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Effects of Rearing Temperature and Photoperiod on the Larval Development of the Mulberry Longicorn Beetle, *Apriona germari* Hope, on an Artificial Diet

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To determine effects of temperatures and photoperiods on larval development of the mulberry longicorn beetle, *Apriona germari*, the larvae were reared at various rearing temperatures and under the various photoperiods on an artificial diet. The larval period of *A. germari* was extended as long as the temperature was lowered. Also the larval development in terms of length and weight of larvae was increased. However, survival rate during larval stage significantly decreased at 15°C and 20°C than at 25°C and 30°C. The results indicated that the favorable temperature for artificial diet rearing of *A. germari* fell at least above 25°C constantly. In photoperiod conditions, survival rate and larval development for *A. germari* were obviously most effective under a photoperiod of 14L:10D. As a result in artificial diet rearing of *A. germari* at 25°C and under a photoperiod of 14L:10D was mostly favorable in terms of larval development and period.

Key words: Mulberry longicorn beetle, Temperature, Photoperiod, Larval development

Introduction

The mulberry longicorn beetle, *Apriona germari* Hope, is one of the major pests of mulberry tree in the region of the eastern Asia (Lee, 1987; Hua, 1982). *A. germari* larvae hide in the living trunk and feed on it (Yoon *et al.*, 1997). Also *A. germari* passes a long developmental period to complete its life cycle in the mulberry fields (Zhang and Shen, 1980; Paik, 1987; Yoon *et al.*, 1997).

The life history of *A. germari* has been mostly studied in the laboratory. In the previous paper (Yoon and Mah, 1999) it was reported that life cycle of *A. germari* under the laboratory conditions was examined on artificial diet. The life cycle of *A. germari* posses in larval stage in which they inhabitate in the trunk. It is tedious and time-taking job to investigate the developmental characteristic of *A. germari*.

Insects generally require an adequate level of environmental conditions in order to keep their physiological systems working normal (Mellors *et al.*, 1984; Emori, 1976; Bauer, 1976; Hoy, 1975; Tsurumaki *et al.*, 1999). Among these environmental conditions for artificial rearing, rearing temperature and photoperiod are most important. Detailed information on the relationship between rearing conditions and larval development is not currently available for *A. germari*. Artificial rearing of *A. germari* in the laboratory condition was conducted at the constant temperature (25°C) and under photoperiod (14L:10D) (Yoon and Mah, 1999). And no report has been available in terms of the effect of temperature and photoperiod on the larval development of *A. germari* yet.

In this regard the objective of the current study was aimed assess the effects of variable rearing temperatures and photoperiods on larval development of *A. germari*.

Materials and Methods

Insects

Larvae of *A. germari* were obtained from a colony, which

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has been maintained in the laboratory for two generations (Yoon *et al.*, 1997). *A. germari* was reared on an artificial diet as described previously (Yoon and Mah, 1999). Each larva was reared individually. The various sizes of plastic container were used for rearing of *A. germari* as larval development proceeded (Yoon and Mah, 1999). To break diapause and to accelerate pupation, the larvae, which ceased feeding, were kept in a cold chamber (5°C and dark condition) for 60 days. For the pupation, the larvae exposed to a low temperature were incubated at 18°C for 1 day and moved into a glass container thereafter (Yoon and Mah, 1999).

Temperature treatment

Each larva was individually maintained in the plastic container. The larvae were divided into four groups. The four groups of larvae were then reared in various temperatures (15°C, 20°C, 25°C and 30°C) and under the photoperiod of 14L:10D in the growth chamber.

Photoperiod treatment

Each larva was individually maintained in the plastic container. The larvae were divided into seven groups. The seven groups of larvae were then reared under the various photoperiods (8L:16D, 10L:14D, 12L:12D, 14L:10D, 16L:8D, 24L:0D and 0L:24D) at 25°C growth chamber.

Developmental characteristics

Rearing tests were conducted at four temperatures and seven photoperiods regimes. The larval development was measured in each group. Larval period, growth, and survival rate of each group were determined as follows. Thirty newly hatched larvae were placed on an artificial diet and held at the various temperatures and photoperiods. The larvae were examined daily, and food was added as needed. Body weight, length, head width, and growth rate were measured individually. Periods and survival rate of each instar were also determined. Pupation and emergence rates were measured from each group as well.

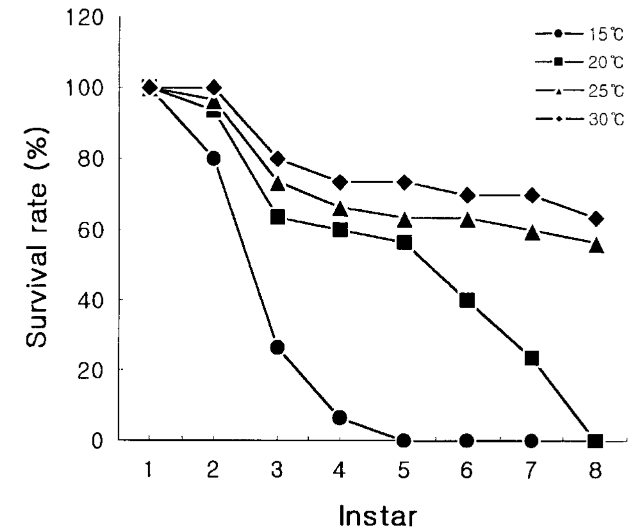

Fig. 1. Survival rate of *A. germari* larvae at the various rearing temperatures. The larvae were reared under a photoperiod of 14L:10D.

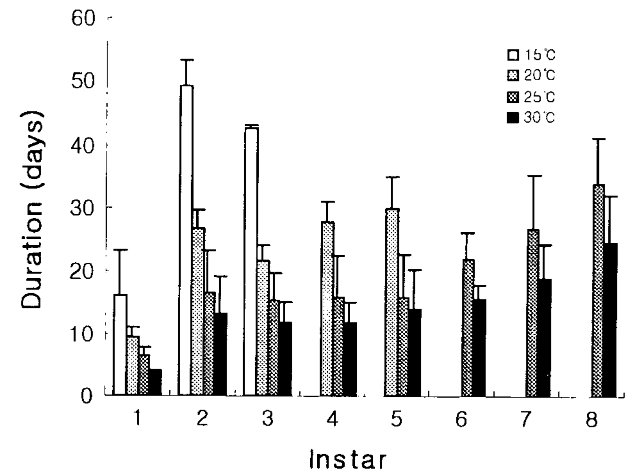

Fig. 2. Duration of each instar of *A. germari* at the various rearing temperatures. The larvae were reared under a photoperiod of 14L:10D.

Results and Discussion

Temperature treatment

Constant rearing temperature was correlated with survival of larvae (Fig. 1). The temperature required for normal development of larva of *A. germari* was at least over 25°C. Larvae completely reared at 15°C and 20°C of constant rearing temperature completely died by the 5th and the 8th instar, respectively. Most of the larvae reared constantly at 15°C and 20°C died during the 3rd instar and the 6th instar, respectively. As shown in Fig. 2, the duration of each instar dragged longer, when reared at relatively low rearing temperatures, as compared to that at high rearing temperatures. The duration of each instar also increased as larval development progressed. Particularly, the duration of the 2nd and the 3rd instar at 15°C was highly prolonged. It seemed that abnormally prolonged duration was due to the physiological disturbance.

Body weight, length, and head width of larvae were determined at the various rearing temperatures (Fig. 3). The larval development increased as instar progressed. The larval development at 25°C was apparently greater from the 4th instar than that at 30°C. A significant development difference in the early stage of larvae was not

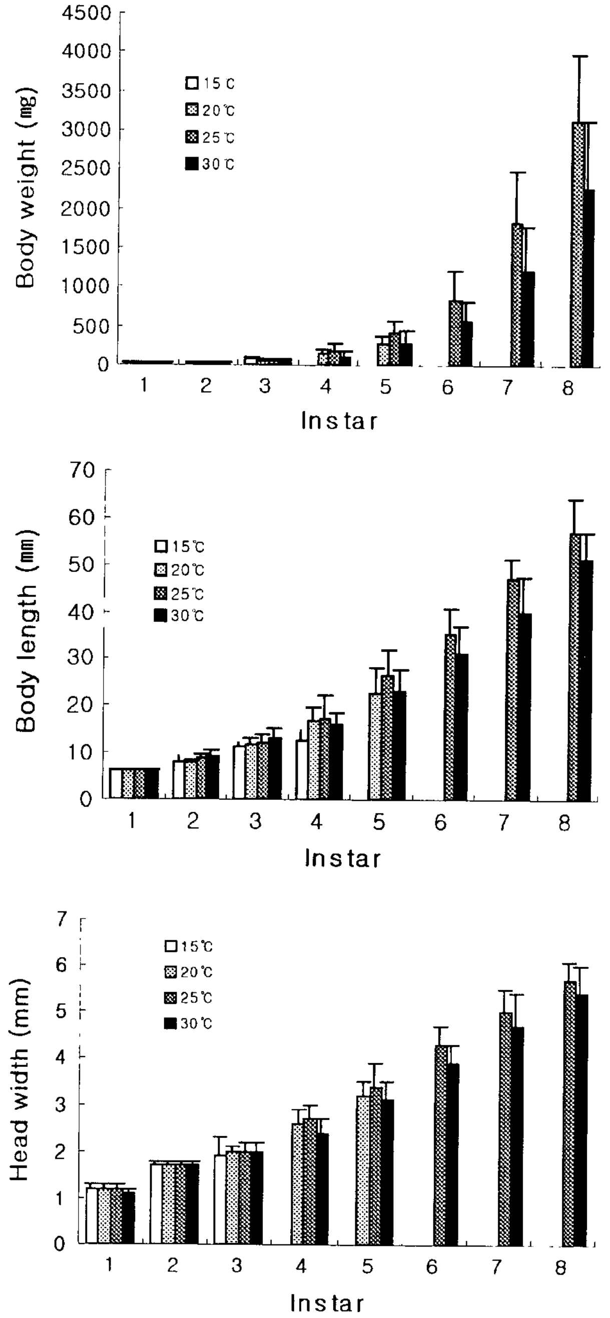

Fig. 3. Larval development of *A. germari* at various rearing temperatures. The larvae were reared under a photoperiod of 14L:10D. Larval development was determined as body weight (A), body length (B), and head width (C) in each instar.

clear between 25°C and 30°C.

The larval period of *A. germari* became longer gradually as the temperature was lowered. Also the larval development in terms of length and weight of larvae was longer and heavier. Thus, it seems probable that the difference of larval development appears to be related to physiologically susceptible larval duration. Our results demonstrated

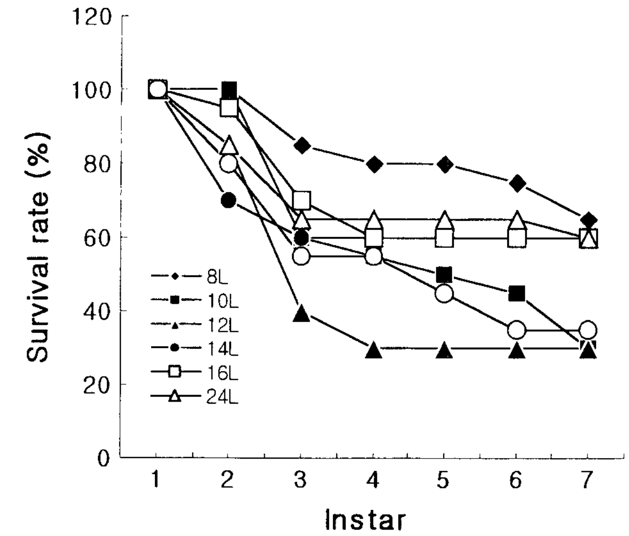

Fig. 4. Survival rate of *A. germari* larvae under the various rearing photoperiods. The larvae were constantly reared at 25°C.

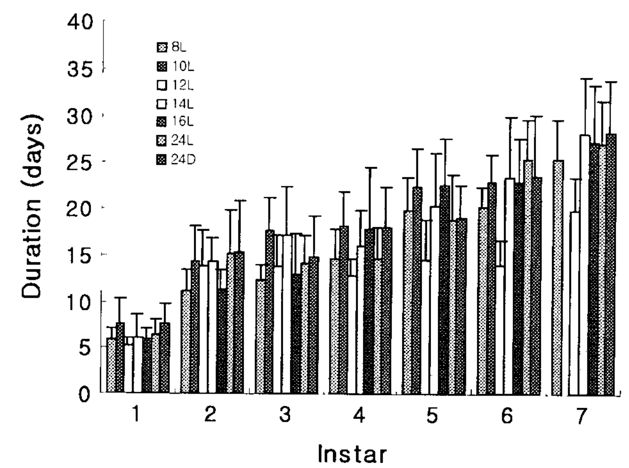

Fig. 5. Duration of each instar of *A. germari* larvae under the various rearing photoperiods. The larvae were constantly reared at 25°C.

that rearing temperature is closely related to larval development.

These results suggested that the optimum temperature for normal development of larva fell on over 25°C when reared on artificial diet.

Photoperiod treatment

In order to study the combined effect of photoperiod and temperature, larvae of *A. germari* were reared under the various photoperiods at 25°C constantly. Survival rate of larvae under photoperiods of 12L:12D, 10L:14D, and 24D was significantly decreased after the 3rd instar (Fig. 4). In Fig. 5, the duration of each instar under each photoperiod

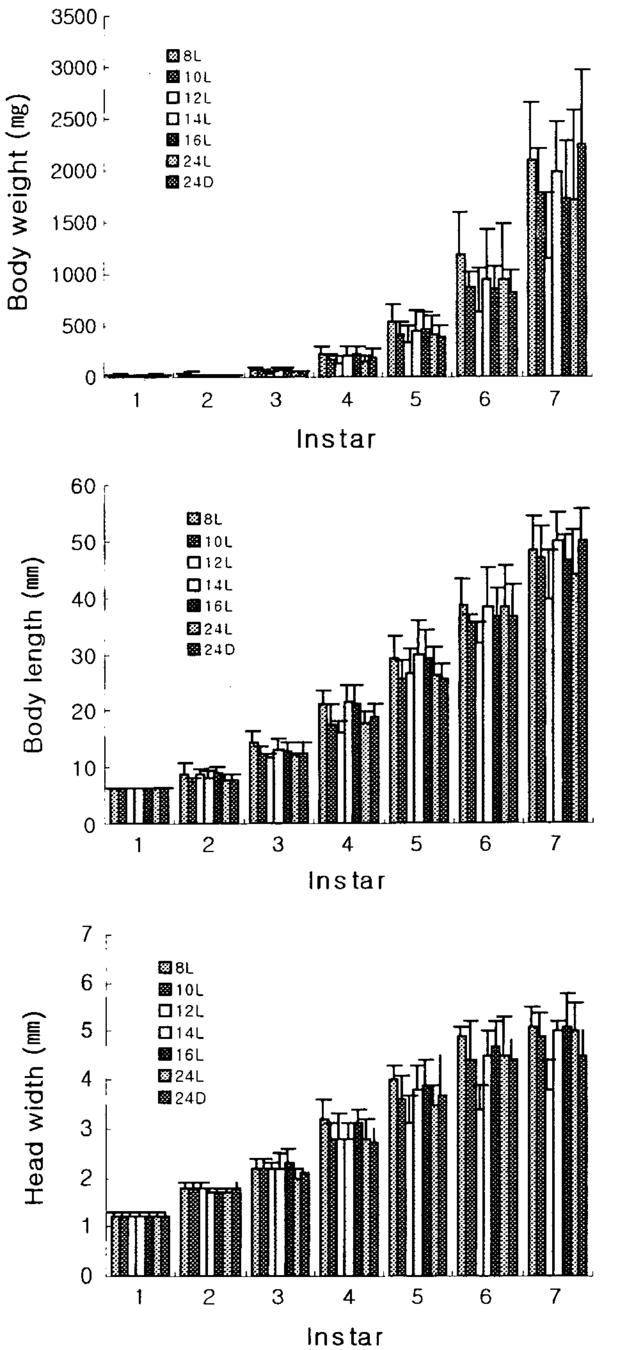

Fig. 6. Larval development of *A. germari* under the various rearing photoperiods. The larvae were constantly reared at 25°C. Larval development was determined as body weight (A), body length (B), and head width (C) in each instar.

also extended as larval development progressed. However, the duration of larval instar in terms of photoperiods condition could be divided into two groups. The larval duration from the 1st to the 6th instar under the condition of photoperiods of 8L:16D and 12L:12D was shortest.

Body weight, length, and head width of larvae were determined under the various photoperiods (Fig. 6). The

Table 1. The pupation and emergence of *A. germari* under the various photoperiods

Photoperiod	Unmolted larvae (%)	Pupation (%)	Emergence (%)
8L:16D	65.0	5.0	5.0
10L:14D	25.0	-	-
12L:12D	25.0	-	-
14L:10D	20.0	35.0	30.0
16L:8D	20.0	20.0	20.0
24L:0D	55.0	-	-
0L:24D	20.0	10.0	10.0

-, No measurement due to all death.

larval development increased as instar progressed, but the increasing pattern was different from each photoperiod condition. Different pattern in a larval development in terms of various photoperiods indicates that there is a threshold in relation to larval development (Emori, 1979). In particular, survival rate and larval development in photoperiod of 12L:12D were significantly decreased, but in photoperiod of 14L:10D was clearly affected. This result may hardly suggest that the difference in light condition critically influences larval development of *A. germari*.

To verify how metamorphosis is affected by photoperiod at 25°C constant rearing temperature, the pupation and emergence under the various photoperiods were measured (Table 1). The rates of pupation and emergence of *A. germari* were relatively lower than as expected, but the metamorphosis was most effective in photoperiod of 14L:10D followed 16L:8D. Furthermore, unmolted larvae were higher in 8L:16D (65%) and 24L (55%) than in the other groups. It suggests that metamorphosis of *A. germari* is primarily dependent on photoperiod as well as temperature.

As most insects also exhibit developmental characteristics with a close relation to temperature and photoperiod (Mellors *et al.*, 1984; Emori, 1976; Bauer, 1976; Hoy, 1975; Tsurumaki *et al.*, 1999), the rearing temperature as well as photoperiod conditions are closely related to larval development. Particularly these are more influenced, when reared on artificial diet. In conclusion, artificial rearing of *A. germari* was most effective at 25°C and a photoperiod of 14L:10D.

References

Bauer, H. C. (1976) Effects of photoperiod and temperature on the cholinesterase activity in the ganglia of *Schistocerca gregaria*. *J. Insect Physiol.* **22**, 683-688.

Emori, T. (1979) Ecological study on the occurrence of the yellow-spotted logicorn beetle, *Psacothea hilaris* Pascoe. II.

The effect of photoperiod on larval and pupal development. *Jap. J. Appl. Entomol. Zool.* **23**, 170-172.

Hoy M. A. (1975) effect of temperature and photoperiod on the induction of diapause in the mite *Metaseiulus occidentalis*. *J. Insect Physiol.* **21**, 605-611.

Hua, L. (1982) A check list of the longicorn beetles of China. pp. 67, China Zhongsham University, Gauangzhou.

Lee, S. M. (1987) Cerambycidae in Korea. pp. 8-212, The National Institute of Science, Taejon.

Mellors, W. K., A. Allegro and S. E. Propts (1984) Adult reproductive diapause in the Mexican bean beetle (Coleoptera: Coccinellidae): Interaction of temperature with photoperiod. *Environ. Entomol.* **13**, 409-414.

Paik, W. H. (1987) The new pestology. pp. 367-368, Hyang-moonsa, Seoul.

Tsurumaki, J., J. Ishiguro, A. Yamanaka and K. Endo (1999) Effects of photoperiod and temperature on seasonal morph development and diapause egg oviposition in a bivoltine race (Daizo) of the silkmoth, *Bombyx mori* L. *J. Insect Physiol.* **45**, 101-106.

Yoon, H. J. and Y. I. Mah (1999) Life cycle of the mulberry longicorn beetle, *Apriona germari* Hope on an artificial diet. *J. Asia-Pacific Entomol.* **2**, 169-173.

Yoon, H. J., Y. I. Mah, I. G. Park, S. B. Lee and S. Y. Yang (1997) The mode of hibernation of mulberry longicorn beetle, *Apriona germari* Hope in Korea. *J. Seric. Sci. Jpn.* **66**, 128-131.

Zhang, S. and Y. W. Shen (1980) Forest insects of China. G. Xiao (ed.), pp. 461-463, China Forestry Publishing House, Beijing.