

## A preliminary study of aggressive behavior in Siberian chipmunk

### Introduction

Antipredator defensive behaviors of various animals have been well categorized by Endler (1986). Many studies have reported different antipredator defensive behaviors of various rodents (Siberian chipmunk, Kobayashi and Watanabe, 1986; California ground squirrel *Spermophilus beecheyi*, Owings and Coss, 1977; Southern flying squirrel *Glaucomys volans*, Borgo et al., 2006; Vole, Gorman, 1984; Black-tailed prairie dog *Cynomys ludovicianus*, Loughry, 1988; Belding's ground squirrel, Robinson, 1980; Wood rat, Richardson, 1942; White rat, Griffith, 1920). Some of these defensive behaviors of rodents have been considered to have a protective function for their litters (Sherman, 1977; Tamura, 1989;

Kobayashi, 1994, 2000).

The Siberian chipmunk *Eutamias sibiricus* is a rodent weighing 80–100 g and inhabiting Japan and northeastern areas of Eurasia. Snakes, we Snak S known to include fleeing, hiding, mobbing, and snake-scent application (SSA) (Kawamichi, 1978; Kobayashi and Watanabe, 1981). SSA (applying snake-scent to the fur) is a unique behavior that has to date only been observed in the Siberian chipmunk and California ground squirrel (Clucas et al., 2008). This SSA behav-

ior in the Siberian chipmunk has been considered to have a preventive function against snake attacks (Kobayashi and Watanabe, 1981, 1986).

I recently observed an aggressive behavior displayed by 10-day-old Siberian chipmunk pups on receiving some stimulus in the nest box. These pups had immature muscles, and therefore, were unable to move out of their nest. However, they showed aggressive behaviors including extensive, rapid body movements and loud calls. Such aggressive behaviors have not been previously observed in mammal pups.

Kobayashi (2008) reported that pups who had begun to leave the nest box displayed SSA behavior by gnawing on pieces of snake slough. In this study, therefore, a piece of snake (*Elaphe climacophora*) slough (3×4cm) was presented to the pups outside the nest box, and their SSA behaviors in response to the snake slough were investigated between 12:00 and 13:00. These observations were also made on the same day when gunshots were observed on the 10th of August. The gunshots were observed at a

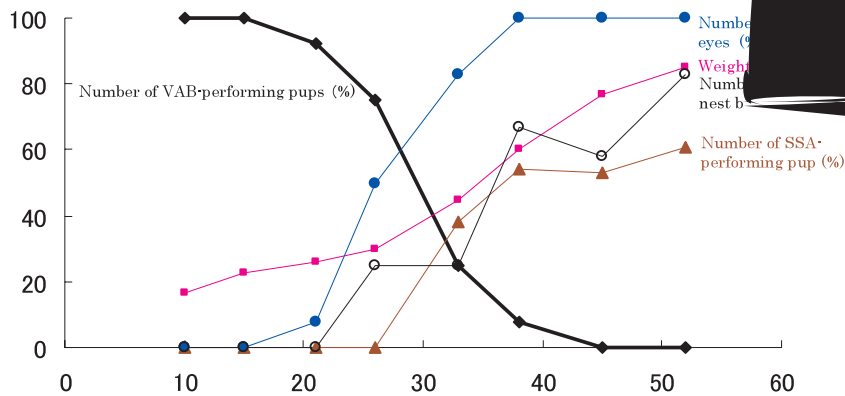


Fig. 4 Relationship between changes in VAB vocalization displayed by pups and their morphological and behavioral developments. Refer the text for the definition of numbers (%) and weight (g) in the figure.

Discussion

Synchronized vocalization and body movements displayed by almost all of the pups are important characteristics related to VAB. The functioning of VAB as an actual defensive behavior is not clear. However, synchronized VAB displayed in a dark nest is likely to be significantly effective as a defense.

Siberian chipmunks are known to construct their nests underground or in hollows in the trunks of large trees (Kawamichi, 1978; Kawamichi and Kawamichi,

1980). Field research on Siberian chipmunks performed by Kawamichi and Kawamichi (1980) showed that the time spent by a mother chipmunk away from the nest increased after the birth of the pups and reached a maximum of approximately 10 h a day, when the pups were approximately 10-day-old (Fig. 5). Moreover, a study by Kawamichi and Kawamichi (1980) as well as the findings of the present study suggest that pups younger than approximately 20 days seldom leave their nest. These findings imply

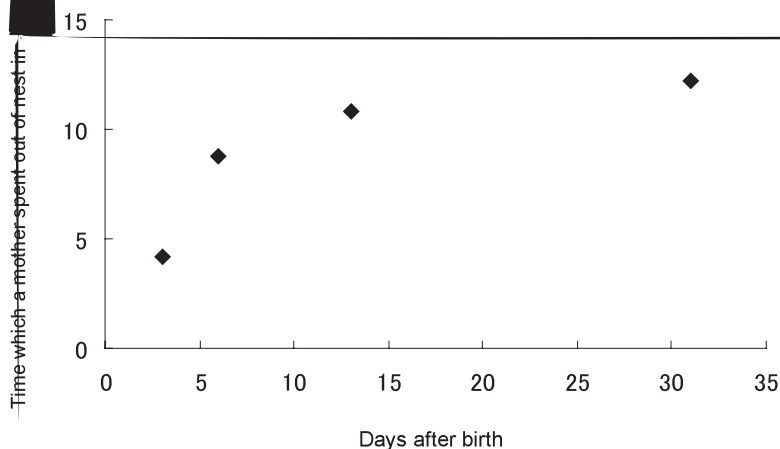


Fig. 5 Change in daily time spent away from the nest by a mother chipmunk compared with the increasing age of the pups. This plot has been constructed using the values reported by Kawamichi and Kawamichi (1980).

that, pups older than 10 days frequently encounter a predator that intrudes into their nest in the absence of their mother. Pups older than 30 days can leave the nest and hide in alternative shelters. Moreover, they also display other defensive behaviors including SSA behavior. Therefore, synchronized VAB is believed to be displayed by 10-day-old pups and decreases once they reach an age of 20 days.

In this study, the relationship between the types of stimuli and the occurrence of VAB was not investigated. However, the following were observed as stimuli to induce VAB in addition to the removal of the lid of the nest box:

(1) Noises near the nest box and (2) Direct, gentle touching of the pups by hand.

In this case, the pups performed the VAB more intensely than other stimuli.

These findings suggest that light, sound, vibration, and direct touch can induce VAB.

## II Experiment to investigate the antipredator function of VAB vocalization

Siberian chipmunks usually give birth in an underground nest, which is connected to the surface by a burrow or in the hollow of a tree trunk (Kawamichi and Kawamichi, 1980).

Weasels (*Mustela*), snakes, foxes (*Vulpes*), and owls (*Strix*) are known natural predators of Siberian chipmunks (Kawamichi, 1978). From the nature of these

animals, weasels and snakes are suspected to enter the burrows leading to the chipmunk nests. In addition, these animals are able to hear the VAB vocalizations of chipmunk pups, which are emitted at a frequency of less than 7 kHz (Weasels: Hayashi, 1968; Snakes: Young, 1999). The VAB vocalizations of chipmunk pups may function as a defensive behavior against weasels and/or snakes.

In the present study, I undertook a preliminary investigation of the possibility that VAB vocalizations produced by the pups defend them against attacks by polecats or weasels.

## Materials and Methods

Three ferrets (*Mustela putorius furo*; ♀ 630 g, approximately 0.5-year-old; ♀ 640 g, 0.8-year-old, ♂ 750 g, 1-year-old) obtained from an animal supplier were used for the experiment. Ferrets are known to be a domesticated form of the European polecat *Mustela putorius* retaining many wild characteristics including their hunting instinct (Hayashi, 1968; King, 1984).

The experimental apparatus was prepared as follows:

The corridor (5×5×55cm) was made of wood, except for the upper panel, which was a transparent plastic plate (Fig. 6). A speaker (ELE COM MS-77WH) was placed at one end of the corridor and the other end of corridor was left open for the ferrets to enter. The size of the entrance (6×6cm) is thought to

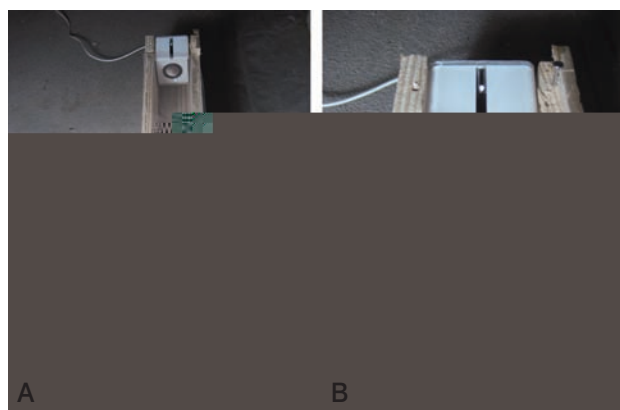


Fig. 6 Apparatus used for the experiment to investigate the effect of VAB vocalizations on ferrets. A: View of the corridor at the end of which a speaker was set up. B: Close-up of the speaker set.

be similar to that of a Siberian chipmunk burrow based on the report by Kawamichi et al. 1983.

The VAB vocalizations could be played back at any time at an amplitude of 3.5 dB at the entrance of the corridor.

The experiment proceeded as follows:

Each ferret was reared in a pen (1 × 1 × 1m) with food bought from a pet shop. The experiments were performed in a room with dimensions 5 × 4 × 2.5 m. The strength of the light in the room could be adjusted to 860, 470, 52, or 7 lux.

The pen in which the ferret was reared was placed in the room, and the door of the pen was opened to allow the ferret to exit. Then the experimental apparatus (the corridor including the speaker) was placed in the center of the room. The ferret was left to roam freely in the room one or two days (sometimes entering the corridor) under light conditions of 860 and 7 lux during the period 06:00 18:00 and 18:00 06:00, respectively. After this habituation of the ferret to the

room and the apparatus, the room was darkened ( 52 lux ) and the experimental trials began.

In the first trial, a piece of boiled chicken meat ( 18 g ) on a plastic sheet was placed in the corridor about 3 cm in front of the speaker. Some time later, the ferret entered the corridor. I observed and recorded the behavior of the ferrets in the corridor with a Sony Digital Handycam DCR-TRU17K ( set for night shooting ) from the corner of the room where a chair and desk were placed. After the first trial, the apparatus was removed from the room.

The second trial begun about 30 min after the first trial and the apparatus was brought back into the room. In the second trial, the apparatus and the procedure were the same as for the first trial, except that VAB vocalizations were played back.

Some time after the second trial began, the ferret would enter the corridor. I observed and recorded the behavior of the ferret in the corridor with the handycam set for night shooting. When the ferret's nose was 10 cm from the meat, I began to play back the recorded VAB vocalizations continuously for 1 min to observe the ferret's response.

The experiment ( which consisted of both the first and second trials ) was repeated two or three times for each ferret with an interval of more than two days between each experiment.

### Results

The behaviors of the ferrets as they approached within 10 cm of the meat placed in the corridor could be classified into the following four categories: bite and eat, bite and carry away, move back immediately, and move back after approaching the meat.

Table 1 shows the results of the experiment. The three ferrets bit the meat in all eight trials in which

Table 1. Responses of ferrets in the experiments to examine the effect of VAB vocalizations

Experiments	Trials	1		2		3	
		first	second	first	second	first	second
Ferrets	a						
	b						
	c						

See the text for the explanation of response of - .

VAB vocalizations were not played back. In three trials, the ferrets bit the meat and ate it in the corridor (i.e., displayed the behavior categorized as ) In five trials, they bit the meat and withdrew from the corridor with the meat still in their mouth (i.e., displayed the behavior categorized as )

However, when VAB vocalization was played back, the ferrets withdrew from the corridor without biting the meat (i.e., displayed the behavior categorized as ) In two trials, a ferret that had initially withdrawn from the corridor attempted to re-enter the corridor by only placing its head inside, but it stopped and retreated after hearing repeated VAB vocalizations.

The behavior categorized in was not displayed in any of the trials.

#### Discussion

The results indicate that VAB vocalizations produced by Siberian chipmunk pups can suppress the attacks by ferrets. They also suggest that the predatory behavior of other *Mustela* species such as *M. nivalis*, *M. erminea*, and *M. itatsi*, which are biologically similar to ferrets (Hayashi, 1968 ), may also be curbed by such vocalizations.

Young (1999) reported that many species of snakes use a hissing sound in their interactions with predators as well as conspecifics. From the above report, it is clear that the frequency of the hissing sound of snakes overlaps with that of VAB vocalizations (for example, 0.7 kHz) Therefore, VAB vocalization may likely cause the ferrets to retreat because it resembles the hissing of snakes. Matthew et al. (1986) reported that burrowing owls *Athene cunicularia* emit a sound resembling that of rattlesnakes from inside their burrow. The report stated the possibility that the owls hiss caused weasels to retreat from the burrow.

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