

Influence of Cinnamon on the behavior of Amur Tiger (*Panthera tigris altaica*, Temminck, 1844) in Captivity

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Our primary interest is in welfare of Amur tiger (*Panthera tigris altaica*, Temminck, 1844) in the Barnaul Zoo and Leningrad Zoo. As discussed below, behavioral researches can reveal much about the welfare of captive wild animals. Amur tiger's behavior is studied and time budget is calculated for males and females. The Schorygin' similarity coefficient of behavior is determined (82.64% and 86.76%). We analyzed the differences in their behavior before and after olfactory enrichment. Cinnamon oil reduces pacing, sheltering, sleep and rest time, play behavior, increases exploratory behavior in 50% of researched Amur tigers. The reaction time of the flemes increased in both males. Younger animals better perceived olfactory enrichment. Stereotypical behavior (pacing) have decreased in post-enrichment day.

Key words: Captive tiger, Olfactory enrichment, Cinnamon oil, Amur tiger, *Panthera tigris altaica*, Barnaul Zoo, Leningrad Zoo.

Introduction

The species diversity of the planet decreases every year; the habitat of animals is changing, the number of potential species of prey for large cats is decreasing. Therefore, the preservation of the species in nature cannot be done or it is associated with great difficulties. Part of the role of conservation of species diversity can take on specialized nurseries and zoos. Rare species of animals in this place get a second chance for salvation. The Amur tiger (*Panthera tigris altaica*, Temminck, 1844) is one of such species. Captive environments often fail to resemble the wild environment in limited space, unchanging habit, lack of stimulus and contingency. Common animal welfare problems, which occur with captive animals, include low behavioral diversity, abnormal behavior and excessive inactivity (Mason et al., 2014; Yu et al., 2009). With more tigers existing in captivity than in the wild, it is imperative that our understanding of tiger enrichment is expanded. Sensory enrichment is one of the factors of an animal welfare that seeks to enhance the quality of captive felids care by identifying and providing the environmental stimuli necessary for optimal psychological and physiological well-being. Olfactory enrichment is a common approach for addressing stereotypic behavior in captivity animals. Success has been found in olfactory stimulation via the introduction of novel scents (Resende et al., 2011; Vidal et al., 2016; Antonenko, Medvedeva, Panchuk, 2017; Antonenko, Ulitina, Pysarev, 2018). The purpose of the investigation is to establish special aspects of the behavior of the Amur Tiger (*Panthera tigris altaica*, Linnaeus, 1758) and sensory enrichment with cinnamon oil (*Cinnamomum zeylanicum*, Blume).

Materials and Methods

The studies were conducted at the Barnaul Zoo «Forest Fairy Tale» from 2014 to 2017. The behavior of the female Bagira (was born in 2012) and male Sherhan (was born in 2014) has been studied. We also studied the behavior of the male (Amadei was 9 years old) and female (Gerda was 16 years old) tigers in the «Leningrad Zoo» (Saint Petersburg) from 25 January to 5 February 2016 and in September 2016. We studied the cats' behavior by continuous real-time measurement and "Ad Libitum" (Altmann, 1974). The Schorygin' similarity coefficient of behavior is determined (Popov, Il'chenko, 2008). The Schorygin' similarity coefficient is used to compare the time budget for animals with identical ethograms. The data on the occurrence or the place in the time budget patterns of behavior should be presented in the percent or unit fraction (total incidence of all elements of ethograms or the entire time budget – 100% or 1.0). A number of occurrence of the minimum values for each form of activity of the two animals is composed and the terms of this series are summarized to calculate Schorygin' similarity coefficient. The resulting sum of the minimum values is the Schorygin' similarity coefficient. Olfactory enrichment has been investigated with cinnamon oil (*Cinnamomum zeylanicum* Blume). The experiment consisted of background observation, enrichment and post-enrichment.

Results and Discussion

In order to assess the well-being of the animal it is important to quantitate the time' budget and to analyze the causes of such pathological behaviors such as movement stereotypes, abnormal immobility, long-term stay in the shelter and others (Table 1).

Table 1. A time budget (background observations) and Schorygin' coefficient of tigers

Item behavior	The proportion of total observation time, %			
	Bagira	Sherhan	Gerda	Amadei
Sleep (lies with closed eyes)	26.18	22.73	4.25	0,15

Rest (lies with opened eyes)	24.66	25.32	30.44	18,85
Watchful rest (lies. moves with ears)	3.33	7.50	6.29	1,26
Freezing behavior (abrupt cessation of motion and strained pose)	0.88	1.67	2.95	2,41
Motion into the cage (locomotion)	9.32	10.49	18.68	20,39
Stereotypical behavior (pacing)	5.64	9.51	9.80	14,26
Play behavior	2.43	5.09	0.00	1,88
Feeding behavior	2.74	4.17	1.05	1,39
Grooming	2.95	3.46	3.29	1,52
Exploratory behavior	2.55	2.32	1.50	0,88
Hunting behavior	0.73	0.75	0.00	0,00
Territory behavior	0.78	1.21	0.61	0,70
Aggression behavior	0.01	0.01	0.02	0,02
Social behavior	2.08	2.82	2.38	1,54
The animal is in the shelter	15.56	2.77	18.64	34,27
The flemen reaction	0.00	0.20	0.07	0,45
Sexual behavior	0.00	0.00	0.04	0,04
Schorygin' coefficient	82.64		86.76	

Keeping animals in pairs have a copy behavior. Males and females living together in zoos have a similar behavior. These pairs of animals have a high coefficient of Shorygin – 82.64% and 86.76, which indicates the high similarity of the behavior of these Amur tigers and their harmonious existence in a limited area. Bagira's olfactory enrichment of cinnamon oil increased the time of rest, movement, grooming and exploratory behavior (Table 2). Rest time increased from 13.93% (Table 1) and to 37.89 (Table 2). Motion into the cage (locomotion) was 14.74% in day of cinnamon enrichment (Table 2) compared to background observations – 5.74% (Table 1). There was no stereotypical behavior in olfactory enrichment.

Table 2. Olfactory enrichment day

Item behavior	The proportion of total observation time,%			
	Bagira	Sherhan	Gerda	Amadei
Sleep (lies with closed eyes)	17.89	20.69	23.19	1.04
Rest (lies with opened eyes)	37.89	31.03	29.61	23.96
Watchful rest (lies. moves with ears)	10.53	0.00	3.73	0.00
Freezing behavior (abrupt cessation of motion and strained pose)	1.05	0.00	1.45	1.25
Motion into the cage (locomotion)	14.74	6.90	19.05	18.33
Stereotypical behavior (pacing)	0.00	15.52	0.00	0.00
Play behavior	0.00	3.45	0.00	0.00
Feeding behavior	0.00	0.00	0.00	0.00
Grooming	3.16	1.72	1.24	1.25
Exploratory behavior	4.21	6.90	1.66	0.63

Hunting behavior	0.00	0.00	0.00	0.00
Territory behavior	0.00	1.72	0.41	0.63
Agression behavior	0.00	0.00	0.00	0.00
Social behavior	4.21	6.90	3.52	0.21
The animal is in the shelter	6.32	0.00	16.15	50.21
The flemen reaction	0.00	5.17	0.00	2.50
Sexual behavior	0.00	0.00	0.00	0.00

Sherhan's olfactory enrichment of cinnamon oil increased inactive form of non-pathological behavior – rest from 25.32% (Table 1) to 31.03% (Table 2). Stereotypical behavior (pacing) enhanced almost double – 15.52% (Table 2). Exploratory behavior of male from the Barnaul Zoo increased on 1.5%.

We registered that three inactive forms of non-pathological behavior of Amur tiger female have decreased, namely rest, watchful rest and shelter in the Leningrad Zoo,. No stereotypical behavior was recorded in olfactory enrichment. The proportion of sleep increased from 4.25% to 23.19% (Table 1, 2).

In the Amur tiger male from the Leningrad Zoo increased sleep time (0.15% to 1.04%), rest time (18.85% to 23.96%), time in the shelter (34.27% to 50.21%) (Table 1, 2). Quantity of locomotions have decreased in olfactory enrichment day. There was no stereotypical behavior in this day.

The reaction time of the flemen increased in both males. Younger animals better perceived olfactory enrichment.

Stereotypical behavior (pacing) have decreased in post-enrichment day.

Conclusion

Cinnamon oil reduces pacing, sheltering, sleep and rest time, play behavior, increases exploratory behavior in 50% of researched Amur tigers. The reaction time of the flemen increased in both males. Younger animals better perceived olfactory enrichment.

Stereotypical behavior (pacing) have decreased in post-enrichment day.

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