Proc. NIPR Symp. Polar Biol., 6, 182–184, 1993

UNSTABLE COLD-HARDINESS OF THE ANTARCTIC ORIBATID MITE *ALASKOZETES ANTARCTICUS* DURING THE AUSTRAL SUMMER AT KING GEORGE ISLAND (EXTENDED ABSTRACT)

Kimio SHIMADA[1], Cenxuan PAN[2] and Yoshikuni OHYAMA[3]

[1]*Institute of Low Temperature Science, Hokkaido University, Kita-19, Nishi-8, Kita-ku, Sapporo 060*
[2]*Institute of Zoology, Academia Sinica, Beijing 100080, China*
[3]*National Institute of Polar Research, 9–10, Kaga 1-chome, Itabashi-ku, Tokyo 173*

Since the first description by MICHAEL in 1903, an oribatid mite *Alaskozetes antarcticus* has been recorded from many sites of the continental and maritime Antarctic, especially from the Antarctic Peninsula and the adjacent islands (WALLWORK, 1967). Because being a very common and abundant species among the terrestrial arthropods inhabiting the Antarctic, this oribatid mite has been used for investigating the mechanism of cold-hardiness developed by the Antarctic arthropods. In the present study, we used this material for assessing the effects of dietary constituents on the cold tolerance of the Antarctic terrestrial arthropods in natural habitats.

Tritonymphs and adults of *Alaskozetes antarcticus* were collected from soil surfaces, beneath rocks, moss patches and algal-covered areas near Great Wall Station (62°13′S, 58°58′W) on King George Island in January and February, 1990. Supercooling points were determined for the mites attached on the fine tip of a copper-constantan thermocouple with silicone grease. These mites were cooled to –30°C or below at the rate of 0.06°C/min (at –30°C) to 0.2°C/min (at 0°C). Distributions of supercooling points showed a variety of shapes with unimodal or bimodal peaks. The variations were compared statistically in terms of the high (supercooling points >–20°C) and low (supercooling points ≤–20°C) groups according to the criterion of BLOCK and SØMME (1982). In addition to the measurement of supercooling points, the survival assay was conducted for 20 mites by cooling them very slowly to certain temperature of –5 to –30°C and then by rewarming the frozen mites at the rate of 5 to 10°C/min. In this assay, the survival was determined by locomotive activity.

The supercooling points of mites were markedly dependent on their developmental stages, sampling sites and habitat humidity. The resting (premoulting) tritonymphs collected beneath rocks showed the supercooling points of –20.0 to –30.8°C with an average of –28.3°C which was the lowest in all the developmental stages. In contrast, most of the active tritonymphs on soil surfaces showed the supercooling points around –3°C and belonged to the high group, though a small number of mites supercooled below –21°C. The active tritonymphs on moss patches also belonged to the high group. Unlike the tritonymphs which were collected beneath rocks and showed a relatively stable level of supercooling points, adult mites collected in the identical microhabitat beneath rocks exhibited a great variation of supercooling points from –2 to –29°C. On the other hand, almost all of the adults collected on soil surfaces or in moss patches belonged to the high group, exhibiting the mean supercooling point of about –4°C.

The inoculative freezing reduced the supercooling ability of the resting tritonymphs and the adults collected beneath rocks and on semi-dried green foliose algae, respectively. However, this reduction did not occur in the active tritonymph and the adults which were collected on soil surface of algal-covered area. Mortalities of the active tritonymphs on moss patches and the adults on soil surfaces appeared to increase along the cumulative frequency distribution curves of supercooling points, indicating that these mites survived at subzero temperatures until they were frozen. The active mites seemed to be killed by spontaneous freezing which started from the inside of their bodies before they were influenced by inoculative freezing which occurred in the presence of external ice crystals.

While the resting tritonymphs exhibited nearly stable supercooling points below –20°C, the active mites often started to freeze at temperatures above –20°C. This variation of supercooling ability seems due to the difference of feeding activity, dietary constituents and dietary water content. The starved mites were superior to the fed ones in supercooling ability (YOUNG and BLOCK, 1980), and the resting tritonymphs have less dietary constituents and water than the active tritonymphs and the adults. This observation suggests that the resting tritonymphs attained a stable supercooling ability by ceasing the feeding while the active mites reduced their supercooling ability by resuming the feeding in the habitat rich in ice-nucleators. In the soil of Signy Island, WYNN-WILLIAMS (1985) discovered a potent ice-nucleating bacterium *Pseudomonus fluorescens*. The present study site King George Island may also be inhabited by *P. fluorescens*. If this is the case, these bacteria may effectively reduce the supercooling ability of active mites.

The present survey demonstrated that inoculative freezing was effective below –20°C in reducing the supercooling ability of the oribatid mites but less effective at higher temperatures at which the spontaneous freezing occurred preferentially. Thus it is suggested that the unstable supercooling ability of the mites is mainly attributed to the dietary constituents which often nucleate the ice. At Great Wall Station, the daily minimum air temperatures sometimes dropped to subzero temperatures which are very close to the supercooling points of active mites, suggesting that these detrivorous mites are occasionally exposed to the hazard of freezing. However, BLOCK and DUMAN (1989) demonstrated the presence of thermal hysteresis antifreeze proteins in the active mites of *A. antarcticus* collected on Signy Island. Those proteins probably play a key role in protecting the detrivorous mites from the hazard of freezing in the cool Antarctic summer rather than in the winter.

References

BLOCK, W. and DUMAN, J.G. (1989): Presence of thermal hysteresis producing antifreeze proteins in the Antarctic mite, *Alaskozetes antarcticus*. J. Exp. Zool., **250**, 229–233.

BLOCK, W. and SØMME, L. (1982): Cold hardiness of terrestrial mites at Signy Island, maritime Antarctic. Oikos, **38**, 157–167.

MICHAEL, A. D. (1903): Acarida (Oribatidae). Résultats du voyage du S. Y. Belgica en 1897–1899. Rapp. scient. (Zool.), Acariens libres. R., **17**, 1–7.

WALLWORK, J. A. (1967): Cryptostigmata (Oribatid mites). Entomology of Antarctica, ed. by J. L. GRESSITT. Washington, D.C., Am. Geophys. Union, 105–122 (Antarct. Res. Ser., **10**).

WYNN-WILLIAMS, D. D. (1985): Photofading retardant for epifluorescence microscopy in soil micro-ecological studies. Soil Biol. Biochem., **17**, 739–746.

YOUNG, S. R. and BLOCK, W. (1980): Experimental studies on the cold tolerance of *Alaskozetes antarcticus*. J. Insect Physiol., **26**, 189–200.

(Received April 8, 1992; Revised manuscript received August 27, 1992)