Effect of the Prolonged Time after Molting on the Induction of the Behavioral Diapause of *Ixodes nipponensis* Nymphs (Acari: Ixodidae) by Exposure to a Short-Day Photoperiod

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**INTRODUCTION**

The diapause in ticks is controlled by photoperiod, but their age also has an effect on the regulation of the diapause (Belozerov, 1982). In the previous study, Fujimoto (2000) reported that the behavioral diapause of *Ixodes nipponensis* nymphs were induced by exposure to a short-day photoperiod (10L-14D) after molting. However, the nymphs used in this study (Fujimoto, 2000) were exposed to a short-day photoperiod directly after molting. According to Belozerov (1982), an increase in age leads to a weakening of the photoperiodic induction and the maintenance of tick diapause. This may suggest that the photoperiodic sensitivity of *I. nipponensis* nymphs weakens with a prolonged time after molting, and consequently, the proportional occurrence of behavioral diapause decreases. The objective of this study is to clarify whether or not the prolonged time after molting affects the photoperiodic sensitivity of *I. nipponensis* nymphs.

**MATERIALS AND METHODS**

*Ixodes nipponensis* adults were collected in a hilly region of Saitama Prefecture by the flagging method. Tick rearing was done the same way as in the previous report (Fujimoto, 2000). Larvae and nymphs fed on albino mice, while the adults fed on the ears of domestic rabbits in a laboratory maintained at 24°C under a 16L-8D (16 hr light/8 hr dark) photoperiod. The nymphs that molted from the engorged larvae were divided into two age groups determined by the time elapsed after molting. One age group was kept for about one month at 24°C under two photoperiodic conditions (16L-8D and 10L-14D groups) after molting. The other age group was kept for four months at 24°C under a 16L-8D photoperiod after molting, and subsequently, half of the nymphs were transferred to a 10L-14D photoperiod. The transferred nymphs were kept for about one month at 24°C under a 10L-14D photoperiod. The remaining nymphs were kept for about one month at 24°C under a 16L-8D photoperiod. Each of the two photoperiodic groups of nymphs in the two age groups were placed...
on the heads of mice with an infestation density of 20 per mouse. They were kept in incubators that were maintained at 24°C under each photoperiodic condition. The mice were confined to small cages (food cages for mice) for about 8 hrs after infestation and then they were set free. The number of engorged nymphs were counted for each photoperiod and age group, and the rate of engorgement was calculated as an index of the host-feeding activity.

RESULTS AND DISCUSSION

Table 1 shows the engorgement percentages of *I. nipponensis* nymphs exposed to 16L-8D and 10L-14D photoperiods at different ages after molting. The mean percentage of engorgement of nymphs reared at 24°C under a 16L-8D photoperiod before and after molting was 81.0% when they were kept for about one month at the same conditions four months after molting. This percentage of engorgement was high compared with that (55.0%) of the nymphs kept for about one month at the same conditions after molting (Table 1). It is probable that the feeding activity of nymphs reared at 24°C under a 16L-8D photoperiod, before and after molting, became active with a prolonged time after molting.

On the other hand, the percentage of engorgement of nymphs reared at 24°C under a 16L-8D photoperiod before and after molting was reduced to 41.7% when they were transferred to a 10L-14D photoperiod four months after molting. The percentage of engorgement was reduced by half compared with that of the nymphs (81.0%) exposed to a 16L-8D photoperiod four months after molting. There was a significant difference in the engorgement percentage of the nymphs between 10L-14D and 16L-8D (*X*^2^=35.2, P<0.001). These results suggest that the behavioral diapause occurs in the nymphs transferred to a 10L-14D photoperiod four months after molting. In other words, *I. nipponensis* nymphs appear to retain their photoperiodic sensitivity up to one day after four months following molting. However, the engorgement percentage of the nymphs was more than 40%. This percentage of engorgement was considerably high compared with that of the nymphs (0%) transferred to a 10L-14D photoperiod directly after molting (Table 1). This suggests that the proportional occurrence of behavioral diapause is low in the nymphs that were transferred to a 10L-14D photoperiod four months after molting. Thus, the photoperiodic sensitivity of *I. nipponensis* nymphs appears to weaken four months after molting.

*Ixodes nipponensis* nymphs are abundant on host lizards from the spring to the summer,

### Table 1. Engorgement percentage of *I. nipponensis* nymphs exposed to two photoperiodic conditions (for about one month) at different months after molting.

<table>
<thead>
<tr>
<th>Photoperiodic conditions (hr)</th>
<th>* Months after molting</th>
<th>0</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of mice used</td>
<td>Total no. of nymphs used</td>
<td>Mean % engorgement</td>
<td>No. of mice used</td>
</tr>
<tr>
<td>10L-14D</td>
<td>5</td>
<td>100</td>
<td>0.0</td>
</tr>
<tr>
<td>16L-8D</td>
<td>3</td>
<td>60</td>
<td>55.0</td>
</tr>
</tbody>
</table>

* These do not include the time (about one month) exposed to two photoperiodic conditions. The nymphs used in this experiment were reared at 24°C under a 16L-8D photoperiod from the egg to molting to the nymphal stage.
but they’re scarce in autumn (Fujimoto et al., 1987). Judging from the previous reports (Fujimoto, 1994, 2000), the autumnal disappearance of the nymphs can be explained by behavioral diapause. However, the few nymphs that are seen on host lizards in autumn (Fujimoto et al., 1987) may be old-aged ticks which have lived for the summer after molting based on the present results.

REFERENCES


