

Analysis of Locomotor Activity on Pika (Whistle Rabbit)

Mitsuo KOSAKA¹, Guo-Jie YANG¹, Takaaki MATSUMOTO¹,
Nobu OHWATARI¹, Katsuhiko TSUCHIYA¹, Chi-Ming CHEN¹,
Koichi NAKAMURA¹, Sachiko MATSUO¹ and Toshiyuki MORIUCHI²

¹ *Department of Environmental Physiology, Institute of Tropical Medicine,
Nagasaki University, 12-4 Sakamoto-machi, Nagasaki 852, Japan*

² *Animal Research Center for Infectious Tropical Diseases,
Institute of Tropical Medicine, Nagasaki University*

Abstract: The factual ecological information on thermoregulatory behavior of pika (whistle rabbit) is almost scanty, therefore, the present study was designed to determine whether the pika is a diurnal or nocturnal animal, from the analytical data of locomotor activity in the laboratory condition. Under the light (8:00-20:00)-dark (20:00-8:00) photoperiod, four cases of locomotion activity measured by using an air-vibration detector which was modified of an earphone-receiver attached to the animal cage confirmed that locomotion behavior of the pika trends forward more active in early morning as well as in evening until midnight. And furthermore in the visual observation on 27 pikas (experiment period: n=134), the peak time of the resting phase of the locomotor curve was at 17:00 in the light phase, and the moving phase of the locomotion curve indicated a complete mirror image of recording to the resting one. This suggests that the pika might be a nocturnal animal. Therefore from these findings, behavioral thermal adaptation in relation to evolutionary changes of temperature regulation of the pika was discussed in this study.

Key words: Afghan pika (whistle rabbit), Locomotor activity, Temperature regulation, Cold- and high altitude-adaptation

INTRODUCTION

Since 1985, Afghan pikas (*Ochotona rufescens rufescens*) were reared and breded at the Animal Research Center for Infectious Tropical Diseases, Institute of Tropical Medicine, Nagasaki University (Puget, 1973a, b; Matsuzaki *et al.*, 1980; Kosaka *et al.*, 1985, 1987; Yang *et al.*, 1988). And the morphological characteristics and thermophysiological evidences of the pikas, such as the constitutionally short rounded ears, moderate pyrogenic responses, high metabolic rate, high body temperature and poor heat

Received for Publication, September 19, 1988.

Contribution No. 2126 from the Institute of Tropical Medicine, Nagasaki University.

All pikas were reared and breded at the Animal Research Center for Infectious Tropical Diseases, Institute of Tropical Medicine, Nagasaki University.

dissipation ability compared to albino rabbits were previously thought to be ecologically adaptable changes to cold- and high altitude-environment (Haga, 1958; Puget, 1973 a, b; Kosaka *et al.*, 1985, 1987; Sakai *et al.*, 1987; Yang *et al.*, 1988). Although it is presumed that heat loss responses of pikas mostly depend on its behavioral thermoregulation, the factual ecological information on thermoregulatory behavior of pikas is scanty except several reports on the Yeso-pika (*Ochotona hyperborea yesoensis*) which is the closed species to the Afgan pika in the present study, as shown in Table 1 cited from Nishida.

Therefore, the objective of the present investigation is to estimate the locomotor activity of pika reared in the laboratory condition in the relation to an evolutionary changes of behavioral thermoregulation.

Table 1. Classification of Lagomorpha (Rabbit)

<u>Order</u>	<u>Family</u>	<u>Subfamily</u>	<u>Genus</u>	<u>Species</u>	
Lagomorpha	Eurymylidae		+ Eurymylus		
			+ Titanomys		
	Ochotonidae		Ochotona	Ochotona rufescens rufescens (Afgan whistle rabbit)	
				Ochotona hyperborea yesoensis (Yeso whistle rabbit)	
	Leporidae	Palaeolaginae		+ Palaeolagus	
				Pentalagus	Pentalagus furnessi (Amami rabbit)
				Pronolagus	
				Romerolagus	Romerolagus diazi (Volcano rabbit)
			+ Nekrolagus		
		Leporinae		Caprolagus	
				Lepus	Lepus brachyurus augustidens (Tohoku hare)
				Sylvilagus	
			Oryctolagus	Oryctolagus cuniculus (Japanese white rabbit)	
			Nesolagus		

+ These genres of rabbits were extinction

(cited from Nishida and partially modified by Kosaka)

ANIMALS AND METHODS

Twenty seven pikas, body weighing 200–295 g, bred and reared at 22°C in the Animal Research Center in our Institute were used for this study. All pikas were supplied food and water at 9–10 o'clock and took *ad libitum*. During visual observation of locomotor activity under the light (8:00–20:30)-dark (20:30–8:00) photoperiod, every kinds

of artificial exotic disturbances were blocked because of pika's high sensitivity to light, noise and odour. The visual observations were daily performed in the times at 8:30, 11:30, 13:30, 15:00, 17:00, 22:00, 24:00, 2:00, 6:00 in March 5, 6, 7, 12 and 19.

To measure the locomotor activities precisely, in 4 out of 27 pikas, air-vibration-detector modified of an earphone-receiver was attached to the bottom of an animal cage. This technique enabled us to convert the air-vibration as to an electric voltage change of which duration time was considered to be the moving action time of the animal in the cage. The voltage change during the moving action was picked up with a data recorder (SONY) and analysed by ATAC 450 (Nihonkoden Co.).

RESULTS

Light-dark photoperiod was 12 hour : 12 hour, with light period 8 to 20 o'clock and dark period 20 to 8, and these artificial light-dark phases still remain unsolved problems in the present experiment. Although No. 1 and No. 2 pikas in Fig. 1 were slightly resting at

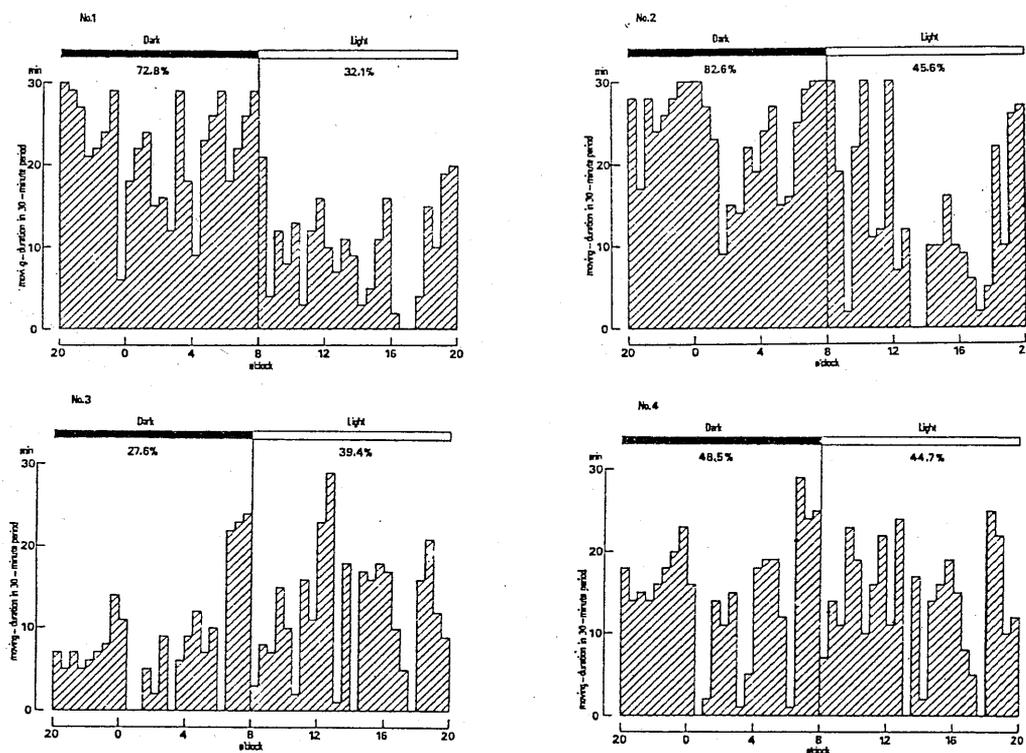


Fig. 1. Comparison of moving duration in each 30 minute period in between the dark (20→8 o'clock) and light (8→20 o'clock) environmental conditions.

No.1~No.4 show the typical recordings obtained from four rabbits. For example;

No.1: percentage of moving duration in the dark: 72.8 %
and resting duration in the dark: 27.2 %.

No.1: percentage of moving duration in the light: 32.1 %
and resting duration in the light: 67.9 %.

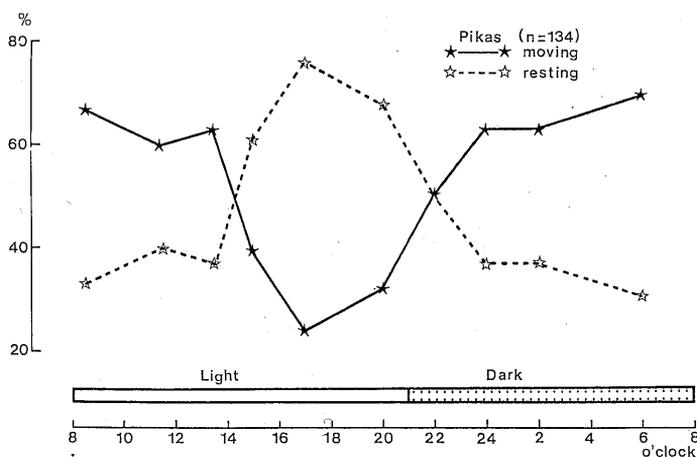


Fig. 2. Percent comparison of resting and moving (locomotor activity) period in the light and dark condition. light phase (8:00~20:30), dark phase (20:30~8:00).

(No. of pika $n=27$, No. of observation $n=27 \times 5=134$)

Visual observation performed in the following five days: March 5, 6, 7, 12 and 19.

24:00–4:00, percentage of active locomotion in dark phase was 72.8% in No. 1 and 82.6% in No. 2 pika, respectively. In light phase, locomotor curves of No. 1 and No. 2 pikas seem to be mirror images if compared those to No. 3 and No. 4 pikas. However, locomotion behaviour trends toward more active in early morning and in the evening to mid-night in all 4 pikas in Fig. 1. From these results, pika might be thought to be a nocturnal animal, that was confirmed from the present finding shown in Fig. 2.

The detailed results of the numbers of animals resting at ten different time points of observation compared to the numbers of animals moving were 44 resting (90 moving) at 8:30, 53 (81) at 11:30, 50 (48) at 13:00, 82 (52) at 15:00, 102 (32) at 17:00, 91 (43) at 20:00, 67 (67) at 22:00, 56 (84) at 24:00, 49 (85) at 2:00 and 42 (92) at 6:00. And in Fig. 2, the results of these percentage were plotted as the solid line (moving) and dotted line (resting).

DISCUSSION

The classification of Lagomorpha (rabbit group) is demonstrated in Table 1, where Yeso-pikas (*Ochotona hyperborea yesoensis*) close to Afghan-pika (*Ochotona rufescense rufescens*), and phylogenetically very old Amami rabbit (*Petalagus furnessi*), Mexican volcano rabbit (*Remerolagus diazi*), Tohoku hare (*Lepus brachyurus augustidens*) and Japanese white rabbit (*Orytolagus cuniculus*) are also precisely classified as the different species (Nishida, 1983). The Amami rabbit, the so-called Amami black rabbit is well known as to be a nocturnal animal and its behavior in dark environment was precisely described by Japanese biologist (Kirino, 1977).

Regarding behavior in light and dark environment on Yeso-pikas, it was observed and reported that they usually feed and gather the fallen leaves and hays in very early

morning as well as in the evening, but they sometimes behave actively even in the daytime, which is similar to albino rabbit (*Oryctolagus cuniculus*) (Odajima, 1982).

The present study on Afghan pikas is limited to locomotor activity in a cage in the Animal Research Center of the Institute of Tropical Medicine, Nagasaki University. There is scanty information of pika's behavior in natural environment. According to natural observation of Yeso-pika, its *terrain* is mostly in rocky region. Temperature of the *interstice* is very low even in summer, about 12 to 14°C. Their living habit seems to be not influenced by ambient temperature, humidity nor the vegetation of the regions. They live in the hole or interstice together but do not co-operate each other (Haga, 1958). These observation findings correspond with those of the present observation that an individual cage is available only for one pika. And pikas behave quickly and they are sensitive to exotic disturbances in the cage (Matsuzaki *et al.*, 1980; 1982, Horiuchi *et al.*, 1983).

From the comparative analysis of histological investigation among the brains of pika, house rabbit and rat, Seki *et al.* (1983) reported that the visual system of pika was poorly developed to compare with that of auditory system. And olfactory system is thought not to play an important role as the sensory system, although olfactory sensation closely related to instinctive behavior of pika is sensitive like house rabbit, while the motor system in pika is not markedly well developed among these three animals, but nevertheless, the rubro-cerebellar system in pika is attractively well developed to compare with house rabbit and rat (Seki *et al.*, 1983).

Thermophysiological characteristics of pika reported previously were as follows; pika's better heat conservation ability thought to be due to its higher metabolic rate, higher body temperature, poor heat dissipation through weak thermal panting and smaller ear surface area than those of house rabbit (Kosaka *et al.*, 1985). Regarding pyrogenic response in pika, though it's very sensitive to narcotics, it is reported that it responds poorly to intra-peritoneal LPS (Lipo-poly saccharide) pyrogen. However, pika can elicit a monophasic fever (mean peak T_{re} : 40.23°C, mean ΔT_{re} : $0.73 \pm 0.3^\circ\text{C}$ which persisted for 70 minutes after a mean latent period of 20 minutes) with intra-venous LPS pyrogen, but the heat loss mechanisms differ from those of house rabbit (Horiuchi *et al.*, 1983; Kosaka *et al.*, 1987). Regarding the poor heat loss ability in pika it constituted by smallness of ear surface (the ear surface area ratio to body surface area is 7% in pika and 17% in albino rabbit) and a lack of thermal panting (Yang *et al.*, 1988).

Therefore it is suggested that the pika's heat dissipation owe to behavioral responses. Pikas mostly lie down on the abdomen (which is the most thin in all surface of pika) with all limbs stretched out and licked their skin surface under hot environments.

As mentioned above, in order to cover the poor activity of thermoregulatory heat loss responses, the pika may owe its compensatory functions mostly to the behavioral functions such as an enhancement of locomotor activity even in the darkness and well developed mid-brain rubro-cerebellar system associated with extra-pyramidal motor function.

ACKNOWLEDGMENT

The authors greatly appreciate the excellent secretarial assistance of Misses Junko Kawashima and Junko Hayashima.

REFERENCES

- 1) Haga, R. (1958): Ecological studies on *Ochotona*, Pika, for development of new experimental animal. *Exp. Anim.*, 7 (3), 69–80. (in Japanese with English summary)
- 2) Horiuchi, S., Kodama, S., Shigemori, M. & Miyoshi, T. (1983): Consideration of chemical drug sensitivity on pika (in Japanese): Abstract of research project on small experimental animals. Grant-in Aid for Special Research (1) (No. 57123110) in 1983. The Ministry of Education, Science and Culture Japan. p. 112–122. (in Japanese)
- 3) Kirino, M (1977): A living fossil: The Amami black rabbit. (in Japanese) In Japanese wild animals (No. 5 Series), Chyobun-sha.
- 4) Kosaka, M., Ohwatari, N., Iwamoto, J., Tsuchiya, K., Fujiwara, M., Fan, Yu-Jen, Matsuo, S., Moriuchi, T. & Matsuzaki, T. (1985): Studies of temperature regulation on pika (*Ochotona rufescens rufescens*); An old-fashioned rabbit. *Trop. Med.*, 27 (4), 289–294.
- 5) Kosaka, M., Yang, Guo-Jie, Riwa, P. G., Matsumoto T., Ohwatari, N. & Fan, Yu-Jen (1987): Pyrogenic response in pika (Whistle rabbit). *Trop. Med.*, 29 (3), 175–179.
- 6) Matsuzaki, T., Saito, M., Yamanaka, M., Esaki, K. & Nomura., T. (1980): Breeding and rearing of the pika (*Ochotona rufescens rufescens*) as a new laboratory animal species. *Exp. Anim.*, 29 (2), 165–170.
- 7) Matsuzaki, T., Saito, M. & Kamiya, M. (1982): Breeding and rearing of the volcano rabbit (*Romerolagus diazi*) in captivity. *Exp. Anim.*, 31 (3), 165–188.
- 8) Nishida, T. (1983): Comparison of the aorta and intersegmental arteries among pika, Japanese white rabbit, volcano rabbit, Amami rabbit and Tohoku hare (in Japanese). Grant-in-Aid for Special Research (1) (No. 57123110) in 1983. The Ministry of Education, Science and Culture Japan. p. 20–27. (in Japanese)
- 9) Odajima, M. (1982): The wild animal in Hokkaido. (in Japanese) p. 224 Hokkaido Shinbun-sya.
- 10) Puget, A. (1973a): *Ochotona rufescens* in captivity: reproduction and behaviour. *J. Inst. Anim. Tech.*, 24 (1), 17–24.
- 11) Puget, A. (1973b): The Afghan pika (*Ochotona rufescens rufescens*): A new laboratory animal. *Lab. Anim. Sci.*, 248–251.
- 12) Sakai, A., Ueda, G., Kobayashi, T. & Teng, G. (1987): Characteristics of pika as high-altitude adapted animal. *J. Physiol. Soc. Japan*, 49, 588.
- 13) Seki, M., Jo, K. & Nishida, T. (1983): Morphological characteristic of the brain of pika—comparison between house rabbit and rat—. The Ministry of Education, Science and Culture Japan. p. 20–27. (in Japanese)
- 14) Yang, Guo-Jie, Matsumoto, T., Kosaka, M., Yamauchi, M. & Ohwatari, N. (1988): Poor heat loss ability of pika (Whistle rabbit). *Trop. Med.*, 30 (1), 45–48.