The Activity Budget of Timor Deer (*Cervus timorensis*) in Savana Bekol, Baluran National Park

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Abstract. The timor deer (*Cervus timorensis*) is deer that natively distributed within Java and Bali, and has been introduced to other regions and other countries. The aim of this study is to observe the daily behavior of timor deer that inhabited Savana Bekol, Baluran National Park. We collected the data of timor deer behavior using continuous focal animal sampling method (Altmann 1974). We collected the daily activity budget data for 12 hours, from 06.00 until 18.00. Results showed that in general females spent most of their activities during the day (from high to low) on feeding, resting, moving, other activities, and vigilance While males spent most of their activities on resting, feeding, moving, other activities, and vigilance.

1. Introduction
The timor deer is deer that natively distributed within Java and Bali, and has been introduced to other regions and other countries. The distribution of timor deer is related to their ability in utilizing environmental conditions and habitat potential [1]. Timor deer are primarily diurnal, but can active at night when disturbed (i.e. poaching). Timor deer can live in both primary and secondary forest. Timor deer usually feeding in open-habitat like savannah or pasture. Timor deer preferred to use habitat with sloping topography and dense plant for breeding ground. Baluran National Park (at least in the 1990s) was considered have the largest timor deer population within its native range [2].

The amount of time that individual animals spent on their activities is known as their time budget or activity budget. Ungulates behaviour depends on individuals (condition, sex, age and group size) and also on environment conditions (time of day and weather) [3]. Beside natural factors like resources availability and predation risk, the activity budget could be modified by human factors [4]. Human activities or presence could influence and modified ungulates time budget [3].

Study of behavior is a tool for conservation [5]. Behavioral studies can be used to improve strategies or planning for wildlife management by providing the expression of behavioral pattern in the species of being concern [6]. The information of timor deer behavior in Baluran National Park is very limited. The information of their behavior is important because the success in surviving and reproducing rate of such animals depends on their behavior [7]. The aim of this study is to measure the activity budget of timor deer in Savana Bekol, Baluran National Park. Ungulates have a high level of sensitivity to human activity [8]. The study of timor deer behavior in Baluran National Park is conducted because the species may habituate to very high human activities.
2. Method

2.1. Study Sites
The study was conducted in Savana Bekol, Baluran National Park, Situbondo, East Java. Average temperature about 27.2°C–30.9°C and humidity around 77%. Savanna Bekol (7°50′27″ S, 114°26′23″ E) consisted about 300 ha of savanna.

![Figure 1. Study site in Savanna Bekol, Baluran National Park](image)

2.2 Behavioral Observation
We collected the data of timor deer behavior using continuous focal animal sampling method [9] by following individual target then record all of their activities and duration. We collected the behavior data during daytime for 12 hours, from 06.00 until 18.00. The observations were conducted from June to July 2019. In total, we collected 300 observation hours.

The timor deer which observed in this study were adult females and adult males. Adult is characterized by large body size, and have well-grown three branches of antler (only males). We observed the behavior of 6 individuals of timor deer (3 adult males and 3 adult females), and individual markings was used to identify individual targets. Binocular (10–30x50) was used for behavioural observation from such distance to minimize disturbance (around >100 m).

The activity bouts were divided into five categories, including: feeding, resting, moving, vigilance, and other activities. Feeding includes eating, foraging, and drinking. Resting includes sitting and standing still. Moving includes running and walking. Vigilance includes standing and scanning for something suspicious, in alert posture (focusing and ears were facing to the front), and sounding alarm call. Other activities include socializing, grooming, wallowing, decorating antler with vegetation, fighting, urinating, and defecating [10].

2.3 Data Analysis
For each hour of observation, all activities data were calculated. Mean for every activity proportions per hour were calculated by averaging all activities data. The percentage of each activity between males and females was calculated. Mann-Whitney $U$ test was used to measure the potential differences of each activity bouts between female and male. Data were analyzed using IBM SPSS Statistics version 25. Significant level was set at $P=0.05$. 


3. Result and Discussion

Overall, results showed that females spent most of their activities during the day (from high to low) on feeding (51.92%), resting (36.93%), moving (7.13%), other activities (2.50%), and vigilance (1.52%). While males spent most of their activities on resting (70.30%), feeding (19.27%), moving (6.36%), other activities (3.17%), and vigilance (0.90%) (Table 1). There were significant differences between male and female activities on feeding and resting (Mann-Whitney U test, P = 0.05).

| Activity  | Female (Mean ± SE) | Male (Mean ± SE) | Mann-Whitney U test (p) |
|-----------|--------------------|-----------------|------------------------|
| Feeding   | 51.92 ± 10.04      | 19.27 ± 6.84    | 0.013*                 |
| Moving    | 7.13 ± 1.72        | 6.36 ± 1.84     | 0.707                  |
| Resting   | 36.93 ± 10.97      | 70.30 ± 9.25    | 0.024*                 |
| Vigilance | 1.52 ± 0.39        | 0.90 ± 0.39     | 0.082                  |
| Other activities | 2.50 ± 0.55 | 3.17 ± 1.13 | 0.524                  |

* = Significant

![Activity budget of adult female in Savana Bekol](image)

Figure 2. Activity budget of adult female timor deer in Savana Bekol

The spread of activity budget of adult female timor deer during the day from 06.00 until 18.00 is shown in Figure 2. It showed that female spent most of their time for feeding. Mean feeding activity peaked in the morning (06.00-09.00) and in the afternoon (14.00-18.00). Mean resting and other activity peaked in the day (09.00-14.00). Mean moving and vigilance activity peaked in the morning and in the afternoon.

The spread of activity budget of adult male timor deer during the day from 06.00 until 18.00 is shown in Figure 3. It showed that male spent most of their time for resting. Mean feeding activity peaked in the morning (06.00-08.00) and in the afternoon (15.00-18.00). Mean resting activity peaked in the day (08.00-15.00). Mean moving, vigilance, and other activities peaked in the morning and in the afternoon.

Both females and males used most of their activity for feeding in the morning and in the afternoon. Feeding activity on females was higher than males. Higher feeding behavior on females because...
females had higher energy demands for lactation which was reported in timor deer in Panaitan Island, Ujung Kulon National Park [11] and musk deer (Moschus sifanicus) [12]. Timor deer usually feed together with other groups. Many groups prefer foraging around waterholes in the morning. After feeding, big groups usually separated into smaller groups. In the afternoon, feeding activity peaked on both females and males. This feeding behavior continued into the night (18.00 and above).

A herd of timor deer is led by alpha female. As a leader, alpha female seen more often vigilant while the group members were feeding. Leader provide an alarm call when a source of predation risk approaching. This behavior was also reported on study of timor deer in plantation [13] and timor deer in Ujung Kulon National Park [11]. Alpha female behavior can reduce spent time of other members on vigilant and increase spent time for feeding. It supported the collective vigilance hypothesis by Pays et al. [14], who reported that there was a positive correlation between group size and collective strategy in waterbuck.

Vigilance behavior peaked in the morning and afternoon. Timor deer increased vigilance behavior when they were staying around human or human infrastructure (i.e. roads, building). This is consistent from previous study suggested that perceived risk of predation increased with distance from protected areas [15]. Timor deer stayed around human infrastructure (i.e. roads, building) in the morning and in the end of afternoon. The presence of predators was very low during the day, so vigilance was only occurred in respon to human presence. There was no poaching or lethal activity in Savana Bekol. Timor deer have adapted to human presence and became habituated because there is no direct lethal threat. Theory predicts that when predators disappeared, prey species should become less fearful [16]. Human activity can instill fear in wildlife, that animals adjusted their behaviour to avoid human presence. Animals still perceived human as a threat or risk of predation (although there is no direct lethal threat) to keep them safe [17]. Animals avoided human presence on both spatial [18] and temporal avoidance [17].

Moving activity is activity that actually used to move from one location to another location. Moving was conducted to reach feeding ground, waterhole, cover for resting, and moving to avoid human presence. During the day when human presence was high, timor deer avoided human presence and human infrastructure in the day by moving away to another sites (around 300 m to 1200 m from roads or buildings). Avoiding human infrastructure like roads or buildings were also reported in the
behavior of wildebeest [19] and cougar [20]. Timor deer often moved to reach more protected (safer) areas or microhabitats (i.e. under trees, shrubs, or edge of forest). This behavior was also reported on the behavior of roe deer [21]. Timor deer also modified their movement pattern and speed to avoid walking on roads and running so fast when they were reaching or passing roads. This moving behavior was also reported in movement pattern of lion in response to human-dominated landscape [22].

In the day, most of timor deer were resting. They were resting together under a tree or edge of the forest. Females usually resting with their group, while males usually resting separated from groups (some males were still inside a group). Males started to rejoin group when they were feeding in the afternoon (after resting during the day). Resting activity of timor deer in Savana Bekol, Baluran National Park was very high (female 36.93% and male 70.30%) compared to resting activity of timor deer in Panaitan Island, Ujung Kulon National Park (female 11.20% and male 17.81%) [11]. We predicted that timor deer in Savana Bekol, Baluran National Park spent more time on resting to avoid human presence. Human presence was very high in Savana Bekol because Savana Bekol was opened for tourism. Tourism or recreation could affect the activities of ungulates including red deer (Cervus elaphus) [23], elk (Cervus canadensis) [24], red deer (Cervus elaphus) and pronghorn (Antilocapra americana) [8], sika deer (Cervus nippon) and wildboar (Sus scrofa) [25], and mule deer (Odocoileus hemionus) [26]. However, wildlife behavior adjustment to cope with human presence (i.e. reduced feeding activity and increased vigilance rates), could affect their condition and their reproduction rates [27]. Restriction for not entering savannah >5 m in Savana Bekol is useful to avoid or minimize contact between timor deer and human.

Timor deer were also grooming while resting. They actually prefer self-grooming rather than allogrooming (grooming with other individual). Females conducted grooming activity more often than males. Females conducted grooming activity between activities from morning to afternoon. Males conducted grooming activity only in the morning and afternoon and spend all the time at midday for resting (sitting). The function of grooming was reported for protection against pathogenic infection [28] and to reduce tick load [29].

Males were seen more often used mud in waterholes for wallowing their body and antler during rut season. There are 6 human-made waterholes and the waterholes location are varied (from 10 m near buildings and up to 200 m from road in open savanna). Males used mud in the waterholes which only used when there was no human around. After wallowing their body, males rubbed their antler on vegetation. Fighting between males occurred when aggressive males stayed near each other. Fighting is conducted to acquire female for mating [13]. At night (18.00 and above) we also saw that timor deer were still active. They were feeding, socializing and conducted more other activities at night.

Precipitation in Baluran National Park is low. Creating waterhole for wildlife management is very important in dry season. Timor deer mostly used waterholes for drinking in the early morning and in the end of afternoon. Waterholes were also used by many other animals such as banteng, buffalo, monkeys (long-tailed monkey and javan langur), birds, and other animals.

4. Conclusion

Females spent most of their activities during the day (from high to low) on feeding (51.92%), resting (36.93%), moving (7.13%), other activities (2.50%), and vigilance (1.52%). While males spent most of their activities on resting (70.30%), feeding (19.27%), moving (6.36%), other activities (3.17%), and vigilance (0.90%). Timor deer behavior pattern was influenced by sex, human presence, temperature, social group, and resource availability. Restriction for not entering savannah in Savana Bekol is useful to avoid or minimize contact between timor deer and human. Timor deer were still active at night.

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