Effects of temperature on hunting performance of an ectothermic venomous predator (*Gloydius blomhoffii*, Viperidae)

Tomonori Kodama

Introduction

Generally, behavioral performance of ectotherms including hunting are thermally dependent. On the other hand, few studies have been examined thermal effects on hunting performance under fully natural conditions. In addition, considering that almost all venomous animals are ectotherms, it is expected that temperature would affect their envenomation performance and thus hunting success. Nonetheless, we know almost nothing about those effects. In this study, I examined the effects of temperature on the hunting performance of an ectothermic venomous snake, *Gloydius blomhoffii*.

Materials and methods

Mamushi*, Gloydius blomhoffii,* is widely distributed across the main islands of Japan and the adjacent islands. This species is a mid-sized viperid snake and generalist predator feeding on various prey taxa. The active body temperature of the species in the field varies across a wide range (12.0 – 31.5℃). To investigate the effects of temperature on the hunting performance of Mamushi of the population in Takizawa, Iwate Pref., I used three approaches: long-term field radiotracking, a field experiment, and a laboratory experiment. I used the combined method of radiotelemetry and field-videography to describe the detailed sequence of hunting behaviors of free-ranging Mamushi and examine temperature effects on its strike performance to prey animals. In addition, to investigate the thermal effects on the envenomation performance of Mamushi toward its primary rodent prey, *Apodemus speciosus,* I conducted behavioral experiments both in the field and laboratory and attempted to quantify venom expenditure with ELISA (enzyme-linked immunosorbent assay).

Results

Mamushi forages from late April to late October, with the primary prey being mice. Encounters with prey mainly occurred during the night. This pitviper was identified as a typical ambush predator, spending approximately 3/4 of the duration of a foraging bout in ambush and allocating the remaining 1/4 to select ambush sites. Attacks occurred in about 45% of encounters with prey, with a

success rate of approximately 32%. It was estimated that Mamushi successfully prey on animals approximately once every 25 days. Its estimated annual food consumption was approximately 107 – 129% of their body mass.

The occurrence and success of strike to prey were observed over a broad temperature range, from 13.4 to 25.8℃. Statistical analysis revealed that strike occurrence was affected by distance to prey, and strike success was affected by prey dodging movement. The temperature did not influence strike occurrence, strike success, and performance of prey dodging movement. These results suggest that the influence of temperature on the occurrence and success of strikes of Mamushi in the field is limited.

I found that both in the field and laboratory experiments, temperature effects on venom expenditure, venom injection speed, and duration of envenomation were limited. These results suggest that envenomation performance of Mamushi is robust to temperature variation.

Discussion

My study suggested that Mamushi adopts a typical “mobile ambush” strategy, with short-term mobile searching for ambush sites and long-term ambushing prey. Annual prey consumption rate was similar to other viperid snakes in terms of low energy requirement.

The thermal effects on feeding performances and outcomes of interactions involving ectotherms have been extensively studied, but most studies have been conducted under the laboratory conditions. Laboratory contexts allow detailed analyses of a few potentially influential variables but come at the cost of reduced ecological realism of the results. Therefore, my study focused on the interactions between Mamushi and its prey mainly with field-based approaches and provided a unique dataset of the thermal effects with maximized ecological realism, which demonstrated the thermal insensitivity of performances at least in strike and envenomation. My study demonstrated the robustness of prey subjugation performance to temperature in Mamushi ambushing in the field.

Conclusion

This study revealed that prey subjugation performance of Mamushi is robust to temperature variation across a wide range of body temperature. Future study should examine the mechanism of thermal robustness and its ecological and evolutionary function.