The Time Budget of Javan Deer (*Rusa timorensis*, Blainville 1822) in Panaitan Island, Ujung Kulon National Park, Banten, Indonesia

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Javan deer that exist in Panaitan Island was reintroduced from Peucang Island during 1978-1982. We observed behavior of the reintroduced Javan deer inhabiting Panaitan Island. Javan deer in this island spent most of their diurnal time for feeding. There were no significant differences between all age-sex variation for all activities pattern. The behavior of Javan deer was influenced by age, sex, social group, temperature, and food availability.

Key words: Javan deer, behavior, reintroduced, time budget

INTRODUCTION

Javan deer is protected by Indonesian law (Kemenhut 1999). Panaitan Island is one of the area for habitat of Javan deer. Javan deer which is occur in this island was reintroduced from Peucang Island during 1978-1982 (sixteen individuals; 3♂: 13♀). In 1997, Ujung Kulon National Park Agency reported that the population size of Javan deer in Panaitan Island was about 78 individuals and in 2008 it increased to about 400 individuals. The information of Javan deer in this island is very limited; information on ecology including behavior is unavailable, whereas the success of animal for surviving and reproducing depends on its behavior (Krebs & Davies 1990).

Behavioral studies are useful for conservation (Caro 2007). The information on behaviour can be incorporated into improved strategies for wildlife management by facilitating the expression of behavioral pattern in the species being managed (Singh & Kaumanns 2005). The knowledge of Javan deer behavior in Panaitan Island is expected to provide useful information to be used in their conservation.

One ways to quantify the animal behavior is to record the duration of each behavior type over a specified time period (Blackshaw 1986), and a record of how an organism spends its time is called time

budget (Crews *et al.* 2002). The objective of this research was to measure the time budget of Javan deer in Panaitan Island and to address their age-sex class variation.

MATERIALS AND METHODS

Study Area. Panaitan Island is located at Sunda strait around 06°34'8" S and 105°12'50" E, with an area of 17.500 ha (Figure 1). Panaitan Island is composed by primary dryland forest (9.213%), secondary dryland forest (55.81%), shrub (15.444%), secondary mangrove forest (5.727%), secondary swamp forest (9.877%), shrub swamp (3.927%) and grass land (0.002%). Topography of Panaitan Island is generally flat and the highest point is Gunung Raksa with a height of 320 m. Panaitan Island has three big rivers and many of wallows and swamps. Panaitan island is an area for habitat of javan deer (*Rusa timorensis*), barking deer (*Muntiacus*
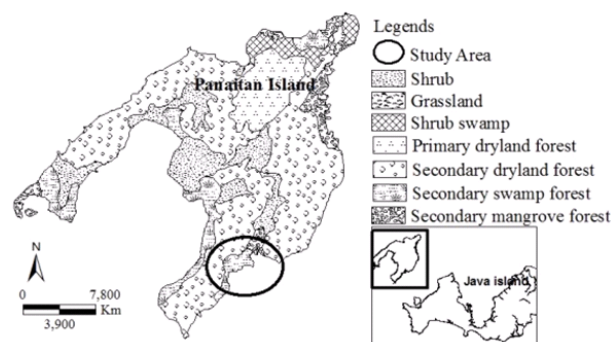

Figure 1. Research site.

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muntjak), smaller mouse deer (*Tragulus javanicus*), wild boar (*Sus scrofa*), long-tailed macaque (*Macaca fascicularis*), musang (*Paradoxurus hermaphrodites*), lizard (*Varanus salvator*), python (*Python reticulatus*), crocodile (*Crocodilus porosus*) and many species of birds. Mean temperature and humidity of the island varies 24-32 °C and 65-92%, respectively.

Behavioral Observation. The behaviors of Javan deer were observed using focal animal sampling method (Altmann 1974) by following the individual target and record the activity and its duration. When the individual target went out of sight, other individual with the same age-sex class was picked up and its behavior with the duration were recorded. The observations were conducted during daytime from 08.00 to 16.00 and recorded from March to December 2013.

The Javan deer were classified into: fawn, sub adult male, sub adult female, adult male and adult female. Determination of the age criteria based on body size and behavior of each age class (Yuliawati 2011). Fawn is characterized by small body size with smooth feathers, still in the care of its mother so always be near its mother. Sub adult is characterized by medium body size (bigger than fawn), usually active in groups of same age-sex class. At sub adult, males start growing single antler. Adult is characterized by a large body size. Adult male is marked by the antler that has developed and adult female usually be followed by fawn. We recorded behavior of 23 individuals of Javan deer (4 adult males; 5 adult females; 3 sub adult females; 5 sub adult males; 6 fawn) with total of 7200 minutes observation. Binocular was used to observe the behavior.

The activities pattern of Javan deer were divided into six categories: feeding, moving, resting, grooming, anti predator, and others. Feeding includes searching for food, handling the food and chewing, ruminating, drinking and drinking mother's milk. Moving includes walking and running. Resting includes standing still, sitting still, and sleeping with eyes closed. Grooming includes licking itself, scratching itself, and licking another deer. Anti-predator includes standing scanning for anything suspicious, an alert posture, and giving alarm call. Others were defined as defecating, urinating, playing, fighting, wallowing, display (rubbing forehead or antlers on vegetation and decorating the antlers with vegetation), and sexual behavior. (Sharaichandra & Gadgil 1980; Xu *et al.* 2012).

Statistical Analysis. The percentage of each activity type of each individual was calculated. Kruskall-Wallis test was used to measure the potential behavior and sexual differences between each age class of Javan deer. Data were analyzed using SPSS 16.0 statistical package. Significant level were set at $P = 0.05$.

RESULTS

The result showed that all age-sex classes of Javan deer spent most of their time for feeding (Table 1). There were no significant differences between all age-sex variation for all activities pattern (Kruskal-Wallis test, $P > 0.05$), although adult female dedicated more time for feeding ($76.72 \pm 3.61\%$) than adult male ($57.73 \pm 6.23\%$) and adult male spent more time for other activities ($3.68 \pm 1.85\%$) than fawn ($0.08 \pm 0.03\%$).

The spread of time activity budget of adult female from 08.00 to 16.00 can be seen in Figure 2. It showed that adult female dedicated most of their time for feeding. Adult female spent most of their time for resting at 12.00-14.00. Meanwhile, adult male spent most of their time for resting in the morning (08.00-10.00) and in the afternoon (13.00-15.00), and they dedicated most of their time for feeding at 10.00-13.00 and 15.00-16.00 (Figure 3).

The spread of time activity budget of sub adult female and sub adult male were almost similar (Figure 4 & 5). During the day, sub adult male and sub adult female spent most of their time for feeding which interspersed by resting, moving, grooming, anti predator, and other. Sub adult male spent more

Table 1. Activity time budget of Javan deer in Panaitan Island

Activity patterns	Proportion of time spent (mean ± SE)					Different time budget between all age-sex class compared by Kruskal-Wallis test
	Fawn	Sub adult male	Sub adult female	Adult male	Adult female	
Feeding	57.69 ± 16.18	60.66 ± 20.77	72.46 ± 5.34	57.73 ± 6.23	76.72 ± 3.61	χ2=2.433; df=4; P=0.657
Moving	16.1 ± 5.42	9.84 ± 2.43	4.85 ± 3.04	8.01 ± 3.62	5.63 ± 0.72	χ2=5.433; df=4; P=0.246
Resting	19.93 ± 9.25	18.84 ±13.99	17.48 ± 2.73	17.81 ± 5.25	11.2 ± 4.03	χ2=0.700; df=4; P=0.951
Grooming	1 ± 0.52	4.48 ± 4.43	3.12 ± 1.42	6.59 ± 3.41	1.29 ± 0.65	χ2=2.680; df=4; P=0.613
Anti predator	5.19 ± 1.83	5.18 ± 1.74	1.99 ± 1.13	6.17 ± 0.87	4.94 ± 0.77	χ2=4.333; df=4; P=0.363
Other	0.08 ± 0.03	1.01 ± 0.57	0.09 ± 0.05	3.68 ±1.85	0.22 ± 0.03	χ2=6.214; df=4; P=0.184

Time budget of adult female in Panaitan Island

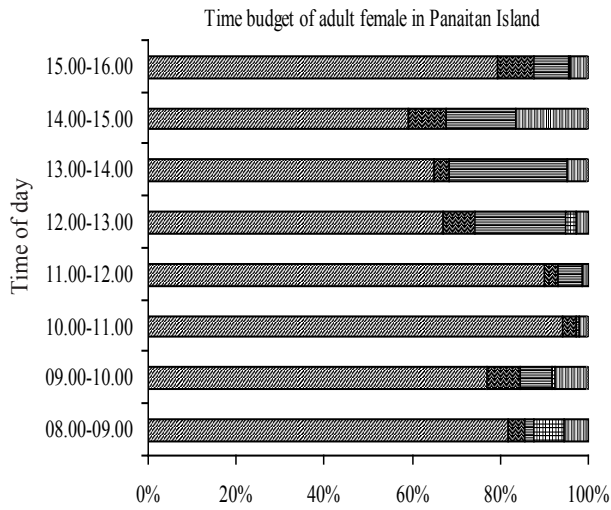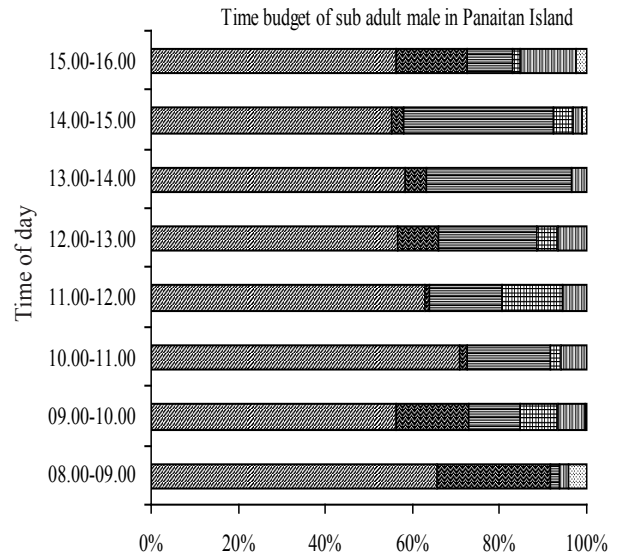Figure 2. Time budget of adult female. feeding, moving, resting, grooming, anti predator, others.

Time budget of adult male in Panaitan Island
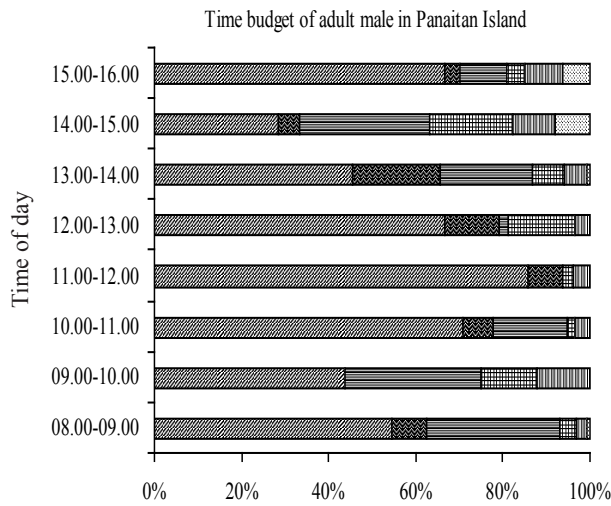

Figure 3. Time budget of adult male. feeding, moving, resting, grooming, anti predator, others.

Time budget of sub adult female in Panaitan Island

Figure 4. Time budget of sub adult female. feeding, moving, resting, grooming, anti predator, others.

Time budget of sub adult male in Panaitan Island

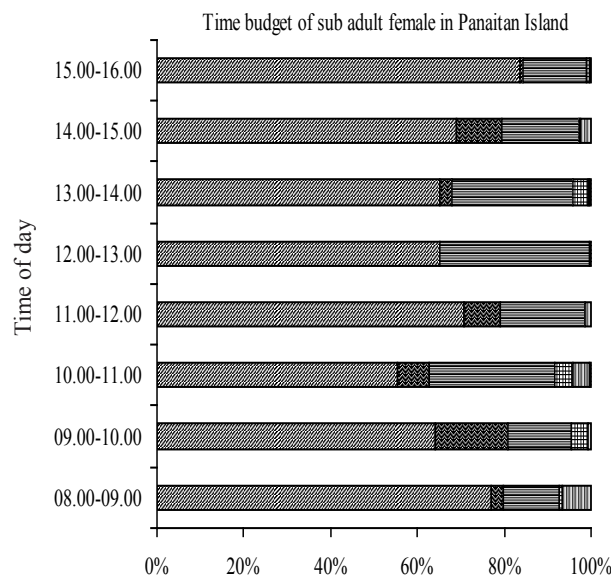

Figure 5. Time budget of sub adult male. feeding, moving, resting, grooming, anti predator, others.

Time budget of fawn in Panaitan Island
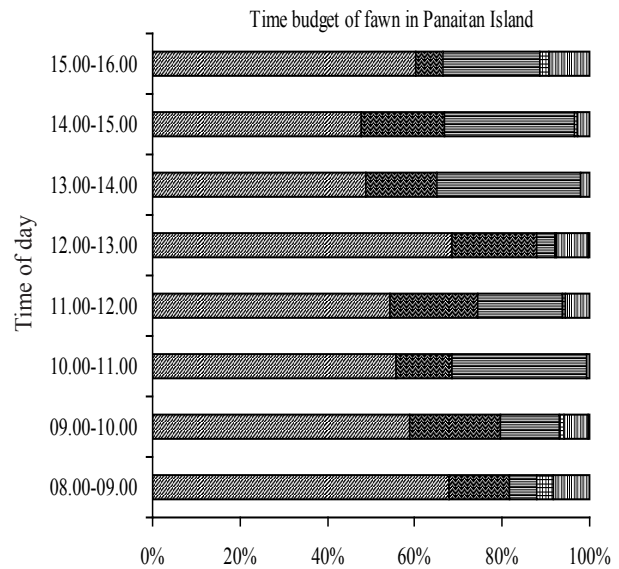

Figure 6. Time budget of fawn. feeding, moving, resting, grooming, anti predator, others.

time for moving in the morning (08.00-10.00) and in the afternoon (15.00-16.00), while sub adult female spent more time for moving in 09.00-10.00. Sub adult male spent their time for other activity also in the morning (08.00-09.00) and in the afternoon (15.00-16.00).

The spread of time activity budget of fawn can be seen in Figure 6. During the day, the fawn spent most of their time for feeding which interspersed by moving, resting and anti predator activities.

DISCUSSION

The Javan deer in Panaitan Island spent most time for feeding, which is consistent with the behavioral observation of Javan deer in grazing area of Bali

Barat National Park (Masy'ud *et al*. 2007), plantation area in PT. Kuala Tembaga (Wirdateti *et al*. 2005), and in Taman Safari Indonesia (Wirdateti *et al*. 1997). While Javan deer in Sadengan grazing area of Alas Purwo National Park (Subeno 2007) and Sambar deer in Taman Wisata Alam Bumi Kedaton (Dewi & Wulandari 2011) spent most of their time for resting.

During the day, adult female dedicated most of their time for feeding. We predicted that it compensated higher energy demand for lactation as reported in musk deer (Ma *et al*. 2011) and in black howlers (Dias *et al*. 2011). We also observed that adult female with fawn would be more vigilance than adult female without fawn. This case also occurred in cattle (Kluever *et al*. 2008), Przewalski's gazelle (Li *et al*. 2009), African oryx (Ruckstuhl & Neuhaus 2009), and goitered gazelle (Xia *et al*. 2011). Adult female with infant spent more time for vigilance to detect predator earlier and escape danger (Xia *et al*. 2011), to protect themselves and their young (Halofsky & Ripple 2008; Xia *et al*. 2011), and to increase infant survival (Lung & Childress 2006).

In Javan deer, adult female is a group leader. It provide a signal when the predation risk increase or a danger comes. A similar behavior was reported on Javan deer in plantation (Wirdateti *et al*. 2005). Behavior of group members is a source of information about the environment including predation risk (Beauchamp 2009).

As the group leader, adult female also seen to be vigilant while other group members were feeding quietly. It support the collective vigilance hypothesis of Pays *et al*. (2007), who demonstrated positive correlation between collective and group size in waterbuck. An individual waterbuck that belongs to coherent and communicating group, can reduce time spent vigilant while also enjoying security through increased probability that at least one waterbuck will be vigilant at any moment.

Adult male dedicated most of their time for feeding at 10.00-13.00 and 15.00-16.00, so they can allocate their time for other activities such as resting, grooming, moving, fighting, defecating and display. Larger male with higher metabolic rate needs less time for feeding (Van Soest 1985; Xu *et al*. 2012). Grooming was conducted from morning to afternoon in between of other activities. The function of grooming has been reported to reduce tick load for in wild baboons (Akinyi *et al*. 2013), insect defense against pathogenic infection (Zhukovskaya *et al*. 2013), and as an incentive for helper (Lazaro-Perea *et al*. 2004).

In the morning, adult male visited the sea and drank seawater. They were feeding the coastal vegetation such as *Barringtonia asiatica* Kurz, *Hibiscus tiliaceus* L. and *Terminalia catappa* L. and resting on the beach under the coastal vegetation afterward. Javan deer drank sea water to fulfill the requirement of mineral salt as reported on banteng (Santosa & Delfiandi 2007). The function of mineral is to form bones, teeth, hair, and antler (Semiadi & Nugraha 2004). We predicted that adult male visited the ocean in the morning to avoid high temperature in midday. It was an indication that temperature influenced behavior (Ockenfels & Bissonette 1982; Beier & McCullough 1990). Adult males in Panaitan Island ate the leaves and sprouts of Sonneratia which could not be found in Peucang Island. This finding indicated that adult males have adapted to the environment as reported in Macaques (Hadi *et al*. 2007)

Adult male conducted other activities such as rubbing forehead or antlers on vegetation, fighting, urinating and defecating. Rubbing forehead or antlers on vegetation, urinating and defecating can be considered as scent marking (Decima & Black 2000). The functions of scent marking include inter-sexual communication (Gomes *et al*. 2013), honest signals of health and infection (Zala *et al*. 2004), and serve both in territorial and mate signaling (Roberts 2012). The function of fighting is to acquire adult female for mating (Wirdateti *et al*. 2005).

During the day, sub adult female spent most time for feeding and spent less time for anti predator activity. We predicted that it related to food availability and the safety of environment. Abundant food availability in Panaitan Island has triggered sub adult female to spend more time for selecting the best food as reported on mule deer (Kuzyk & Hudson 2007). There are many kinds of foods which is available in this island such as grass, sprouts, leaf of seedling, leaf of sapling, fallen leaf, fallen flowers, fallen fruits, mushroom, and seaweed. Sub adult female stayed within group with adult female as group leader. Adult female would be vigilant when danger comes, while sub adult female can continue feeding quietly. Sub adult female was enjoying security through the vigilance of adult female. It support the collective vigilance hypothesis (Pays *et al*. 2007).

Sub adult male spent more time for moving and other activity in the morning and in the afternoon. Moving was done from one patch to another patch searching food and cover for resting. Other activities

which was done by sub adult male were rubbing forehead or antlers on vegetation, fighting, urinating, and defecating.

Sub adult male spent most time for anti predator in the afternoon (15.00-16.00). We observed that sub adult male separated with its group in the afternoon, although from morning it stayed with adult male or adult female. We predicted that it related to the group size that call group size effect; vigilance declines with increases in group size (Roberts 1996). Group size effect has been reported in Tibetan antelope (Lian *et al*. 2007), Tibetan gazelle (Li & Jiang 2008), asiatic ibex (Xu *et al*. 2010), svalbard reindeer (Reimers *et al*. 2011), and goitered gazelle (Xia *et al*. 2011). Several hypotheses have been proposed to explain the mechanism of group size effect including: collective vigilance (Ebensperger *et al*. 2006; Pays *et al*. 2007), detection and dilution (Fairbanks & Dobson 2007; Li & Jiang 2008; Li *et al*. 2012), and social facilitation (Michelena & Deneubourg 2011).

Fawn stayed with adult female especially in lactation period as reported on calf of European bison (Daleszczyk 2004). In ungulates, a major function of maternal behavior is the facilitation of learning processes in the infant (Lent 1974). We observed that when adult female was sitting with rumination, fawn walked around adult female to explore surroundings. We predicted that fawn was learning food type variation and the location to search for them. Exploring surroundings also found in calves of European bison (Daleszczyk 2005). When its mother started to vigilance, fawn would be vigilance immediately. We predicted that fawn was copying the vigilance behavior of its mother. Behavior of group members is a source of information about the environment including predation risk (Beauchamp 2009).

In general, Javan deer spent most of their time for feeding. The behavior of Javan deer was influenced by age, sex, social group, temperature and food availability. The grassland that has invaded by *Chromolaena odorta* should be reopened and maintained. The function of grassland for Javan deer is to search food and social activity. In addition, the manager of this island should create a secure condition for Javan deer activity.

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