Study on Daily Activity Pattern of Captive Lion (*Panthera leo*) in Siantar Zoo, North Sumatra, Indonesia

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Abstract. The present study investigated diurnal or daily activity patterns of an individual captive lion (*Panthera leo*) in Siantar Zoo, North Sumatra, Indonesia. Behavioral observations of 70 hours in 10-days observation were analyzed descriptively for common Felidae behaviors identified using a standardized Felidae ethogram. The methodology used was focal animal sampling with continuous sampling of data record or 5-minute sampling periods. We reported that the captive lion allocated the most time budgets in inactive behavior or sleeping with the percentage of 62.88% or 2,604 minutes. Incidence of pacing as stereotypic behavior was documented in low percentage or 4.46% within the duration of or 189 minutes in our study. The dominant sleeping behavior may be considered as normal to captive Felidae in many zoos while some consideration upon their effect to visitor may be evaluated in the future study. Dynamic condition of display cage may be enriched to trigger better behavior related to welfare implications on the captive lion.

1. Introduction

Behavioral studies may be conducted to assess the preliminary condition of animal welfare or even the presence of abnormal behaviors [1]. Application of animal behavior in zoo management must be based on species-specific behavior under comprehensive and consistent review. The goal of implementing behavioral assessment is to ensure animal sustainability in captivity while being supported as the most sensitive and non-destructive method to derive stress condition of captive animals [2]. This approach may be applied to all zoo conditions with species-specific knowledge requirements of captive animals.

Large cats (Felidae) have been considered as exotic collections in many zoos regarding its superior image and its important conservation status. The success of zoo management as ex-situ conservation site for Felidae depends on the animal welfare of captive animals. Huge investment on captive Felidae must be supported by the welfare data which can be retrieved from its daily activity pattern or behaviors. It has long been reported that big cats may show dominant inactive behavior or frequent stereotypic behavior [3–5].

African lion (*Panthera leo*) is a vulnerable species with a decreasing population trend [6]. In this study, we present the recent information on daily activity pattern and possibility of stereotypic behavior exhibited by captive lion in Siantar zoo, North Sumatra, Indonesia. Our results then may reflect the importance of future modification on environmental enrichment to improve lion’s behavior to support a good animal welfare state in zoo management.
2. Materials and method

2.1. Animal housing and husbandry

The study was conducted at Taman Hewan Pematang Siantar or Siantar Zoo, North Sumatra, Indonesia. The subject was 10-year old male African lion (*Panthera leo*) named Siro housed in a large enclosure with a back-cage. The ground is characterized by soil and sandy area with a pool stretching near the display cage. During the study, the lion was fed with interchangeably chicken and beef meat in the afternoon at 10:00 to 11:00 hours and was fasted once in a week.

2.2. Behavioral data collection

Captive lion was observed for 70 hours with daily observation started from 10:00 to 18:00. The diurnal observation period was chosen as the peak time for visitor in the zoo. An ethogram was used to facilitate a 3-day preliminary assessment of total behaviors [7]. Categorization of lion behaviors are Active (Feeding, Locomotion, Defecate, Urinate, Vocalize), Inactive (Resting Awake, Sitting, Sleeping, Grooming), and Stereotypic (Pacing). Methodology used was focal animal sampling with continuous sampling of data record or 5-minute sampling periods [8].

2.3. Data analysis

The frequencies of behaviors were combined to form aggregate categories of ‘Active’, ‘Inactive’, and ‘Stereotypy’. Data were analyzed using Microsoft Excel 2010 in the expression of mean. Diurnal of daily activity pattern was constructed into 7, 1-hr increments, starting from 10:00 and ended at 18:00 hours (expressed in mean and standard deviations). Graphical images were constructed using GraphPad Prism 8.0.

3. Results and discussion

A record of 2,347 sampling points from 70-hr (4,200 minutes) observation was documented from captive lion in Siantar zoo, North Sumatra. Aggregate of behaviours was grouped into Active, Inactive, and Stereotypic, and Not Visible. Based on frequency, Inactive behavior was observed as the most frequent behavior with the percentage of 54.32%, followed with Stereotypy (22.24%), Active (21.99%), and Not Visible (1.45%) (Figure 1). Meanwhile, based on duration (minute), Inactive behavior was observed as the longest duration of behavior with the percentage of 83.19%, followed with Active (8.36%), Stereotypy (4.46%), and Not Visible (3.99%) (Figure 2).

![Figure 1](image_url)

*Figure 1*. Percentage of behavioral frequencies by captive lion (*Panthera leo*) in Siantar Zoo. Total frequency observed was 2,347 sampling points.
Figure 2. Percentage of behavioral durations (minute) by captive lion (*Panthera leo*) in Siantar Zoo. Total time budgets observed was 4,200 minutes.

Hourly time budgets for each behaviors by captive lion are shown in Table 1. In Active category, captive lion was observed to exhibit more locomotion or movement (5.41%) inside display cage with intentional feeding (1.24%) on carcasses given by the management. In Inactive category, lion was observed to rest or sleeping (62.88%) along with frequent sitting (10.70%) and resting awake (7.96%) in the cage. The sleeping behavior spent the longest duration during our study, with 2,604 min from total 4,200 minutes of observation. In Stereotypy category, pacing was the only known of stereotypic behavior exhibited by the captive lion with the percentage of 4.46% or 189 min. By comparing mean behavioral duration in percentage (%) from each repetitive observation, a daily activity pattern is then constructed as shown in Figure 3.

| No. | Categorization | Behaviors       | Percentage (%) |
|-----|----------------|-----------------|----------------|
| 1.  | Active         | Feeding         | 1.24           |
| 2.  |                | Locomotion      | 5.41           |
| 3.  |                | Defecate        | 0.01           |
| 4.  |                | Urinate         | 0.21           |
| 5.  |                | Playing         | 0.99           |
| 6.  |                | Vocalize        | 0.49           |
| 7.  |                | Resting Awake   | 7.96           |
| 8.  | Active         | Sitting         | 10.70          |
| 9.  | Inactive       | Sleeping        | 62.88          |
| 10. |                | Grooming        | 1.65           |
| 11. | Stereotypy     | Pacing          | 4.46           |
| 12. | Not Visible    | Not Visible     | 3.99           |
Based on Figure 3, the most allocated behavior was observed in Inactive behavior, indicating that captive lion was sleeping for the most study period. Pacing was the only stereotypic behavior observed in this study with its peak at 10:00 to 11:00 hours and steadily decreased until late afternoon or 18:00 hour. In addition, a drop in active and stereotypic behavior during the morning and midday to late afternoon is related to the elevated inactive or resting behavior during that time. The peak in resting behavior occurred during afternoon at 14:00 to 15:00 hours. In general, the daily activity pattern of captive lion (Panthera leo) is still considered as normal in Siantar zoo with low incidence of stereotypic behavior.

Animal welfare, especially in zoo management, has been an interesting yet crucial topic to ensure animal longevity in enclosure. The findings of the study showed that Siantar zoo management has applied considerably optimum conditions or facilities for animal housing. Repetitive behavior, e.g. pacing might appear as their anticipation to feeding time or food delivery by the zoo management. In addition, time budget in a repetitive order may be correlated with animal perception on resources and environmental conditions [9]. Animal’s time budget in the enclosure is different than in the wild. The response of captive lion to particular captive condition may be enhanced if it almost resemble the natural condition of habitat [10]. Captive animals must allocate and distribute their time budgets to meet the circadian rhythms distinct from its conspecifics in the wild [4]. Improved enclosure condition and decreased abnormal behavior will then ensure their survival and reproduction effort of animals [11].

Large cats in captivity tend to perform dominant inactive (sleeping) behavior and this kind of behavior is not related to visitor presence [12,13]. However, zoo visitors may be showing greater interests when large cats are active during display. Viewing time by zoo visitors have been reported to be longer in active animal than inactive animal which is consistent across zoos [14]. Future efforts may be investigated to improve any active behaviors by captive lion, for example vocalize and playing to increase visitor’s responses. Some studies considered inactive behaviors as stereotypic behavior yet was avoided in zoo management [15,16].
Enrichment techniques have been reported to improve temporal behaviors and reduction in stereotypic behavior of Felidae through several strategies. To date, a comprehensive review on environmental enrichment is still only proposed to Sumatran tiger (Panthera tigris) while many innovations in enrichment technique may be applied to African lion [17,18]. Increased activity and decreased sleeping in captive lion were then regarded as the main objectives to future enrichment in Siantar zoo.

4. Conclusion
A captive lion (Panthera leo) housed in Siantar zoo, North Sumatra was observed to allocate most of its time budgets in Inactive behavior (Sleeping) followed with Active behavior (Locomotion) and low percentage of Stereotypy (Pacing). The daily activity pattern peaks at 14:00 to 15:00 hours for inactive (sleeping) and at 10:00 to 11:00 for active and pacing behaviors.

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