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[Short Communication]

Winter polyol metabolism of the house spider, *Parasteatoda tepidariorum* is essentially the same between adults and nymphs

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Abstract — Low-molecular-weight carbohydrates accumulated in the overwintering adults of *Parasteatoda tepidariorum* were identified. At least three compounds, sorbitol, *scyllo*-inositol, and *myo*-inositol, were detected in the extract. The spectrum and the amounts of accumulated polyols were almost the same as those accumulated in the overwintering nymphs. Thus, within the same species, winter polyol metabolism did not differ between the developmental stages.

Key words — *myo*-inositol, *scyllo*-inositol, sorbitol

Many spider species accumulate low molecular weight sugars and polyhydric alcohols (polyols) prior to winter (Kirchner & Kestler 1969; Duman 1979; Tanaka 1995; Tanaka & Ito 2015). These compounds function as cryoprotectants or antifreezes (Bale 2002; Yancey 2005; Hayward et al. 2014). Glycerol is the only or the major polyol accumulated prior to winter, but multiple component systems also occur (Tanaka & Ito 2015).

The house spider, *Parasteatoda* (formerly *Achaearanea*) *tepidariorum* (Koch), utilizes a multiple-component system of polyol; the overwintering nymphs accumulate three kinds of polyols, namely sorbitol, *scyllo*-inositol and *myo*-inositol (Tanaka 1995). The thermal optima for inositol and sorbitol synthesis were different; synthesis of inositol began with the induction of diapause, while that of sorbitol required not only short-day inducing diapause state, but also exposure to low temperature (Tanaka 1995).

Parasteatoda tepidariorum overwinters not only as nymphs, but also as adults (Tanaka 1989). Both nymphs and adults can enter diapause in response to short photoperiods (Tanaka 1991, 1992). However, it is unclear whether the overwintering adults accumulate same spectrum of polyols as the overwintering nymphs did. Thus, this spider provides an opportunity to compare winter polyol metabolism between different developmental stages within the same species. In the present study, therefore, low-molecular-weight carbohydrates accumulated in the overwintering adults were identified, and then the spectrum and concentration were compared with those of the overwintering nymphs.

Overwintering adults of *Parasteatoda tepidariorum* used for the present study were collected from the campus of Hokkaido University, Sapporo, in January 1992, immediately before sugar/polyol determination. The samples were homogenized individually with 4-mL of 80% ethanol in a glass homogenizer, and 1 mol erythritol was subsequently added as an internal standard according to the method of Shimada et al. (1984). The homogenate was centrifuged at 3,000 ×g for 15 min, and the supernatant was evaporated in a vacuum at 50°C to dry out. 0.05 ml of trimethylsilyating reagent (TMSI-C, GL Science Inc., Tokyo) was added to the residue, and the solution was subsequently heated at 65°C for 40 min. The resulting derivative was injected into a gas chromatograph (GC-4CMPF, Shimadzu, Kyoto) with a glass column (3 mm inner diameter and 3 m in length) containing 1.5% OV-1. The column was heated from 130°C to 270 °C at 5 °C/min and subsequently maintained at the final temperature for 10 min. Compounds were identified based on the retention time of standard mixtures of known carbohydrates.

Biochemical analysis revealed that at least three compounds, sorbitol, *scyllo*-inositol and *myo*-inositol, were detected in the extract from the adults of *P. tepidariorum* collected in January (Table 1). The spectrum and the amounts of accumulated polyols were almost the same as those accumulated in the overwintering nymphs (Table 1). Thus, the winter polyol composition of *P. tepidariorum* did not differ between nymphs and adults, suggesting that both nymphs and adults exhibit the same polyol metabolism for overwintering. At present, whether such similar phenomenon is common among spider species, which hibernate at two or more developmental stages, is not known. It is usual in arthropod life cycles for only one developmental stage to enter diapause (e.g., Tauber et al. 1986). There are, however, some exceptions. The bush tick, *Haemaphysalis longicornis*, overwinters as nymphs and adults. When the nymphs and adults were exposed to low temperatures, marked elevation of glycerol content occurred (Yu et al. 2014). The arctic beetle, *Pytho americanus*, also overwinters as adults and larvae. In this freeze-tolerant beetle, both larvae and adults synthesize glycerol during cold acclimation (Ring & Tesar 1980). Overwintering larvae and adults of *Epilachna admirabilis* accumulate a significant amount of trehalose (Hoshikawa

Table 1. Polyol contents (mean ± SD mg/g wet weight) of *P. tepidariorum* adults and nymphs collected from field in January 1992.

	n	Sorbitol	*scyllo*-inositol	*myo*-inositol
Adults	3	3.8 ± 2.0	3.6 ± 0.1	9.0 ± 0.6
Nymphs*	5	4.1 ± 2.2	4.3 ± 0.9	9.2 ± 1.7

*Data from Tanaka (1995)

1981). Considered together, it is highly probable that, within the same species, winter polyol metabolism is essentially the same between the developmental stages. Further studies are necessary to evaluate the generality of this phenomenon.

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