes from a suitable point from where the enclosure can be best seen without creating any disturbances to the animal or the environment. Total observation period was 33,600 minutes.

Table 1. Ethogram used for collecting behavioural data of tiger (*Panthera tigris tigris*) in captivity at Alipore Zoo, Kolkata (based on Vashisth *et al.,* 2023; Mohapatra and Sethy, 2020; Rofiqoh *et al.,* 2022; Szokalski *et al.,* 2012 and Mohapatra *et al.,* 2014)

Category	Type	Description
	Standing	Standing in an upright position with all four feet at a specific position.
	Walking	Moving from the one place to another quadrupedally.
	Running	Forward locomotion movement at a quick gait.
	Climbing	Moving up the tree trunk or object or a structure.
	Feeding of offered feed	Intake of given food by the zookeepers.
	Drinking	Intake of water by lapping up with its tongue.
Active	Eating grass	Chewing grasses or leaves from the ground or bushes.
	Panting	Breathing noisily with its mouth visibly open.
	Bathing	Immersing the body in the water filled area.
	Stretching	Extending body and foreleg forward and curve the back.
	Aggressive	Threat display or warning motions directed toward other tiger or animal keeper.
	Head/Body shake	Repetitive movement of head and body with short and quick movement.
	Tail movement	Movement of tail, not in any particular direction.
	Crouch	Alert tiger positions its body close to ground, where its four legs are bent and belly is touching the ground.
	Sitting	In upright position with its feet are on ground, hind legs are folded, while front leg are straight and extended.
	Sitting erect	Sitting straight with the help of its fore leg and hind leg on the ground.
Resting	Lying	Resting on its back followed by a roll.
	Sleeping	Laying down with eyes close.
	Belly up	Lies on its back with throats and belly exposed.
	Yawning	Wide gap with deep inhalation, eyes slits or closed and tongue protruded out.
	Head down	Head is down close to the ground.
	Alert	Standing or laying with open eyes, focused on object, conspecies or human.
Exploration	Look around	Turns one's eye towards something or in some direction in orders to see.
	Touching object	Touching the objects with its paw.
	Sniff	Smelling by inhaling air through the nose.
Social	Human interaction	Looking towards the visitor.
	Animal interaction	Chasing or playing with other animals.
	Body/Head against object	Rubbing its head or body against an object.
	Clawing	Scratching an object using the claws of its fore feet.
Territorial	Urination	Releasing of urine on the ground while in squatting position.
	Urine spraying	Jet of urine by raising its tail in upright position, against a vertical surface or object.
	Defecation	Releasing faeces on the ground while in a squatting position.
	Chuff	Expelling jets of air through the nose creating a low intensity, soft, pulsed sound, described as being similar to the snorting of a horse.
	Roar	Long, throaty, high intensity call.
Vocalization	Moaning	A passive and non-threatening form of sound produce by tigers.
	Grunt/cough	Short, throaty call due to deep contraction and expansion of diaphragm.
	Growl	A low pitched, throaty, rumbling noise produced while the mouth is closed.
	Grooming/ licking itself	Licking its own fur.
Maintenance	Sneeze	Sneezing to clear the respiratory tract of dust, mucus and other obstruction.
	Rolling	Rotating its body on the longitudinal axis coming to rest on the dorsal surface.
	Rubbing	Rubbing body on objects.
	Clawing itself	Scratching itself but gently.
	Pacing	Repeated walking movement in same path, without an apparent goal.
Stereotype	Circling	Repeated movement in a circular path.
	Chewing object	Chewing an object by using its teeth.

Ethogram

An ethogram is a comprehensive catalogue of behaviours exhibited by the study animal, also serving as a detail inventory of its behavioural pattern. When creating an ethogram, it is vital to accurately denote a name to each behaviour with an apt description. An ethogram was prepared for the present study on the basis of prior studies on captive Royal Bengal tigers (Vashisth *et al.*, 2023; Mohapatra and Sethy, 2020; Rofiqoh *et al.*, 2022; Szokalski *et al.*, 2012; Mohapatra *et al.*, 2014; Mishra *et al.*, 2013) and initial observations of the current study. A total of 8 major type of behaviour were found for the Royal Bengal tiger of Alipore zoo which are active, resting, exploration, social behaviour, territorial behaviour, vocalization, maintenance and stereotypic behaviour. The time budgeting of different activities exhibited by the species of interest in a particular time span provides an opportunity for making comparisons between the behaviours expressed in wild and captivity, pointing out the differences observed and then finding the root of such differences (Table 1).

Data analysis

For the determination of diurnal activity time budget, the primary step was to differentiate activities into various behavioural categories. Then duration for each activity was recorded. The obtained data from simple observation on the studied tiger were analyzed and then calculated as mean percentage of time, engaged in each behaviour (Crockett and Ha, 2010). All the graphical representations needed for the study were constructed using MS-Excel software. The observational data were presented as mean percentage ± standard error (SE). For the comparison of different activity patterns among the three different seasons as well as within the studied hours, 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.

Results

During the current research, a total of 33,600 minutes of daytime behavioural data of *Panthera tigris tigris* were gathered in all the three studied seasons. The data was then analyzed and shown as the percentage of time spent in various activities by the tiger.

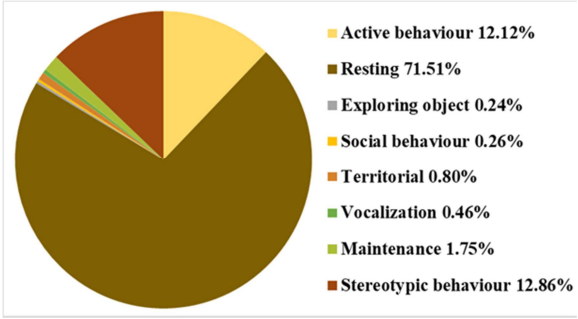

Fig. 2. Percentage of time spent in different behavioural categories by tiger during monsoon season at Alipore Zoological Garden, Kolkata

Diurnal activity budget of tiger in different behavioural categories during monsoon, winter and summer season

Throughout the monsoon season (Fig. 2), the tiger was mainly involved in resting behaviour accounting for 71.51% of its time, followed by stereotypic behaviour (12.86%), active behaviour (12.12%), maintenance (1.75%) and territorial behaviour (0.80%), vocalization and social behaviour at the rate 0.46% and 0.26% respectively. Exploring object only constituted 0.24% of the observation period.

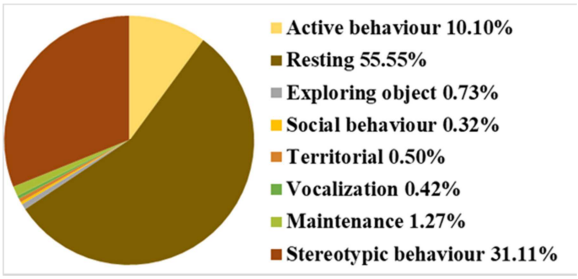

Fig. 3. Percentage of time spent in different behavioural categories by tiger during winter season at Alipore Zoological Garden, Kolkata

In winter season (Fig. 3), the tiger primarily exhibited resting behaviour, marking up to 55.55% of its time, followed by stereotypic behaviour (31.11%), active behaviour (10.10%), maintenance (1.27%), exploring object (0.73%), territorial behaviour (0.50%), vocalization (0.42%) and social behaviour (0.32%) of its observed time.

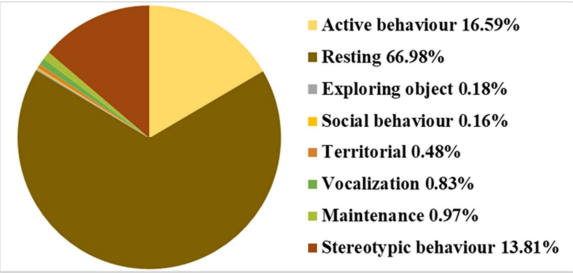

Fig. 4. Percentage of time spent in different major behavioural categories by tiger during summer season at Alipore Zoological Garden, Kolkata

During the summer season (Fig. 4), the tiger was predominantly engaged in resting, accounting for 66.98% of its time. This was followed by active behaviour (16.59%), stereotypic behaviour (13.81%), maintenance (0.97%), vocalization (0.83%), territorial behaviour (0.48%), exploring objects (0.18%), and social behaviour (0.16%) of its diurnal time.

Diurnal activity budget of tiger in different behavioural subcategories during monsoon season

During the monsoon season, the tiger was found to be spending significantly higher percentage of time in feeding of offered feed (4.12 ± 0.22) (P<0.05; DMRT), followed by walking (3.17 ± 0.31), under the active behaviours whereas, values for the time spent in standing, panting and bathing activities showed no significant variation (DMRT) (Fig. 5). The studied tiger devoted less time in drinking, eating grass, stretching and tail movement (P<0.05). Among resting behaviours, the tiger spent the majority of its time in laying down (39.48± 0.18) (P<0.05; DMRT), followed by sleeping (14.10 ± 0.20), sitting (10.65 ± 0.26) and head down activity (3.71 ± 0.10), while significantly lower value was observed for crouching behaviour. Under the exploration object subcategory, looking around was observed to be significantly higher (0.17 ± 0.01) (P<0.05; DMRT). When the territorial behaviours were considered, urination was found to be significantly higher (0.33 ± 0.07) (P<0.05; DMRT), followed by urination marking (0.23 ± 0.11), while the behaviours like clawing and defecation showed no significant variation (DMRT). Among the vocalization behaviours, significantly higher value was observed for moaning (0.19 ± 0.09) (P<0.05; DMRT). When considering the maintenance behaviours, grooming was noted to be significantly higher (1.17 ± 0.28) (P<0.05; DMRT), whereas, mean time spent for clawing itself behaviour was found to be lower (0.03 ± 0.07). The tiger was predominantly engaged in stereotypic activity, pacing (6.94 ± 0.20) (P<0.05; DMRT), followed by circling (5.85 ± 0.26) and chewing objects (0.05 ± 0.06).

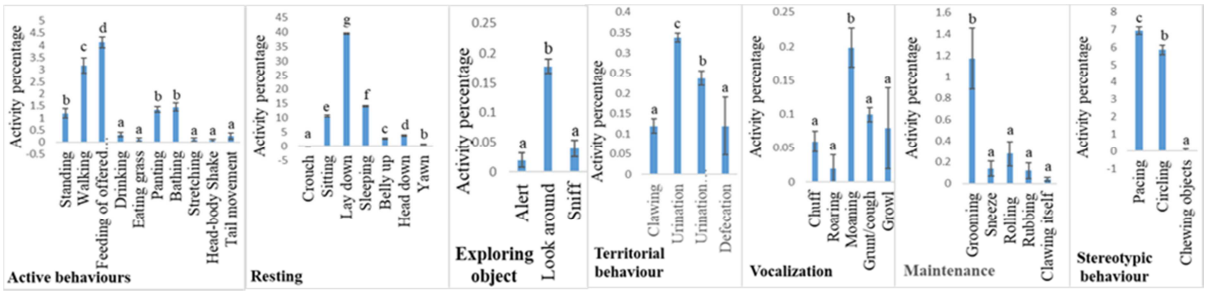

Fig. 5. Percentage of time spent in different subtypes of active, resting, exploring object, territorial, vocalization, maintenance and stereotypic behaviour by tiger during monsoon season at Alipore Zoological Garden, Kolkata. Values are mean ± SE. Bars with different letters are significantly different (P<0.05) using DMRT after one way ANOVA

Diurnal activity budget of tiger in different behavioural subcategories during winter season

During the winter season, the tiger allocated significantly higher amount of time in walking (4.26 ± 0.28) (P<0.05; DMRT), followed by feeding of offered feed (3.15 ± 0.24) and panting (1.03 ± 0.18) under active behaviours. The tiger spent less amount of time in drinking water (0.77 ± 0.13), tail movement (0.27 ± 0.11), stretching (0.11 ± 0.10) and eating grass activities (0.07 ± 0.06). In case of resting behaviours,

the tiger was engaged most of its time in laying down (27.89 ± 0.24) (P<0.05; DMRT), followed by sleeping (13.96 ± 0.26), sitting (7.93 ± 0.22) and head down (2.89 ± 0.25). When the exploring of objects was taken under consideration, looking around was observed to be significantly higher (0.57 ± 0.10) (P<0.05; DMRT), whereas, under territorial behaviours, urination (0.25 ± 0.09) was noted to be more (P<0.05; DMRT), followed by clawing (0.15 ± 0.10) and defecation (0.1 ± 0.09). Moaning was found to be significantly higher (0.23 ± 0.10) (P<0.05; DMRT) among vocalization behaviours, followed by grunting/coughing (0.15 ± 0.12). Significantly higher value was found for grooming among maintenance behaviours (0.83 ± 0.19), while the mean value for rolling was lower (0.05 ± 0.06). The tiger was observed engaging in stereotypic behaviour with maximum amount of time in circling (26.96 ± 0.33) (P<0.05; DMRT), followed by pacing (3.94 ± 0.19), chewing objects (0.19 ± 0.09) (Fig. 6).

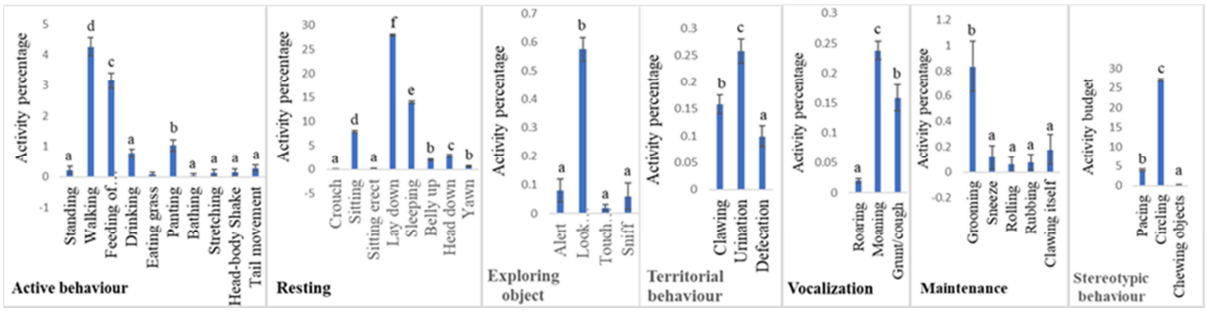

Fig. 6. Percentage of time spent in different subtypes of active, resting, exploring object, territorial, vocalization, maintenance and stereotypic behaviour by tiger during winter season at Alipore Zoological Garden, Kolkata. Values are mean ± SE. Bars with different letters are significantly different (P<0.05) using DMRT after one way ANOVA

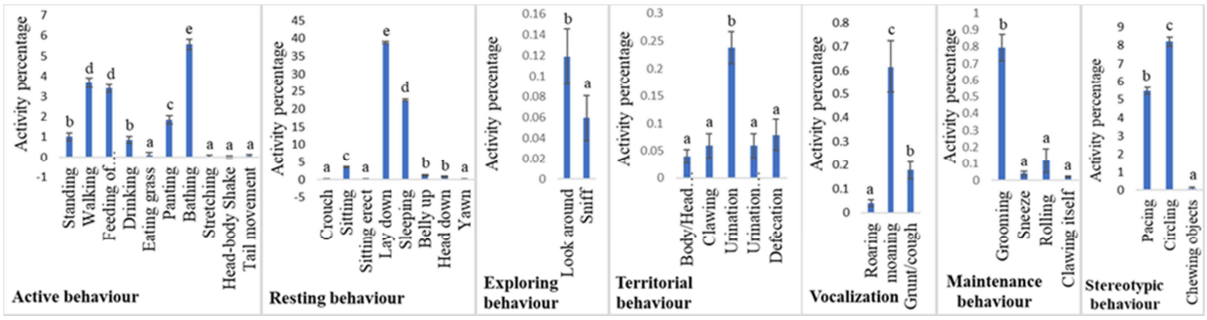

Fig. 7. Percentage of time spent in different subtypes of active, resting, exploring object, territorial, vocalization, maintenance and stereotypic behaviour by tiger during summer season at Alipore Zoological Garden, Kolkata. Values are mean ± SE. Bars with different letters are significantly different (P<0.05) using DMRT after one way ANOVA

Diurnal activity budget of tiger in different behavioural subcategories during summer season

During this season, the tiger was observed bathing (5.57 ± 0.25) for a significantly longer period of time (P<0.05; DMRT) among the active behaviours, whereas, lower mean value was found for stretching (0.03 ± 0.05). When considering the resting behaviours, the tiger spent maximum time in lay down (38.84 ± 0.24) (P<0.05; DMRT), followed by sleeping (22.48 ± 0.23) and sitting (3.53 ± 0.22). Under exploring objects, looking around (0.11 ± 0.09) was observed to be significantly higher (P<0.05; DMRT), while the studied tiger devoted less of its time in sniffing (0.05 ± 0.06). Urination (0.23 ± 0.08) and moaning (0.61 ± 0.10) had the significantly higher value (P<0.05; DMRT) among territorial and

vocalization behaviours respectively. On the other hands, grooming was noted to be significantly higher among maintenance behaviours (0.79 ± 0.17), while the lower mean value was found for clawing itself (0.02 ± 0.01) during the studied hours. The tiger displayed stereotypic behaviours, with the majority of its time spent on circling (8.21 ± 0.24) (P<0.05; DMRT), followed by pacing (5.49 ± 0.18) and chewing objects (0.09 ± 0.07) (Fig. 7).

Comparison of diurnal activity budget of the tiger among three seasons

When comparing the activity budget data among the three studied seasons, under active behaviours, it was observed that the tiger exhibited walking behaviour notably higher in winter than the other two seasons (P<0.05; DMRT). Drinking, bathing and panting reached peak during summer (P<0.05; DMRT), whereas activities like standing and feeding of offered feed were significantly higher during monsoon. Among the resting behaviours, activities such as sitting, head down and belly up were maximum in monsoon (P<0.05; DMRT) (Fig. 8). Laying down was significantly low in winter compared to the two seasons, while sleeping was observed to be highest during summer (P<0.05; DMRT). Time spent by the tiger for sitting, belly up and head down activities under the resting category was the lowest during the summer season. When the stereotypic behaviours were considered, circling was found predominant in winter (P<0.05; DMRT) and pacing in monsoon, while, on the contrary, significantly lower during the monsoon and winter season respectively.

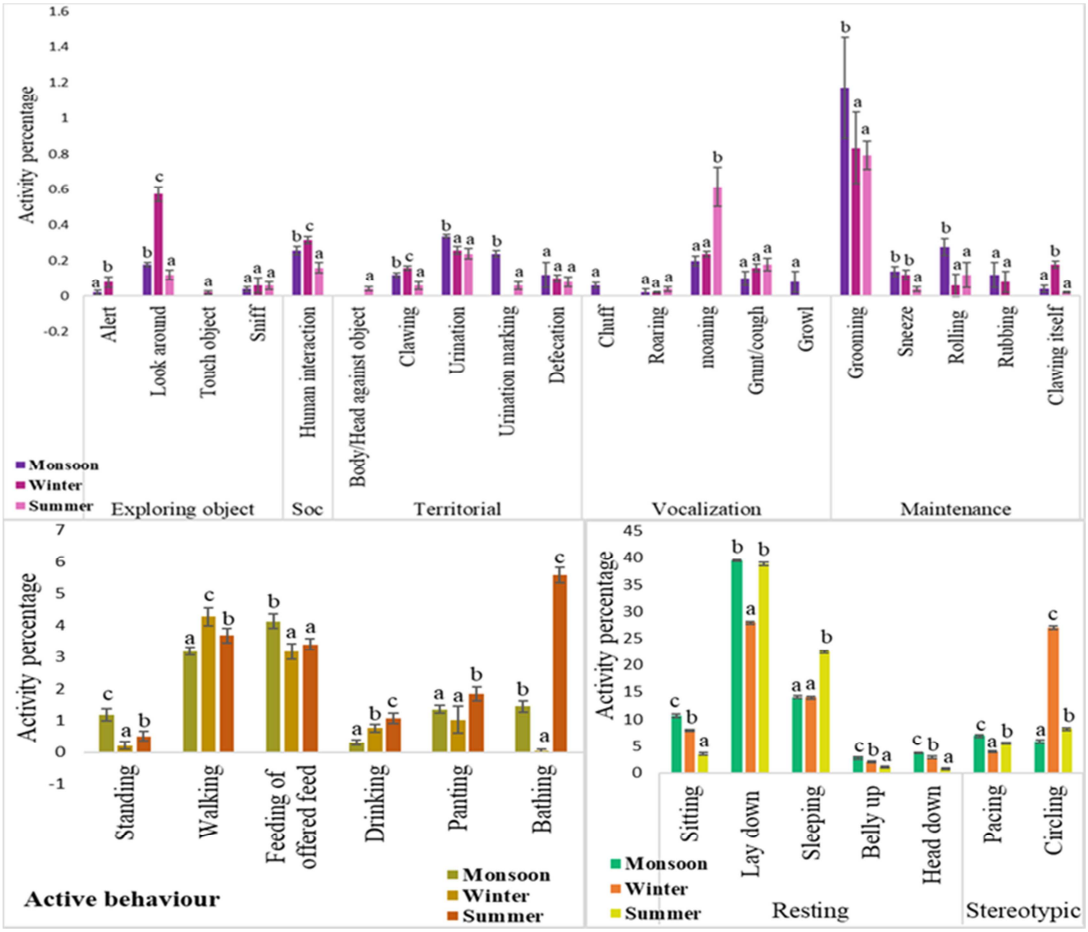

Fig. 8. Comparison of the time spent percentage in different behavioural categories by tiger among three different seasons at Alipore Zoological Garden. Values are mean ± SE. Bars with different letters are significantly different (P<0.05) using DMRT after two-way ANOVA

Under exploring object category, sniffing was almost constant throughout all the seasons (DMRT), while looking around was significantly higher in winter (P <0.05; DMRT). Alert was recorded with significantly higher value in winter, whereas was not observed in summer season. The tiger did not exhibit touching object activity in any of the seasons except in winter. When the social behaviours were taken under consideration, the studied animal showed higher human interaction in winter than the monsoon and summer seasons. In case of territorial behaviours, urination was noted to be more in monsoon (P<0.05; DMRT) whereas, clawing was noted more frequent during winter (P<0.05; DMRT). Defecation did not vary significantly among the three seasons (DMRT) while, the tiger displayed urination marking behaviour only in monsoon and summer season with significantly higher value in monsoon. Under vocalization, moaning and grunting was significantly higher in summer, whereas, under the maintenance activities, grooming and rolling was exhibited more during monsoon season and clawing itself during the winter season.

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

Behavioural categories	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
	Standing	1.11	0.97	0.42	0.28	0.56	1.11	3.47
	Walking	1.81	1.53	1.39	1.39	1.25	2.22	12.08
	Feeding offered feed	0.00	0.00	0.00	0.00	0.00	0.00	28.89
	Drinking	0.14	0.14	0.14	0.14	0.14	0.28	1.11
Active	Eating grass	0.14	0.14	0.14	0.00	0.00	0.14	0.14
	Panting	0.97	1.67	1.39	0.56	0.97	0.97	2.92
	Bathing	0.56	2.22	0.83	0.00	0.00	2.64	3.89
	Stretching	0.00	0.00	0.00	0.00	0.00	0.00	0.56
	Head-body Shake	0.28	0.00	0.14	0.14	0.00	0.00	0.00
	Tail movement	0.14	0.14	0.14	0.42	0.14	0.56	0.14
	Crouch	0.00	0.14	0.00	0.00	0.00	0.00	0.14
	Sitting	16.94	7.78	5.69	7.50	14.72	18.06	6.39
	Sitting erect	0.14	0.14	0.00	0.28	0.14	0.14	0.00
Resting	Lay down	33.61	44.58	68.89	56.67	28.75	34.17	9.03
	Sleeping	3.75	21.67	16.11	16.39	31.94	9.17	0.00
	Belly up	6.81	1.94	1.53	4.03	3.33	3.19	0.28
	Head down	7.64	4.31	0.00	1.53	10.83	1.39	1.39
	Yawn	0.42	0.28	0.14	0.56	0.69	0.83	0.97
	Alert	0.00	0.14	0.00	0.00	0.00	0.00	0.00
Exploration	Look around	0.42	0.28	0.00	0.14	0.00	0.00	0.28
	Sniff	0.14	0.14	0.00	0.00	0.00	0.00	0.00
	Human interaction	0.56	0.00	0.00	0.28	0.00	0.42	0.42
	Clawing	0.00	0.00	0.00	0.00	0.14	0.14	0.56
Social	Urination	0.42	0.14	0.00	0.14	0.42	0.42	0.83
	Urination marking	0.42	0.00	0.14	0.28	0.00	0.14	0.56
	Defecation	0.14	0.00	0.14	0.14	0.00	0.14	0.14
	Chuff	0.28	0.00	0.00	0.00	0.00	0.00	0.14
	Moaning	0.56	0.14	0.00	0.14	0.00	0.14	0.28
Vocalization	Grunt/cough	0.00	0.00	0.00	0.42	0.00	0.00	0.28
	Growl	0.00	0.14	0.28	0.14	0.00	0.00	0.00
	Grooming	1.67	1.39	0.00	1.81	0.56	2.08	0.69
	Sneeze	0.42	0.14	0.00	0.14	0.14	0.00	0.28
Vocalization	Rolling	0.14	0.42	0.69	0.42	0.14	0.14	0.14
	Rubbing	0.00	0.00	0.00	0.14	0.28	0.00	0.42
	Clawing itself	0.00	0.00	0.00	0.00	0.00	0.00	0.28
	Pacing	14.03	5.69	0.97	3.61	2.78	11.11	10.00
Stereotypic	Circling	6.25	3.61	0.83	2.36	2.08	10.42	13.06
	Chewing objects	0.14	0.00	0.00	0.00	0.00	0.00	0.28

Hourly activity time budget of tiger during monsoon season

When the result of hourly activity budget of monsoon season was considered, among the different hours under the active behaviours, feeding of offered feed and stretching was observed only from 16:00h to 17:00h. Other activities such as standing, walking, drinking and panting was found throughout the day, peaking in the last hour (16:00h to 17:00h), while head-body shake was maximum in the first hour of the day (10:00h to 11:00h). Among resting behaviours, the tiger spent maximum time for sitting activities from 15:00h to 16:00h, whereas, laying down predominated throughout the day with the highest frequency from 12:00h to 13:00h, followed by consistent sleeping reaching peak level from 14:00h to 15:00h. Under exploring object activities, looking around was found to be peaked during the first hour of the day (10:00h to 11:00h), while alert was only observed from 11:00h to 12:00h. Upon observing the social behaviours, human interaction was noted to be highest during first hour (10:00h to 11:00h). Among the territorial behaviours, activities like clawing, urination, urination marking was predominant during the final hour of the observation period (16:00h to 17:00h). Chuff and moaning were maximum during the first hour (10:00h to 11:00h) among vocalization behaviour, while activities such as growl and grunt/cough were found highest during 12:00h to 13:00h and 13:00h to 14:00h respectively. Within maintenance behaviours, the tiger exhibited rolling and grooming mostly from 12:00h to 13:00h and 15:00h to 16:00h respectively. In stereotypic behaviour, pacing was predominant throughout the day with the highest frequency during the first hour of the day (10:00h to 11:00h), followed by circling peaking during last hour (16:00h to 17:00h) (Table 2).

When data were compared within hours, among active behaviours, walking was found to be dominant during the first (10:00h to 11:00h), third (12:00h to 13:00h), fourth (13:00h to 14:00h) and fifth (14:00h to 15:00h) hour of the day, whereas, bathing activity dominated the second (11:00h to 12:00h) and second last (15:00h to 16:00h) hour. During the final hour of the observation period (16:00h to 17:00h), feeding of offered feed was significantly higher within that behavioural subcategory. Upon considering the resting activities, the tiger was engaged in laying down in all the hours except the fifth one (14:00h to 15:00h) where sleeping was found to be dominant. The second highest value was observed for sitting in the first (10:00h to 11:00h), sixth (15:00h to 16:00h) and final hour (16:00h to 17:00h) and for sleeping during the rest of the hours. Among exploration category, the tiger devoted most of its time in looking around while in the third (12:00h to 13:00h), fifth (14:00h to 15:00h) and second last hour (15:00h to 16:00h) no exploration was shown. The studied tiger interacted with human mostly during the first hour (10:00h to 11:00h). When the territorial activities were considered, it was observed that, urination dominated all the hours of the day except from 12:00h to 14:00h when urination marking along with defecation and urination marking alone was dominant respectively. During the fifth hour (14:00h to 15:00h) of the observation period, an absence in vocalization behaviours was noticed. Other than that, moaning was noted to be significantly higher during the rest of the hours except the third (12:00h to 13:00h) and fourth (13:00h to 14:00h) when growling and grunting/coughing was found dominant. Among its maintenance activities, the tiger exhibited grooming through-out the day except from 12:00h to 13:00h when rolling was observed to be highest. In stereotypic activities, pacing was notably higher in all of the hours except the final hour (16:00h to 17:00h) when the tiger was predominantly engaged in circling. Chewing objects was absent during the whole day except the first (10:00h to 11:00h) and last (16:00h to 17:00h) hour.

Hourly activity time budget of tiger during winter season

The findings from the hourly activity budget during the winter season showed that among the different hours under the active behaviours, feeding of offered feed only occurred between 16:00h to 17:00h. Activities like drinking, and panting were observed consistently through-out the day, reaching peak from 10:00h to 11:00h, 12:00h to 13:00h, 13:00h to 14:00h and 15:00h to 16:00h respectively.

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

Behavioural categories	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
	Standing	0.00	0.28	0.28	0.28	0.00	0.28	0.28
	Walking	4.17	3.33	2.78	3.33	2.22	5.56	8.19
	Feeding offered feed	0.00	0.00	0.00	0.00	0.00	0.00	22.08
	Drinking	0.97	0.83	0.97	0.69	0.69	0.83	0.56
Active	Eating grass	0.00	0.00	0.14	0.00	0.14	0.14	0.14
	Panting	1.11	0.69	1.25	1.39	0.28	1.39	0.56
	Bathing	0.00	0.14	0.00	0.00	0.00	0.14	0.00
	Stretching	0.00	0.14	0.28	0.14	0.14	0.00	0.14
	Head-body shake	0.00	0.14	0.14	0.14	0.00	0.14	0.28
	Tail movement	0.42	0.42	0.28	0.28	0.14	0.28	0.00
	Sitting	11.25	5.14	6.67	12.36	6.53	4.31	8.89
	Sitting erect	0.14	0.42	0.00	0.28	0.28	0.00	0.28
	Lay down	57.22	40.00	31.11	24.58	19.86	21.39	4.03
Resting	Sleeping	0.00	4.03	21.39	18.89	33.61	17.78	0.00
	Belly up	0.97	5.00	0.97	1.39	2.92	2.78	0.00
	Head down	0.56	2.50	5.97	2.78	4.72	2.22	1.25
	Yawn	0.28	1.25	0.14	0.83	0.56	0.69	0.83
	Alert	0.00	0.00	0.00	0.14	0.00	0.14	0.28
	Look around	0.42	0.28	0.56	0.42	0.28	0.83	1.11
Exploration	Touch object	0.00	0.00	0.00	0.00	0.00	0.00	0.14
	Sniff	0.00	0.00	0.14	0.14	0.00	0.14	0.00
	Human interaction	0.28	0.28	0.28	0.56	0.28	0.14	0.42
	Clawing	0.28	0.28	0.14	0.14	0.00	0.00	0.28
Social	Urination	0.00	0.28	0.28	0.56	0.28	0.14	0.28
	Defecation	0.00	0.28	0.00	0.14	0.00	0.28	0.00
Vocalization	Moaning	0.14	0.69	0.00	0.14	0.28	0.14	0.28
	Grunt/cough	0.00	0.42	0.14	0.14	0.14	0.14	0.14
	Grooming	0.28	2.36	0.28	0.97	1.39	0.14	0.28
	Sneeze	0.14	0.14	0.00	0.00	0.00	0.28	0.14
Vocalization	Rolling	0.00	0.14	0.14	0.00	0.00	0.14	0.00
	Rubbing	0.14	0.00	0.00	0.00	0.00	0.14	0.14
	Clawing itself	0.14	0.28	0.00	0.00	0.00	0.42	0.42
	Pacing	4.72	1.94	4.03	2.78	2.22	6.11	5.14
Stereotypic	Circling	16.25	27.78	21.53	26.39	22.92	32.64	43.33
	Chewing objects	0.14	0.28	0.14	0.14	0.14	0.28	0.14

Under the resting behaviour category, the tiger was predominantly engaged in laying down activity during the first hour (10:00h to 11:00h) of the day, whereas, sleeping peaked from 14:00h to 15:00h. Behaviours like belly up and yawning were maximum during the second hour (11:00h to 12:00h). Upon observing the exploration of object behaviour, it was revealed that looking around was maximum from 12:00h to 13:00h, while, alertness peaked from 16:00h to 17:00h. Touching object was only found during the last hour (16:00h to 17:00h) of the study period. Human interaction was consistently seen through-out the day, peaking in 13:00h to 14:00h, under social behaviours. Activities such as defecation and urination were maximum from 11:00h to 12:00h and 13:00h to 14:00h respectively among territorial behaviours and in case of Vocalization behaviours, moaning and grunt/cough peaked from 11:00h to 12:00h. When the maintenance behaviours were considered, it was noted that the tiger was predominantly engaged in clawing itself, grooming and sneezing from 11:00h to 12:00h, 13:00h to 14:00h and 15:00h to 16:00h respectively. Circling was the most common stereotypic behaviour seen all day, peaking in the last hour (16:00h to 17:00h) of the day (Table 3).

The comparison of different activities within the hours during the winter revealed that, within active behaviours, walking was the predominant activity for all the studied hours except the final hour (16:00h to 17:00h) of observation period, when feeding of offered

feed was the dominant activity. In the first and 2nd hour of the day, the second highest value was noted for panting and drinking respectively. During the initial hours of the day (10:00h to 14:00h), under resting behaviour category, laying down was the most prevalent behaviour, sitting following closely behind for the first two hours (10:00h to 11:00h and 11:00h to 12:00h) and sleeping for the next two hours (12:00h to 13:00h and 13:00h to 14:00h). Among the exploration of object behaviours, from 10:00h to 11:00h, looking around was the only behaviour shown by the tiger. Touching object was detected solely between 16:00h to 17:00h, while the activity alert was significantly higher during this particular hour as well. Human interaction was found to be the most frequent behaviour, under social behaviour category with a peak during the fourth hour (13:00h to 14:00h). Within territorial behaviours, during the first hour of the day, only clawing activity was found whereas, from 11:00h to 12:00h and 13:00h to 14:00h, defecation and the urination were observed to be the highest respectively. Between 11:00h to 12:00h, moaning was at its highest level within vocalization behaviour, followed by grunt/cough. Under the maintenance behaviours, grooming was most dominant activity except the last two hours of the observational period, while clawing itself was maximum during the last two hours. When considering the stereotypic behaviours, circling was the most prevalent behaviour, followed by pacing activity.

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

Behavioural categories	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
	Standing	1.53	0.69	0.56	1.53	1.67	0.28	0.83
	Walking	10.28	1.94	1.11	2.08	6.39	1.11	2.78
	Feeding offered feed	0.00	0.00	0.00	0.00	0.00	0.00	23.75
	Drinking	0.83	0.69	0.69	0.56	1.81	0.56	0.83
Active	Eating grass	0.28	0.00	0.00	0.28	0.28	0.00	0.00
	Panting	4.03	2.50	1.11	2.22	1.53	0.83	0.69
	Bathing	0.00	3.61	2.78	3.06	10.69	2.64	16.25
	Stretching	0.00	0.00	0.00	0.00	0.14	0.00	0.14
	Head-body shake	0.00	0.14	0.00	0.00	0.00	0.00	0.00
	Tail movement	0.00	0.00	0.00	0.00	0.14	0.14	0.14
	Crouch	0.00	0.00	0.00	0.28	0.00	0.28	0.00
	Sitting	6.53	5.83	2.36	4.17	3.47	2.36	0.00
	Sitting erect	0.00	0.00	0.14	0.14	0.14	0.00	0.00
Resting	Lay down	41.11	60.14	21.39	38.61	24.17	61.53	25.00
	Sleeping	0.00	14.58	61.39	29.72	17.78	17.92	15.97
	Belly up	1.53	0.00	0.97	2.08	0.97	1.94	0.00
	Head down	1.81	0.00	0.42	1.25	0.42	1.53	0.00
	Yawn	0.14	0.42	0.28	0.14	0.00	0.00	0.00
Exploration	Look around	0.28	0.28	0.00	0.28	0.00	0.00	0.00
	Sniff	0.00	0.42	0.00	0.00	0.00	0.00	0.00
Social	Human interaction	0.28	0.00	0.14	0.00	0.42	0.14	0.14
	Body/Head against object	0.00	0.00	0.28	0.00	0.00	0.00	0.00
	Clawing	0.00	0.00	0.00	0.14	0.28	0.00	0.00
Territorial	Urination	0.42	0.00	0.14	0.28	0.56	0.14	0.14
	Urination marking	0.00	0.14	0.28	0.00	0.00	0.00	0.00
	Defecation	0.14	0.00	0.00	0.14	0.14	0.14	0.00
	Roaring	0.00	0.00	0.00	0.00	0.28	0.00	0.00
Vocalization	Moaning	0.56	0.28	0.28	0.69	1.81	0.00	0.69
	Grunt/cough	0.00	0.42	0.00	0.28	0.56	0.00	0.00
	Grooming	0.83	0.28	0.00	1.25	0.69	1.53	0.97
Maintenance	Sneeze	0.00	0.00	0.00	0.28	0.00	0.00	0.00
	Rolling	0.14	0.14	0.28	0.28	0.00	0.00	0.00
	Clawing itself	0.00	0.00	0.00	0.00	0.14	0.00	0.00
	Pacing	10.56	4.44	1.25	3.89	9.72	3.61	5.00
Stereotypic	Circling	18.47	3.06	4.17	6.25	15.56	3.33	6.67
	Chewing objects	0.28	0.00	0.00	0.14	0.28	0.00	0.00

Hourly activity time budget of tiger during summer season

During the summer season, when data of each activity was compared among the different hours of the observational period, it was noted that, among the active behaviours, feeding of the offered feed, took place exclusively from 16:00h to 17:00h. Walking and panting peaked during first hour (10:00h to 11:00h), while the activities standing and drinking were maximum from 14:00h-15:00h. Bathing was observed to be highest from 14:00h to 15:00h, whereas, head-body shake was found only in the second hour of the observatory period (11:00h to 12:00h). In the category of resting behaviours, laying down predominated throughout the day with the highest frequency from 15:00h to 16:00h, followed by consistent sleeping except the initial hour (10:00h to 11:00h), which reached peak from 12:00h-13:00h (Table 4).

While observing the exploration object behaviours, it was noticed that looking around occurred in first two hours (10:00h to 11:00h and 11:00h to 12:00h) and fourth hour (13:00h to 14:00h) of observation period, while sniffing was only exhibited by the tiger in the second hour (11:00h to 12:00h). Human interaction reached its highest point from 14:00h to 15:00h under social behaviours with a noticeable absence in the second (11:00h to 12:00h) and fourth hour (13:00h to 14:00h). The peak times for activities like clawing and urination under territorial behaviours were from 14:00h to 15:00 h, while urination marking was maximum from 12:00h to 13:00h respectively. Moaning, roaring and grunt/cough were at their highest levels from 14:00h to 15:00h, when Vocalization behaviours were considered, whereas, under maintenance behaviours, grooming dominated from 13:00h to 14:00h, and activities like sneeze and clawing itself were only shown from 13:00h to 14:00h and 14:00h to 15:00h respectively. The most frequent stereotypic behaviour observed through-out the day was circling, following by pacing, reaching their peak in the morning between 10:00h to 11:00h.

When activity budgets were compared within hour among the different activities displayed by the studied animal, it was noticed that under active behavioural category, walking had the highest value during the initial hour (10:00h to 11:00h) in this season, followed by panting. During the final hour of the observational period (16:00h to 17:00h), the majority of time was dedicated to consume provided food. Among the resting behaviour category, lay down was the most prevalent activity shown by the tiger during all of the observation hours except from 12:00h to 13:00h, when sleeping was maximum. During the first hour (10:00h to 11:00h), after laying down, sitting was the highest activity shown by the tiger. under the exploration object category, looking around dominated all of the hours except the second hour, when sniffing was found prevalent. The studied animal did not interact with humans during the second (11:00h to 12:00h) and fourth hour (13:00h to 14:00h) and reached peak value from 14:00h to 15:00h under social behaviour. Within the territorial behaviours, during the first hour of observation period, urination occurred more frequently, followed by defecation while in the next hour (11:00h to 12:00h), urination marking was the only activity shown by the tiger. Upon considering the vocalization behaviours, moaning was the only behaviour shown by the tiger during the first (10:00h to 11:00h) and last hour (16:00h to 17:00h) of the observation period. Grooming had the highest value during the first two hours (10:00h to 11:00h and 11:00h to 12:00h), followed by rolling but grooming was the only activity shown by the tiger during the last two hours, under the maintenance behaviours. Among the stereotypic behaviours, circling dominated all the hours except the second (11:00h to 12:00h) and second last hour (15:00h to 16:00h) of the day, when significantly higher value was found for pacing.

Activity budget of tiger in different seasons:

From 10:00 to 11:00 hour

When data were compared among the season, in the first hour of observational period, it was revealed that the summer season had higher percentages of panting (4.08%) and walking (10.28%) within the active behavioural category compared to winter and monsoon seasons. During the winter, lay down

occurred more frequently (57.22%) compared to the other two seasons, whereas head-down activity peaked during the monsoon under the resting behaviour category. Maintenance behaviours like grooming was observed at a higher frequency in the monsoon with summer and winter seasons following closely behind. During summer, circling behaviour was more prevalent at 18.47%, compared to pacing which was higher (14.03%) during the monsoon season (Fig. 9).

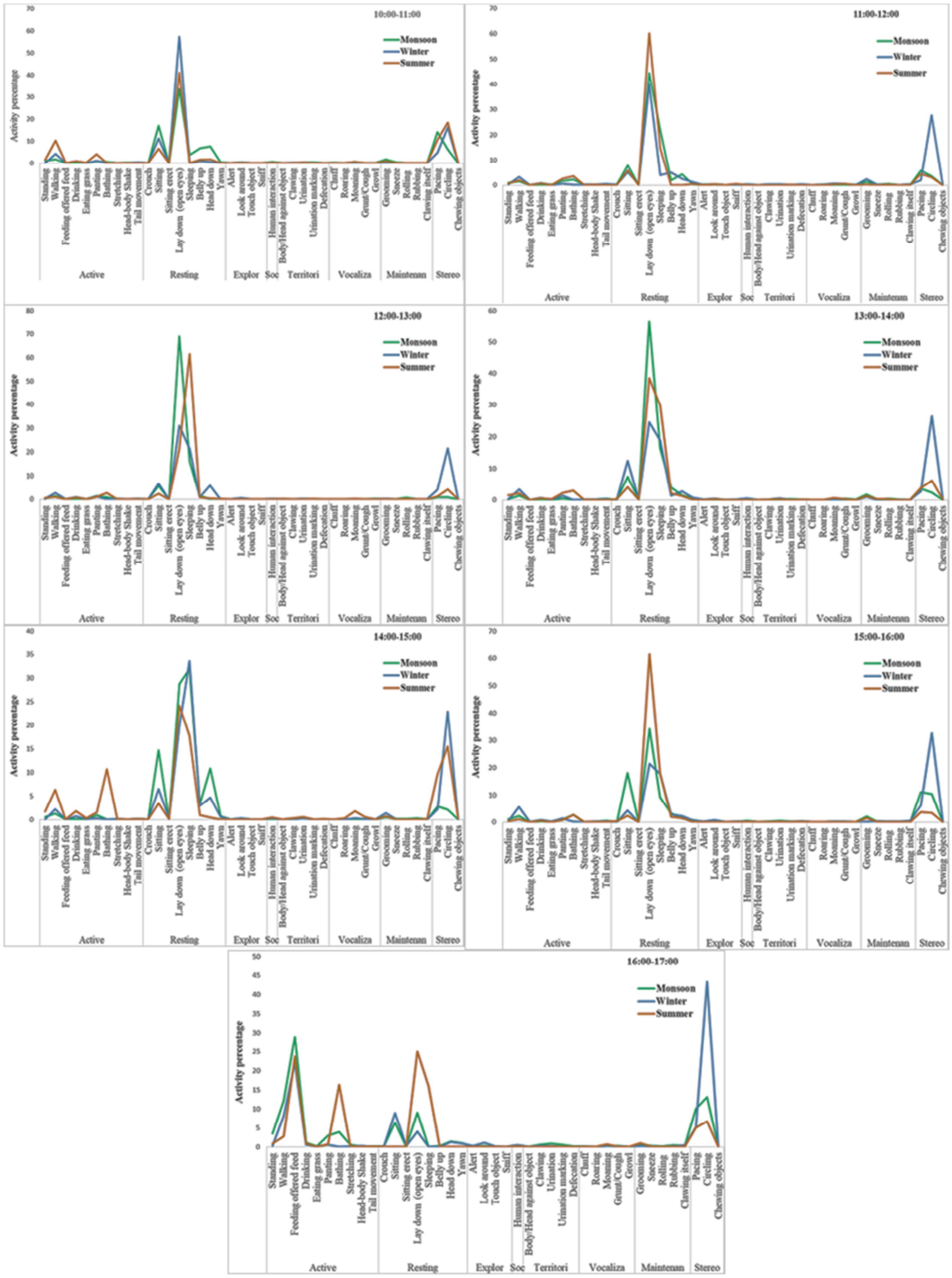

Fig. 9. Comparison of hourly activity budget of tiger in different seasons from 10:00h to 17:00h at Alipore Zoological Garden

From 11:00 to 12:00 hour

During the second hour of observation, walking (3.33%) was most prevalent during winter while bathing (3.61%) was found most common in summer, under the active behaviours. During the summer and monsoon, resting behaviours such as lying down and sleeping were observed more frequently (60.14% and 21.67% respectively), while sitting was more common during the monsoon (7.78%). Among vocalization behaviours, moaning was more frequent in the winter, accounting for 0.69% of occurrences. Maintenance activities like grooming was noticed to occur more frequently during the winter. Circling was significantly higher with a rate of 27.78% during the same season as grooming, whereas pacing behaviour was found dominant (5.69%) in the monsoon among stereotypic behaviours (Fig. 9).

From 12:00 to 13:00 hour

During the third hour of observation, in case of active behavioural category, the plotted graph (Fig) indicated that bathing (2.78%) and standing (0.56%) were maximum during the summer. Higher incidences of lay down (68.89%), sitting (6.67%), and sleeping (61.39%) activities were observed during the monsoon, winter, and summer seasons respectively while exhibiting resting behaviour. Pacing (4.03%), circling (21.53%), and chewing of objects (0.14%) were observed more in the winter during this particular hour when the stereotypic behaviours were taken under consideration (Fig. 9).

From 13:00 to 14:00 hour

Analysis of data showed that in the fourth hour of observation, summer had higher percentages of bathing (3.06%) compared to winter and monsoon, whereas, among resting behaviours, sleeping (56.67%) was noted to be dominant during monsoon. Grooming (1.81%) too was noted to occur at higher rate during monsoon in the maintenance category. In winter, circling was observed more frequently at 26.39%, while pacing was higher (3.89%) in the summer season (Fig. 9).

From 14:00 to 15:00 hour

During the fifth hour of monitoring, standing (1.67%), walking (6.39%), drinking (1.81%), panting (1.53%), and bathing (10.69%) were found to be maximum during summer, compared to the other two seasons. During monsoon, there was a higher occurrence of resting behaviours like sitting and lay down (14.72% and 28.75% respectively), with sleeping reaching peak during winter (33.61%). Under vocalization behaviour, moaning (1.81%) occurred in higher frequency during the summer, while, an increase in grooming (1.39%) was observed in the winter months, under maintenance behaviour. Circling too was observed more often during winter at a rate of 22.92%, while pacing was elevated at 9.72% during the summer, among the stereotypic behaviours (Fig. 9).

From 15:00 to 16:00 hour

Between 3:00 PM and 4:00 PM, the highest levels of walking (5.56%), drinking (0.83%), and panting (1.39%) were observed during winter, while exhibiting active behaviour. During the summer seasons, lay down was observed more frequently at 61.53%. However, sitting and belly-up activities peaked at 18.06% and 3.19% respectively during the monsoon season in the resting behaviour category. Grooming (2.08%) reached its highest point during the monsoon season among maintenance behaviours, whereas, during the winter, circling was noticed more frequently at 32.64% within the context of stereotypic behaviour (Fig. 9).

From 16:00 to 17:00 hour

Upon analyzing the behaviours of the tiger in the final hour, it was noted that, the studied animal exhibited bathing (16.25%) most during summer, whereas, feeding of offered feed (28.89%) was slightly higher in monsoon. Among the resting activities, laying down (25%) and sleeping (15.97%) reached peak in summer and when the stereotypic behaviours were considered, pacing (10%) was noted more in monsoon and circling (43.33%) was maximum during winter in this particular hour (Fig. 9)

Discussion

Information gained from behavioural observation is pivotal in measuring the welfare of captive animals. The current study deals with examining and analysing the different factors affecting the captive female Royal Bengal tiger by determining a diurnal activity time budget to optimize the captive environment.

The studied tiger exhibited walking behaviour notably higher in winter than the other two seasons as the tiger might be more comfortable in cooler temperature due to reduced heat stress. Bathing was observed to be highest during summer, probably to prevent itself from getting overheated due to its thick body coat. The studied tiger also had a higher drinking rate during this hot season which might help it to cope with increased water loss through panting and sweating (through their paw pad). From the observation, it was noticed that panting had reached peak during summer as well, probably to regulate their body temperature and to keep their body cool through evaporation, in the scorching heat of summer. Bengal tigers in wild, being a nocturnal animal, tends to be active during dawn rather than daytime (Melfi, 2009) but here, the captive tiger remained active mostly during the day. A prior study revealed that, apart from the feeding time, tigers remained inactive and were predominantly engaged in resting most of their time during the observation period (Rofiqoh *et al.*, 2022; Biolatti *et al.*, 2016). Here, in captivity too, it was discovered that various resting behaviours, exhibiting different resting postures like belly up and down, supporting a previous study (Mohapatra and Sethy, 2020), peaked at different times of the day in all three seasons, except for the final hour (16:00-17:00), during which feeding on provided feed was noted to be highest. Even though the studied animal was kept in a large open-air enclosure there was no provision of displaying any hunting behaviours as its natural instincts were suppressed, which supported a previous study (Mohapatra *et al.*, 2014) on captive tigers.

During winter, looking around behaviour was maximum which might be due to increased activity level and alertness because of tourist pressure. The studied animal also interacted greatly with human in this season as the increased visitor number might be stimulating for it, prompting it to observe and interact with them.

Despite being in a controlled environment, tiger retains their territorial instincts. The present study also indicated increased urination, urination marking and defecation activities in monsoon season as rain can wash away scent marking more quickly, prompting the tigress to mark their territory more frequently.

Through-out the summer season, the tigress had shown high frequency of moaning and grunt/cough activities. Changes in vocalization behaviour might be the response to heat stress as a form of expressing discomfort or attempting to cool down or a response to boredom or frustration.

The studied tiger was engaged in overgrooming during monsoon than other seasons. The reason behind this might be managing its fur, keeping it clean, dry, and in good condition, as monsoon season brings lots of rain, causing tiger's fur to become wet and potentially matted.

The captive environment affects the lifestyle of the zoo-housed animals and thereby they often show some abnormal behaviours due to stress and anxiety. The findings of this study also indicated that the housing facilities were not optimal as the female tiger exhibited pacing as a large proportion of their daily activity, probably due to its restricted enclosure and continuous contact with visitors (Mohapatra and Sethy, 2020). Under stereotypic behaviour, pacing with extreme restlessness was marked around the feeding time, at the sight of keeper with the feed just like the prior study (Mohapatra and Sethy, 2020). The tiger became more active and tried to get their feed according to previous studies (De *et al.*, 2019; Stryker *et al.*, 2019) which is similar to this captive tiger that had shown high level of pacing activity from 16:00 pm to 17:00 pm, during monsoon season. More circling was observed in the winter season, possibly due to the cold weather causing discomfort and prompting individuals to move more in

order to maintain its internal body temperature. Increasing circling could also rise as a result of the stress encountered by the tigress due to the disturbance created by the visitors and the shifted environment during the winter months.

Conclusion

The observed female Royal Bengal tiger exhibited significant behavioural patterns during all of the three seasons and also among different hours of the day throughout the period of observation.

During all seasons, the tigress mostly spent her time in resting, specifically more often during winter and summer season, whereas, in the final hour of the observation period, the data of feeding of offered feed was maximum in all three seasons.

The results of this current research on the daily activity budget of captive female tiger can help in distinguishing the behavioural patterns of wild tigers from those in captivity and to go to the root of the problems faced by the captive tiger in Alipore zoo. Thus, this present study could be promising in developing essential strategies to address the obstacles of captive environments and to enhance the care of captive tiger which ultimately will promote their well-being in captivity.

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