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HOMALODISCA COAGULATA (HEMIPTERA: CICADELLIDAE) EMBRYONIC DEVELOPMENT AT CONSTANT TEMPERATURES

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Homalodisca coagulata (Say) (glassy-winged sharpshooter), a species exotic to California, is an important vector of the xylem-limited bacterium, *Xylella fastidiosa*, which causes diseases on several crops and ornamentals including Pierce's disease of grapes, citrus variegated chlorosis, phony peach disease, almond leaf scorch, alfalfa dwarf, and oleander leaf scorch (Blua et al. 1999; UCOP 2000; Varela et al. 2001). Little is known about the developmental biology of *H. coagulata*. Eggs of this insect are laid below the epidermis of leaves as a cluster of eggs oriented nearly parallel to one another. The number of eggs per egg mass on chrysanthemums averages 8.8 eggs (range: 1-30) (A.K.A., unpublished data). Data regarding the effect of temperature on the development of the egg stage of this insect are lacking. Such data are useful for two basic purposes: cold storage of eggs for later use in rearing parasitoids (Leopold & Yocum 2001) (needed because of reproductive dormancy of female sharpshooters during fall and winter) and the ability to predict egg hatch in the field.

Egg masses were produced by caging field-collected leafhoppers on small chrysanthemum plants (rooted cuttings) in sleeve cages at 23°C. Plants were checked every 12 h for fresh egg masses. Egg masses were then immediately incubated in situ (inside leaves intact on plant) in growth chambers set at different temperatures: 10, 15, 20, 25, 30, 32, 33, 35, and 40°C. For all temperature treatments, RH was set at ca. 50%, and the light regime at 14:10 L:D. Temperature inside the chambers was recorded using HOBO data loggers (Onset Computer Co., Bourne, MA) in order to arrive at actual incubation temperatures (11.5, 16.7, 19.7, 25.6, 31.2, 32.9, 33.4, 35, and 40.4°C) which corresponded respectively to the set temperatures stated earlier. During embryonic development, egg masses were checked daily (at or above 20°C); or weekly (10, 15°C) until eye spots became faintly visible within eggs, and then daily afterwards. When hatching was imminent (large dark eye spots), leaves containing egg masses were excised and placed inside petri dishes with moist tissue paper. This allowed easier and more accurate observation of emergence of nymphs from individual eggs within an egg mass. At this stage, egg masses were monitored in the morning and evening. Records of time of hatching of each egg and stage of development for each egg mass were kept. Developmental periods and rates were calculated and plotted against actual mean temperatures. Linear regression was used to arrive at estimates of the minimum developmental threshold and degree-days required for development. ANOVA on arcsine transformed data was used to compare egg hatch rates (proportion of hatched nymphs). Statistical analyses were done using JMP IN (SAS Institute 1996).

Complete development (for at least 1 egg) occurred at all temperatures except 11.5 and 40.4°C. At 11.5°C, development was retarded and aborted during early stages of eye spot formation; egg masses desiccated at 40.4°C. The relationship between development rate and temperature was linear for temperatures in the range 16.7 to 25.6°C, peaked at ca. 32.9°C, and then declined at higher temperatures (Fig. 1). Regression of the linear part of the curve yielded the linear equation shown in Fig. 1. From the linear equation, it is estimated that *H. coagulata* requires 113.8 degree days to complete embryonic development with a minimum developmental threshold temperature of 11.9°C. Hatch rate (proportion of hatched

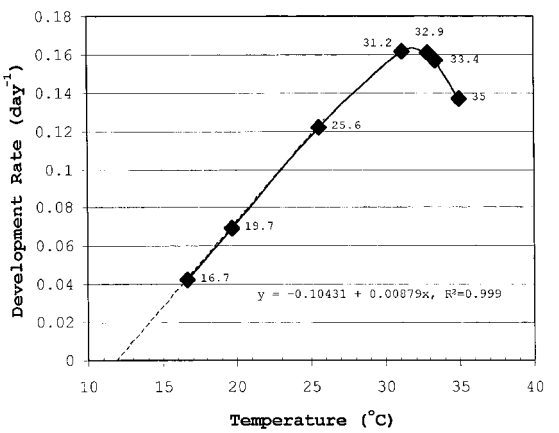

Fig. 1. The relationship between mean embryonic development rate and temperature for *H. coagulata*. 16.7°C, n = 255, SEM = 0.00007; 19.7°C, n = 465, SEM = 0.00013; 25.6°C, n = 212, SEM = 0.00089; 31.2°C, n = 202, SEM = 0.00105; 32.9°C, n = 133, SEM = 0.00099; 33.4°C, n = 137, SEM = 0.00074; 35°C, n = 25, SEM = 0.00189 (n is the number of eggs held at indicated temperatures, and SEM is the standard error of the mean). Linear regression equation for the three lower temperatures is shown. The dotted line represents extrapolation of the linear portion of the curve to the temperature at which development rate equals zero.

nymphs) did not differ significantly among temperatures in the low range (16.7-32.9°C). However, hatch rate was significantly lower at 33.4 than at 19.7°C (Fig. 2). Hatch rate was also significantly lower at 35°C than at all other temperature treatments except 33.4°C (Fig. 2).

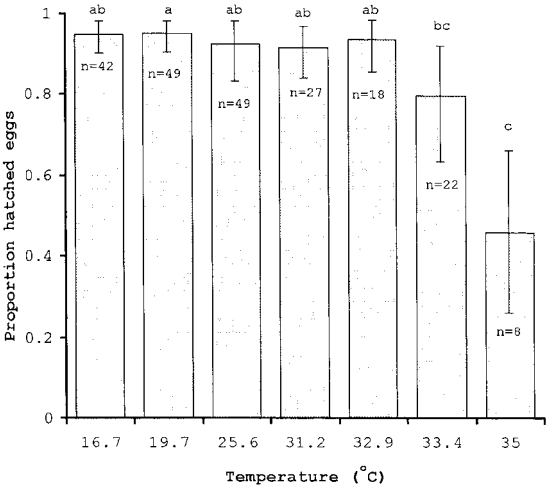

Fig. 2. The effect of temperature on the hatch rate of *H. coagulata* eggs. Hatch rate is based on the proportion of hatched eggs per egg mass for each of the temperature treatments. Original data were arcsine transformed and ANOVA was conducted on transformed data. Means represented by columns were calculated by back transformation of means produced by ANOVA. Bars through the top of columns are 95% confidence limits of the means. Means topped by the same letter are not significantly different (P = 0.0001, Tukey-Kramer HSD). The number of replicates shown within the top of each column refers to the number of egg masses held at each temperature.

This work provides an important tool to predict the time of hatch of *H. coagulata* eggs in the field. It also indicates that constant temperatures equal to or above 35°C will result in high mortality and that development is incomplete at ca. 11.5°C. It appears that the optimal temperature range for successful development of eggs of *H. coagulata* is in the 16.7-32.9°C range. Work is underway to investigate the circadian rhythm of nymphal hatch at different temperatures.

Summary

Development rate of *Homalodisca coagulata* (Say) was linearly related to temperature from 16.7 to ca. 30°C. It is estimated that *H. coagulata* requires 113.8 degree-days from oviposition to egg hatch, with a minimum developmental threshold of 11.9°C. At higher temperatures, hatch rate was significantly reduced, especially at 35°C.

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