ASSESSMENT OF TEMPERATURE-DEPENDENT DEVELOPMENT IN THE GENERAL POPULATION AND AMONG ISOFEMALE LINES OF COCCINELLA TRIFASCIATA (COL.: COCCINELLIDAE)

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Temperature-dependent development of Coccinella trifasciata LeConte from Corvallis, Oregon, was assessed for the general population and compared among a subset of isofemale lines. All eggs died at 10 and 34°C. Survival ranged between 63.3-96.7% from 18-34°C. Development from oviposition to adult ranged from 44.2 days at 18°C to 11.1 days at 34°C. Mean adult weight did not differ among temperatures, and was 15.2 mg overall. For the species, heat-unit requirements for development from egg to adult were 227 degree-days above a developmental threshold of 12.7°C. Values for the developmental threshold differed among isofemale lines, and ranged from 11.4-14.5°C with heat-unit requirements ranging from 186-260 degree-days above their respective threshold. The isofemale line producing the fastest rate of immature development at 18°C was characterized by a heat-unit requirement of 260 degree-days above a developmental threshold of 11.4°C. The isofemale line producing the slowest rate of immature development at 18°C was characterized by a heat-unit requirement of 186 degree-days above a developmental threshold of 14.5°C. Implications of using isofemale lines in culturing biological control agents are discussed.

KEY-WORDS: Coccinella trifasciata, Coccinellidae, developmental threshold, degree-days, isofemale lines

Variation in life history traits within a population of natural enemies in classical biological control programs may be influenced by numerous factors. In particular, the source of the colony and the maintenance of the colony will affect genetic variation (Mackauer, 1972, 1976, 1980; Roush, 1990; Hopper et al., 1993). The desire for a high or low degree of variation in a population of natural enemies being cultured for release may depend on the use of the biological control agent. Mackauer (1972) lists two purposes for release of natural enemies: 1) permanent establishment of the biological control agent, or 2) inundative release conducted to acquire seasonal pest suppression. We would propose that for some life history traits, such as development rate, a low degree of variation may be well suited to certain biological control programs, such as those requiring repeated inundative releases of natural enemies into annual crops or glasshouse environments.

Studies of insect developmental biology indicate that variation may exist among geographic locations and hosts (Haardt & Holler, 1992; Honek & Kocourek, 1988; Ruberson et al., 1987, 1989) as well as among females and clones within local populations (Lamb et al., 1987; Rodriguez-Saona, 1994). One life history trait that is pertinent to maximizing
mass production of natural enemies is the temperature-dependent development rate of the immature stage. Models using age-specific life-table dynamics to predict population growth-potential demonstrate that increased rates of development result in shorter generation time and faster population growth (Gutierrez et al., 1981; Taylor, 1981). Since variation in development rates exists among isofemale lines, individuals chosen as the source of a culture may determine the success of the mass production phase of a biological control project, especially if the objective is to rear millions of individuals for an inundative release (Rodriguez-Saona & Miller, 1995).

An investigation of the temperature-dependent development of Coccinella trifasciata LeConte, an early season lady beetle in various agroecosystems in the Pacific Northwest of North America, was conducted for a comparison among temperate zone aphidophagous coccinellid species and to address the issue of within-population variation of development rates. This study focused on two primary questions: 1) What are the values for the lower developmental threshold and degree-day requirements to complete immature development for the population of C. trifasciata from Corvallis, Oregon, and how do these compare to other temperate zone aphidophagous coccinellids? 2) What values for development threshold and heat-unit requirements may be attributed to individual females based on the developmental rates of her progeny? The results of this study have implications for the (un)intentional selection of biological control agents during foreign exploration and conduct of laboratory mass culture programs.

MATERIALS AND METHODS

The study was conducted during the spring and summer of 1994. Adult beetles were collected from alfalfa fields in Corvallis, Oregon, during April and May. The field-collected adult beetles were kept individually at 22°C and fed pea aphid, Acyrthosiphon pisum (Harris) to obtain egg clusters. Only F1 progeny from the field-collected adults were used in the study.

Seven constant temperatures were used: 10, 14, 18, 22, 26, 30, and 34°C. Eggs were placed among the seven temperatures within eight hours of oviposition and monitored every 12 hours to observe survival and time to larval eclosion. Larvae were reared individually in 1-oz plastic creamers with a cardboard lid. First instars were systematically placed into each temperature according to female source so that all females were represented by offspring in each temperature treatment. A total of 14 females provided a sufficient number of eggs to be reared at each temperature. Because no eggs hatched at 10 and 34°C we transferred first instars to these temperatures from eggs that had hatched at 18 and 30°C, respectively. Observations of survival and time to each molt, and provision of fresh food, were conducted every 12 hours. Larvae were fed the same aphid species, cultured on fava bean (Vicia faba L.), as given to the adults. The observations were terminated upon adult eclosion.

Only certain isofemale lines were assessed for female-progeny differences in development-rate. Female lines were excluded from the isofemale analysis if fewer than three progeny were represented in each temperature treatment. Statistical analyses of survival of larvae and pupae among temperatures were via G-test for independence (Sokal & Rohlf 1981). The developmental threshold and degree-day requirements were calculated using linear regression comparing temperature (independent variable) to the inverse of number of days for development (dependent variable). The linear portions of the growth curves for larvae and pupae, and for overall development, were determined by the greatest correlation coefficients from these regressions. Differences in developmental time among