

DEVELOPMENT TIME OF *COCCINELLA SEPTEMPUNCTATA* IN RELATION
TO CONSTANT TEMPERATURES [COL. : COCCINELLIDAE]

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Development times at constant temperatures were determined for the egg, larval and pupal stages of *Coccinella 7-punctata* L., recently introduced to U.S.A. Males and females developed at the same rate. The egg stage lasted from 2.3 to 13.0 days at 30° and 15° C, respectively. Larvae feeding on *Acyrtosiphon pisum* (HARRIS), pea aphids, required from 6.2 to 31.1 days at 32.5° and 17.0° C, respectively. The pupal stage lasted from 2.8 to 13.0 days at 32.5° and 17.0° C, respectively. These development rates are similar to those reported in the European literature.

Coccinella septempunctata L., an aphidophagous coccinellid, is native to much of Asia, Europe, and North Africa. The extensive worldwide literature on the biology of this species was reviewed by HAGEN (1962) and by HODEK (1973). Detailed studies on the influence of temperature, relative humidity and photoperiodicity on the rate of development were made by HODEK (1958) and on the reproductive rate and longevity by RUZICKA *et al.* (1981).

Attempts to introduce *C. 7-punctata* into the United States began in 1956 when G.W. ANGALET shipped adults into California from India. Further shipments from India, France, Norway and Sweden were sent to Moorestown, NJ between 1959 and 1973. Introductions were made in a number of states. In 1973 a large population of beetles was found in the Hackensack Meadowlands, Bergen County, NJ. The lady-beetle is now found in New York and Connecticut as a result of natural dispersion and, through recolonization, is now established in Delaware, Georgia, and Oklahoma (ANGALET *et al.*, 1979). Details of its release and establishment in Oklahoma are given by CARTWRIGHT *et al.* (1979), and in Georgia by TEDDERS & ANGALET (1981). It has been recovered from one or more counties in all New England states, as well as Pennsylvania, Maryland, Wisconsin, Illinois, Tennessee, Florida, and in Quebec, Canada (P.W. SCHAEFER, pers. comm.).

The origin of *C. 7-punctata* in the New Jersey Meadowlands is not known. It is possible that it arrived at trash disposal sites there in trash from Kennedy International Airport and from other transportation sources (ANGALET & JACQUES, 1975). The present study was conducted to determine the rate of development of this species to compare with results reported in the literature using beetles made available in 1979 by G.W. ANGALET and in 1981 by P.W. SHAEFER from the Meadowlands site.

MATERIAL AND METHODS

In mid-September of 1979, 200 specimens of *C. 7-punctata* which had been field-collected at Lyndhurst, NJ, were received at Phoenix, AZ. Aphids were not abundant at that time so the beetles were held in 150 × 25 mm plastic dishes at 15° C and 14 h photophase until late November when they were transferred to 25° C and fed pea aphids, *Acyrtosiphon pisum* (HARRIS). Eggs were laid on pieces of paper towel in the dishes and were removed daily. Individual egg masses were placed in 50 × 12 mm plastic dishes and placed in one of the constant temperature cabinets, and observed daily for hatching. Aphids were then added to the dish. Additional aphids were added daily, and as the larvae grew, the group of larvae was transferred to larger dishes. When in the last instar, individual larvae were held in 50 × 12 mm dishes so the dates of pupation and adult eclosion could be recorded. Adults were sexed by observing the notch on the last abdominal sternite of the male or the absence of the notch in the female.

Developmental studies were conducted in cabinets modified from household refrigerators equipped with thermostats that held the temperature within $\pm 1^\circ$ C of that desired. Vitalite[®] fluorescent lamps provided a 14 h photophase.

During January 1981, 18 additional field-collected *C. 7-punctata* from Lyndhurst, NJ were received as well as 21 *C. 7-punctata bruckii* collected in Sapporo, Hokkaido, Japan. These were reared under conditions similar to the previous year except the cabinets had a 18 h photophase.

HODEK (1958, 1973) discussed the use of VERHULST's logistic curve to describe the speed of development in relation to temperature. However, a linear relationship holds for the middle range of temperature values used in this study. The rate of development was expressed by the equation $\hat{y} = a + bX$, where \hat{y} was the reciprocal of the number of days in a stage and X the temperature in ° C. Development rates of this study were compared with those given by a table in HODEK (1973) using a technique of NETER & WASSERMAN (1976). The F value obtained was compared with the table F value. If it was less than the 5 % level, table value, we concluded that the development rates being compared were "similar".

TABLE 1

Time (days) required for development of the egg, larval and pupal stages of Coccinella 7-punctata at constant temperatures

Temp ° C	Egg stage duration (days, X \pm SD)		Larval stage duration (days, X \pm SD)		Pupal stage duration (days, X \pm SD)	
	n		n		n	
15.0	141	13.0 1.3				
17.0	407	7.3 0.8	85	31.1 2.9	54	13.0 1.4
20.0	384	4.8 0.45	170	20.2 2.2	116	7.9 1.1
22.5	569	3.3 0.6	190	12.8 2.0	272	5.6 0.7
25.0	399	2.3 0.4	214	9.9 0.9	197	4.3 0.6
27.5			51	9.8 0.6	50	3.1 0.8
30.0	247	2.3 0.4	122	7.7 1.2	105	2.9 0.4
32.5	40	2.0 0	25	6.2 0.4	25	2.8 0.4

RESULTS AND DISCUSSION

The duration of the rate of development of the larval and pupal stages of ♂ and ♀ reared in 1980 was compared and found to be similar. The results for ♂ and ♀ at each temperature were combined and the 1981 rearing results added. The totals are given in table 1 with the duration of the egg stage. The rate of development in relation to temperature of all 3 stages is uniform between the temperatures studied, as the regression equations for development of each stage in relation to temperature produced r^2 values of 0.98.

Comparison of the rates of development observed in this study with the study by HODEK (1958) indicated that between comparable temperature ranges the rate of development of the New Jersey *C. 7-punctata* was similar to that of HODEK's. Similar results were obtained using the pooled results of other authors in addition to HODEK's given in HODEK (1973). Thus *C. 7-punctata* in the Meadowlands of New Jersey has a similar developmental rate in relation to temperature to the European species.

Although the *C. 7-punctata bruckii* from Hokkaido, Japan were held under identical conditions as the beetles from New Jersey, fewer eggs were laid, fewer eggs hatched, and no larvae pupated. Most of the larvae died in the 2nd or 3rd larval stage. Table 2 gives the information on the duration of the egg stage.

TABLE 2

Time (days) required for development of the egg of Coccinella 7-punctata bruckii at constant temperatures

Temp ° C	n	Egg stage duration (days, X ± SD)	
17.0	40	7.2	1.0
20.0	85	4.5	1.2
22.5	33	3.1	0.4
25.0	92	2.3	0.5
30.0	98	2.1	0.3

Although we set up several hundred pairs of reared individuals in plastic Petri dishes, we were unable to obtain any eggs during several months of observation at several temperatures and photophases. This indicates a high tendency to univoltinism, found in the European populations of *C. 7-punctata* (HODEK 1973, HÄMÄLÄINEN 1976).

RÉSUMÉ

Durée de développement de *Coccinella 7-punctata* à températures constantes

Les durées de développement à températures constantes ont été déterminées pour l'œuf, les stades larvaires et l'imago de *Coccinella 7-punctata* récemment introduit aux États-Unis. Les mâles et les femelles se développent au même rythme. Le stade œuf dure de 2,3 à 13,0 j à 30° et 15° C, respectivement. L'alimentation des larves avec le puceron du pois *Acyrtosiphon pisum* (HARRIS) dure 6,2 et 31,1 j à 32,5 et 17,0° C, respectivement. Le stade nymphal est observé pendant 2,8 et 13,0 j à ces mêmes températures. Ces vitesses de développement sont les mêmes que celles données dans la littérature européenne.

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