A PRELIMINARY INVESTIGATION OF THE BEHAVIOUR OF RUSTY SPOTTED CATS
Prionailurus rubiginosus IN CAPTIVITY

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ABSTRACT - This study focused on the behaviour of the Rusty-Spotted Cats *(Prionailurus rubiginosus)* housed in non-exhibit enclosures at the National Zoological Gardens, Dehiwala, Sri Lanka. The observations were conducted on six focal individuals; four males and two females including two potential breeding pairs. Identification of the focal individuals was done by comparing coat patterns on the flanks and the top of the head and neck region. The spot pigmentation of male focal animals was of apparently darker than that of the female focal animals.

Behavioural data were gathered by conducting direct observations and indirectly using remote camera traps placed inside the enclosures. *Ad libitum* sampling and focal animal sampling were conducted. Remote camera traps were used for night-time observations. Ten minute intervals of continuous sampling was done by the observer in 3-hour sessions during the day time (0600hrs to 1800hrs). Nocturnal observations were made using remote camera traps set to record videos ranging from 2 minutes to 10 seconds depending on the location of the camera, from 1800hrs to 0600hrs. For each individual, a minimum 48 hours of observations were recorded.

Twenty four behaviours belonging to six behaviour patterns were identified. Results indicated that rusty-spotted cats in captivity show behaviours defined as "locomotion/activity" most frequently, especially during the early dusk hours(1800hrs to 2000hrs). Males and female did not differ significantly in terms of frequencies of different behavioural patterns, except for comfort behaviour. Cage furniture and hides have shown tobe important for behaviour of the captive cats. Although in the wild they are known to be aggressive and highly agile, the captive animals have shown less aggression and agility. They also have shown very little behaviour under the reproductive behaviour pattern creating doubts about contribution to captive breeding at the zoo. Applicability of results in the context of behavioural study of Rust- Spotted Cats in the wild are discussed.

KEY WORDS : Rusty-Spotted Cat, Behaviour, Captivity, Ethogram, Camera trapping, National Zoo Sri Lanka

INTRODUCTION

Being considered as one of the smallest wild cat species in the world, the Rusty-Spotted Cat *Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire, 1831) is seldom seen in the wild mainly due to its nocturnal behaviour and habitat preferences. The species is highly arboreal and despite the smaller size, they are known to be highly agile and aggressive (Sunquist and Sunquist, 2002).

Rusty-Spotted Cat populations are mainly restricted to the southern parts of India and Sri Lanka. However, recent records indicate that the species is showing a much broader distribution in India, up to Kashmir in northern India (Sunquist and Sunquist, 2002). Rusty-spotted cat occupy densely vegetated and rocky habitats of moist and dry deciduous forests, scrub lands and grasslands, as well as human-modified habitats such as agricultural lands, sugarcane fields, and

teak plantations (Khan and Mukherjee, 2008).

In Sri Lanka, the species has been recorded from habitats throughout the island, including dry zone habitats such as densely vegetated areas of Yala and Udawalawe National Parks (Kittle and Watson, 2004, Patel, 2006) as well as from montane and low land rainforests (Deraniyagala, 1956). According to Deraniyagala (1956), two distinct populations of Rusty-Spotted Cats exist in Sri Lanka; one in the dry zone and the other in the wet zone. The wet zone population has been described as a subspecies *Prionailurus rubiginosus koladivius* by Deraniyagala (1956), while Pocock (1939) described the population in Sri Lanka as the subspecies *Prionailurus rubiginosus phillipsi* (Pocock, 1939), however, these are indicated as synonyms in Wozencraft (2005).

As all the other 35 wild feline species in the world (Lyniuk, 2011), habitat loss and anthropogenic activities such as agricultural expansions have caused the populations of Rusty-spotted cat to decline (IUCN, 2015). In some parts of both India and Sri Lanka, it's been also killed for meat. In response to declining numbers in the wild, the International Union for the Conservation of Nature has listed the global conservation status of Rusty-Spotted Cat as "vulnerable". According to the National Red List 2012 of Sri Lanka, the species is listed as "endangered" (MOE, 2012). Additionally, Rusty-Spotted Cat have been included in CITES Appendix I in India, and CITES Appendix II in Sri Lanka, preventing their exploitation and trade.

With increasing threats to their natural habitats, the future of Rusty-Spotted Cats is likely to depend on existing protected areas of the country, as well as on ex-situ conservation efforts such as captive breeding. However, a main drawback in conservation of Rusty-Spotted Cat is the lack of scientific information on their behaviour and ecology, thus causing unsuccessful breeding in ex-situ conservation programmes. In Sri Lanka, although numerous sightings and observations have been reported on Rusty-Rpotted Cats (Deraniyagala, 1956, Kittle & Watson, 2004), all these are

opportunistic observations made during research focused on other species.

In general, captive animals exhibit certain behavioural changes from normal. Such behavioural changes of wild animals in captivity have been relatively well documented in literature, and much of this work has been focused on stress-related behaviours, aggression, loss of response to predators, and changes in reproductive behaviours (Price, 2002, Mallapur *et al*, 2005, O'Regan & Kitchener, 2005, Bassett & Buchanan-Smith, 2006, Lyniuk, 2011). Despite these, animals in captivity, especially those that are rare and illusive in the wild, provide unique opportunities to make preliminary assessments of their behaviours and daily activity patterns which can provide important information for the conservation and management of wild populations as well as to enhance the welfare of captive animals. Therefore, present work was undertaken with the main objective of making a preliminary assessment of behaviours and daily activity pattern of Rusty-Spotted Cats in captivity.

As the present study was conducted as an antecedent to a study of Rusty-Spotted Cats in the wild, where it is intended to utilize camera trapping techniques, another objective of the current study was to assess the possibility of identifying individual cats based on conspicuous natural markings. Past studies conducted on other wild feline species using similar photographic methods have used conspicuous individual markings especially on flanks and the face to distinguish individuals (Karanth & Nichols 1998, Maffei *et al.* 2004, Silver *et al.*, 2004, Jackson *et al.*, 2006, Wanga and Macdonald, 2009, Sunarto *et al.*, 2013).

MATERIALS AND METHODS
Study animals

Captive Rusty-Spotted Cats housed in non-exhibit enclosures at the National Zoological Gardens in Dehiwala were studied. The observations were made on six cats housed in similar enclosures. The group of cats consist of 04 males and 02 females, with two potential breeding pairs. Out of them, two focal

individuals were housed alone. The cats are fed everyday with chicken meat once-a-day around 1500hrs while water is available throughout the time is not needed. In certain instances the cats are fed live prey (chicken chicks), however, this was not done during the duration of the present study. The enclosures are square shaped with the dimensions of approximately 4x4m area, with sandy substrate and containing hollow logs on the ground as hides and with some enclosures having climbable logs as cage furniture.

Identification of individuals

A photographic method was used to identify focal individuals by studying the morphological features as done with other cats (Jackson *et al.*, 2006, Wanga & Macdonald, 2009, Sunarto *et al.*, 2013). Photographs taken from a digital SLR camera (Nikon D90 70-300mm Nikkor lens) were used to study the skin pigmentation patterns of facial area, flanks, top of the head and neck area of the cats. Natural marks of the head and the neck area of the cats consist of stripes that run along from the top of the head up to the shoulder were suitable to identify focal individuals. Precautions were taken to minimize Hawthorn Effect while photographing and studying their behaviour.

Ad-libitum sampling

Behaviour of Rusty-Spotted Cats under captive conditions were quantified by *ad-libitum* sampling and focal animal sampling. Behavioural data was gathered by direct observations and indirectly with the use of remote camera traps placed inside the enclosures. Direct observations of the selected focal individuals were made for one hour during the feeding time as the cats were predominantly inactive during day time. In addition, video footage captured by remote cameras (Browning® Strike Force) set to take 10-second videos on trigger due to animal movements were also analysed to identify additional behavioural observations that were not noticed during direct observations. Accordingly, ethograms were constructed based on *ad libitum* and focal animal sampling totalling more than 3 hours of direct

and indirect/video observations.

Gathering behavioural data

Following the identification and description of different behaviours under behavioural patterns based on *Ad libitum* sampling, observations were made by focal animal sampling which is a continuous sampling method. Ten minute intervals of continuous sampling were done by the observer in 3-hour sessions during the day time (0600hrs to 1800hrs). In addition, 24-hour observations were also made using remote camera traps (Browning® Strike Force) placed inside each enclosure. Camera traps were set to record videos ranging from 10 seconds to 2 minutes depending on time if the day(10 seconds for night videos to conserve battery power). The cameras were set to record videos on being triggered by the movement of the cats. For each enclosure, a minimum 72 hours of observations were recorded. Data was analysed to determine the frequency and time spent on behaviour types identified during *ad-libitum* sampling.

RESULTS

Identification of individuals

Photographs of face and flanks of each individual were carefully examined for conspicuous individual markings. It was observed that individuals can be identified by comparing flank spot patterns (Figure 1: a, b, c, & d)as well as the whisker spots (Figure 1: e & f). It is also possible to differentiate individuals by the line pattern on the forehead and back of the neck (Figure 1: e & f).

Comparing whisker spots is difficult due the size of the cats; however, they can be distinguished using whisker spots as well with images of good quality and sufficient resolution. In addition, colour variations among individuals were also observed. The males' spots were of a much darker shade that of females. One individual male had a different colouration than the others. It was further observed that mature males have visibly larger skulls than females (Figure 1: e, f, & g).
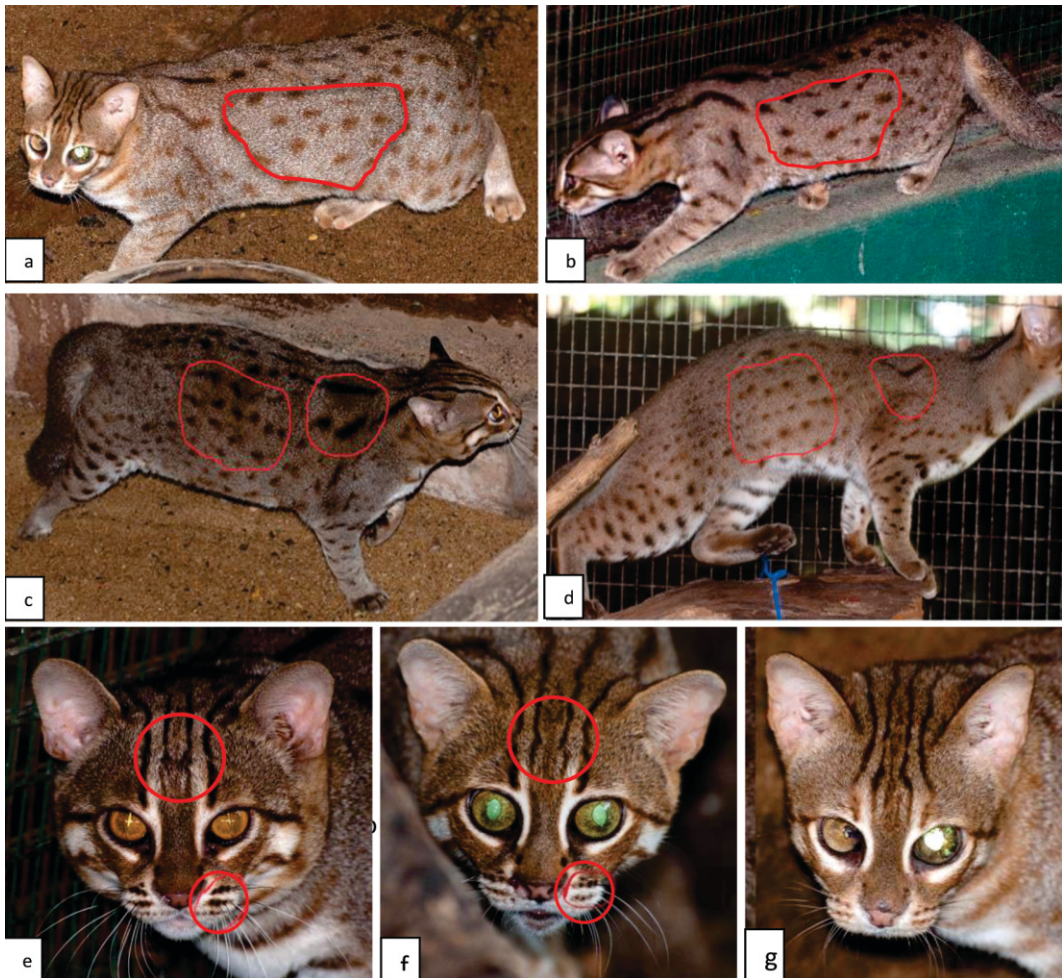
FIGURE 1: (a) & (b): variation of spot patterns in two females (c) & (d): variation of spot patterns in two males (e) & (f): Two individual males distinguished by the darker whisker spots, male on (e) having darker whisker markings. The lateral lines on the top of the head meet in the individual on (e). (g): adult females have comparatively smaller skull size when compared with adult males (e & f).

Identification and categorization of behaviours

A total of 24 different types of behaviours were identified during *ad libitum* sampling, and these were categorized into 06 behavioural categories. Ethograms were created and different behaviors were categorized as indicated in Table 1.

Behaviour frequencies for 06 individual Rusty-Spotted Cats observed, are illustrated in Figure 2. For all studied individuals, locomotion/ activity is the most frequent behaviour type, followed by resting and comfort behaviours. Focal Male 1 was an exception as it showed high frequency of stereotypic behaviours as well as being highly active. Focal Male 4 was significantly less inactive than other focal animals.

TABLE 1: List of behaviours exhibited by captive rusty-spotted cats

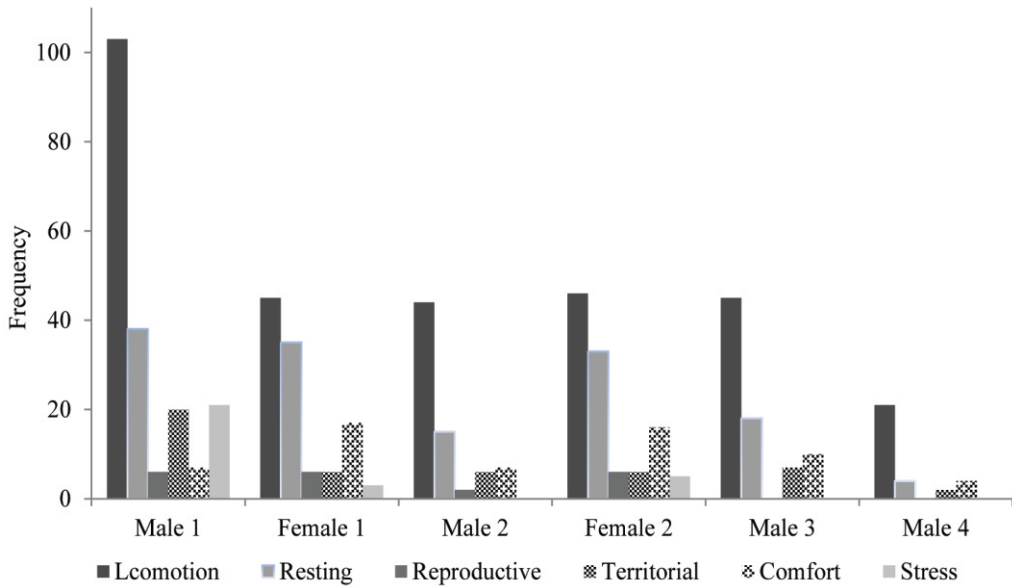| Behaviour	Description	Behaviour category
Grooming	Licking of paw or other part of the body, wiping face with paws	Comfort
Panting	Tongue out with rapid breathing	Comfort
Scratching	Scratching a body parts with retractile claws of paws	Comfort
Clawing/Scratching	Clawing or scratching the logs placed inside the enclosure.	Comfort
Stretching	Stretching of the limbs or the back.	Comfort
Climbing	Climbing placed logs or the cage of the enclosure.	Locomotion/activity
Running	Fast paced movement within the enclosure	Locomotion/activity
Walking	Slow paced movement within the enclosure	Locomotion/activity
Jumping	Jumping movement from either higher to lower or lower to higher place	Locomotion/activity
Feeding	Consumption and ingestion of food material	Locomotion/activity
Curious observations (Attentiveness)	Observing noise or movement outside the enclosure while moving (with ear or head movements)	Locomotion/activity
Crouching	Crouched, ready to pounce. With the back legs close together and the front legs stretched parallel to the ground	Locomotion/activity
Social interaction	Interaction among the male and female (rubbing and sniffing)	Reproductive
Vocalization	As implied. (Vocal related to reproductive behaviour)	Reproductive
Sniffing	Sniffing spots of scent marking and Male, Female sniffing interactions	Reproductive
Lying down	Resting with head down and eyes open.	Resting
Sitting/sitting erect	Fore limbs straight as in standing, stationary	Resting
Sleeping	Head down eyes closed, no movement of other body parts.	Resting
Stereotypic movement	Repeated up and down pacing within one particular section of the enclosure.	Stress
Hissing	Showing anger towards other individual (agonistic related to territorial behaviour)	Territorial
Tail wagging	As implied, done when showing dissent towards movement by other cat in the enclosure	Territorial
Scent marking	Scent marking by urinating	Territorial

FIGURE 2: Individual behaviour frequencies of six cats housed in enclosures

Comparison of mean frequencies of each behaviour category between two genders indicated that males exhibit more locomotion/ activity than females. In contrast, females show resting, and comfort than males (Figure 2).
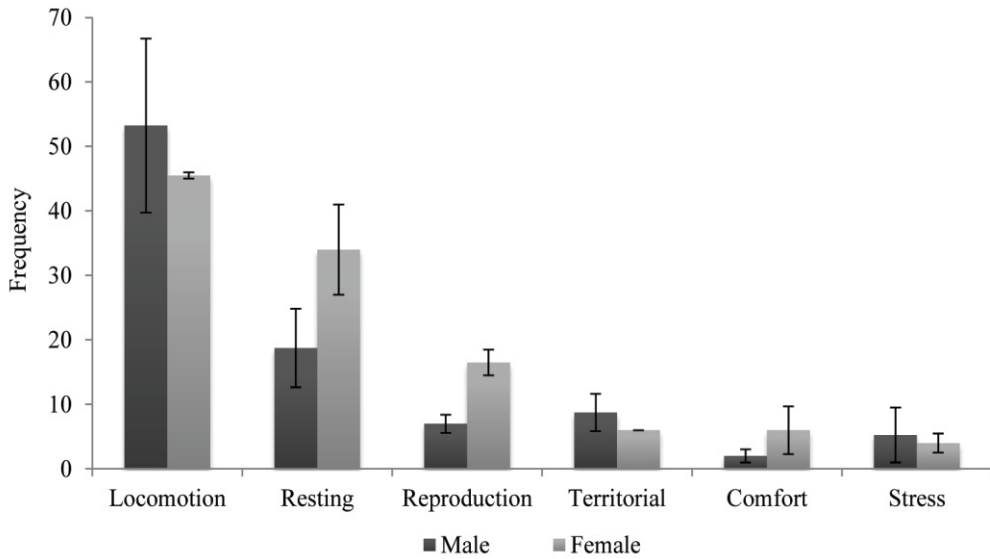

FIGURE 3: Behaviour category frequencies by sex

Mann-Whitney U test was used to test whether the frequencies of behavioral categories differ by gender. However, none of the behavioral categories significantly differed between sexes($p<0.05$) (Table 2). Spearman's Rank Correlations between behavioural categories and sex/gender further revealed no statistically significant relationships at $α=0.05$ level, with the exception of comfort behaviours that showed a strong correlation with female gender (*Spearman's rho* = 0.84, *p=0.036*).

TABLE 2: Mean frequencies of behaviour categories

Sex	Mean frequency of behaviours					
	Activity	Resting	Reproductive	Territorial	Comfort	Stereotypic
Male	53	19	7	9	2	5
Female	46	34	17	6	6	4
Significance	0.48	0.36	0.13	0.62	0.06	0.33

Daily activity pattern of the rusty-spotted cat in captivity was studied by analyzing the photographs captured by remote IR camera traps placed inside enclosure. The cameras automatically trigger when any movement is detected within the detection zone. The number of times the individuals were recorded within each one-hour intervals throughout the day was plotted against time (Figure 4). Highest number of captures were recorded during early dusk between 1800hrs to 2000hrs, indicating that this should be the most active time period of individual cats. In addition, moderately active periods could be identified between 0700hrs to 1100hrs, and exceptionally around 1500hrs. The cats are fed daily around 1500hrs and this may explain the increased activity around that time. Least activity was observed between 2200hrs to 0600hrs (Figure 4).
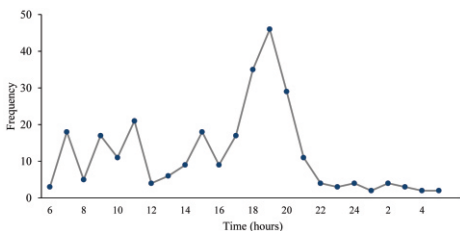

FIGURE 4: Daily activity pattern of the rusty-spotted cat in captivity

Spearman's correlations tests performed between time of the day and activity (measured by the frequency of photographs recorded) for males (S*pearman's rho= -0.512, p=0.006*), females (*Spearman's rho = -0.446, p=0.025*), and for pooled data (*Spearman's rho = -0.462, p=0.015*) indicated statistically significant relationships at $α=0.05$ level.

Further analysis were performed to examine the relationship between time of the day and activity, by partitioning a 24 hour period (1 day) into 4 sessions of 6 hours each *i.e.* morning (6:00am to11:59am), evening (12.00 noon to 5.59pm), night (6.00pm to 11.59 pm) and early morning (12.00 midnight to 5.59am). Kruskal-Wallis test was employed to identify whether there are significant differences in the activity level of rusty-spotted cats (measured by the number of photographs recorded at different times) among the 4 sessions of the day. Tests were performed for males, females and pooled data separately, and all of them showed statistical significance at$α=0.05$ level respectively ($χ^2 = 7.85, p=0.050; χ^2 = 10.567, p=0.014: χ^2 = 9.129, p=0.028)$, indicating that there are time periods of the day that Rusty-Spotted Cats are more active. Accordingly, "night session" was found to be the most active period for rusty-spotted cats housed in enclosures at the zoo with 45% of their activity being recorded between the time period of 6.00pm to 11.59 pm. However, substantial activity (29%) was also observed in morning session (6:00am to11:59am).Early-morning session seems to be the most inactive time period for the group of cats observed, with only 4% activity being recorded between 12.00 midnight and 5.59am.

DISCUSSION

There are no autecological studies conducted on the Rusty-Spotted Cats in Sri Lanka or elsewhere. Also, very little is known about their behaviour and no documented studies have been done in captivity. As a precursor to an autecological study on wild populations of Rusty-Spotted Cat, this work is focused on behavioral observations of Rusty-Spotted Cats housed in non-exhibit enclosures at the National

Zoological Gardens, Dehiwala, Sri Lanka. It is well documented in literature that captive conditions lead to certain behavioral changes in animals, and such behaviour patterns exhibited by wild animals exclusively in captivity are referred to as abnormal behavior (Mallapur *et al.*, 2002).Thus, it is difficult to derive sound conclusions upon study of the behavioural patterns of the rusty-spotted cat in captivity in the non-exhibit enclosures in a zoo environment.

One of the main objectives of the present study was to assess the possibility of identifying individual cats based on conspicuous markings. As in the case with many other wild felids (Maffei *et al.*, 2004, Silver *et al.*, 2004, Jackson *et al.*, 2006, Wanga and Macdonald, 2009, Sunarto *et al.*, 2013), it is possible to use conspicuous natural individual markings especially on flanks and face to distinguish focal individuals of Rusty-Spotted Cats. The colour difference shown by different individuals found in captivity could be due to the location they were found from. For example from the dry zone or the wet zone or due to the altitude there could be colour variations. The colouration change could be seasonal as described by Pocock (1939), as well as it being due to two different sub species *Prionailurus rubiginosus koladivinus* as identified by Deraniyagala (1956) or *Prionailurus rubiginosus phillipsi* identified by Pocock (1939).

Some individuals in captivity were active throughout the day, especially Focal Male 1 and Female 1, and this is contrary to what has been observed of the species in the wild (Sunquist & Sunquist, 2002, Kittle & Watson, 2004). This individual has shown remarkable stereotypic behaviour indicating that the displacement has caused stress and change of natural behaviour. Male 2, Female 2, Focal Male 3 and Male 4 showed most activity after sun set and also in the morning after sun rise, not giving a proper indication of the times of activity the cats might be active in the wild. In general, all animals have shown enhanced activity during darker hours and this is typical with wild counterparts of Rusty-Spotted Cat.

Using a camera trapping method, van Schaiks and Griffiths (1996) classified activity patterns of Indonesian rain forest mammals as diurnal (<10% of observations in the dark), mostly diurnal (between 10 to 30% of observations in the dark), nocturnal (> 90% of observations in the dark), mostly nocturnal (between 90 and 70% of observations in the dark), or cathemeral (sporadic and random intervals of activity during the day or night).Based on the findings of this study, it is difficult to assign Rusty-Spotted Cats into any of the above categories as rather equal frequencies of activity were recorded during both day and night. However, it should be noted that the activity levels in the morning session seems to be substantially influenced by behaviours of highly-active Focal Male 1. Removal of this outlier would allow describing Rusty-Spotted Cats as "mostly nocturnal" under captive conditions.

The cats are fed every day around 15.00 hours; however, only Focal Male 1 and Focal Female 1 were seen feeding immediately as they have habituated to this practice despite being nocturnal creatures. Focal Male 2 and Female 2 were seen feeding after sun set while Focal Male 3 and Focal Male 4 were not coming out of their log hollows even to feed until it was completely dark. It was noticed that the male takes a hierarchy when feeding, with the female feeding after the male had completed feeding. This was, however, not observed with Focal Male 1 and Female 1, who had been introduced more recently. Feeding the animals during late evenings would support their natural behaviours, however, this would not be practical with availability of labour and other procedures of the Zoo.

It was recorded that vocalisation of the species is similar to that of a domestic cat. Vocalisations were only observed during the night form the males and female housed together indicating that it is part of the reproductive behaviour pattern. When observing one video clip a series of vocalisations were heard in what seemed to be exchange of vocalisations between the male and female, with one responding to the others call. This was categorized under

reproductive behaviour pattern as there were no territorial defence behaviour seen and as territoriality was not prominent in this captive enclosure. Focal Male 1 was observed panting during the day, similar to what can be observed in canine species; however, this behaviour was not present in any of the other males or females indicating that they have been habituated to the conditions with time.

Another key observation made regarding the movement is that the Rusty-Spotted Cats are highly agile and climb the cage and logs or utilize cage furniture placed in the enclosures with ease. It is a high possibility that the cats spend time in trees while resting in tree hollows depicting their natural behaviour in the wild. Even while feeding the cats were observed taking their food to the top of the logs or to the edge of the enclosure which is at a higher level than the floor of the enclosure which could be an instinct behaviour. Sunquist & Sunquist (2002) categorize them as highly agile and aggressive animals; however, aggressiveness was not apparent under captive conditions as this would be directly related with defending territories.

Resting was the most commonly exhibited behavioural category after locomotion/activity. Sleeping as considered as a part of resting behaviour. Both males and females spent considerable time to rest, while females devoted higher amount of time on resting behaviours. It is generally believed that, under captive conditions, predators such as wild felids are frequently under-stimulated, and thus exhibit a behaviour profile dominated by resting behaviours (Lyniuk, 2011). Need of proper hide with sufficient isolation is necessary for them to display this behaviour. This is an important factor to consider in ensuring welfare of the animals under captivity.

Despite several limitations, Rusty-Spotted Cats in captivity provide unique opportunities to make preliminary assessments of their behaviours and daily activity patterns which can provide important information for the conservation and management of Rusty-Spotted Cat in captivity as well as to enhance the welfare of captive animals. The present behaviour study clearly indicates that availability of cage furniture and proper hide during day time is very important for their welfare and future success of captive breeding.

CONCLUSIONS

Identification of individual is possible through spot patterns on the coat as well as the lateral lines on the back of the neck. Identification was also possible through the whisker spots. Adult males and females show a difference in body size.

Locomotion/activity behaviour category was shown to be the most frequent type of behaviour recorded for both male and female Rusty-Spotted Cats under captive conditions, followed by resting. Comfort behaviours were mostly shown by females. The observed individuals were mostly active between 1800hrs to 2000hrs. In addition, moderately active periods were observed between 0700hrs to 1100hrs and, around 1500hrs. This could be due to the fact that study individuals being habituated to captive environment. With food being provided at a particular time each day, they may have changed their patterns of activity to coincide with feeding times. Importance of hide and cage furniture was apparent by behaviour.

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