EFFECT OF TEMPERATURE ON EGG DEVELOPMENT OF *DIAPREPES ABBREVIATUS* (COLEOPTERA: CURCULIONIDAE)

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The Diaprepes root weevil, *Diaprepes abbreviatus* (L.), has become a key pest of citrus and ornamental plants in Florida since its introduction to the state in 1964. Adult *D. abbreviatus* feed and oviposit on leaves of many plant species in addition to citrus including crops such as cassava, cotton, peppers, potatoes, sugar cane, and sweet potatoes. As neonate larvae emerge, they drop to the ground and crawl on the surface for a period of up to three hours (Jones & Schroeder 1983) before burrowing into the soil to feed on roots. Eggs are subject to predation by ants and earwigs (Tryon 1986) and parasitization by wasps such as the eulophid *Quadrastichus haitiensis* Gahan. Recent efforts to establish exotic egg parasitoids in Florida have met with some initial success (Hall et al. 2000), but a more complete understanding of host biology may contribute to effective rearing and release.

Lapointe and Shapiro (1999) and Lapointe (2000) described the effects of humidity and temperature on larval and pupal development of *D. abbreviatus*. To complete the description of the thermal requirements for development of *D. abbreviatus*, I report here the response of eggs of *D. abbreviatus* to a range of temperatures and describe the thermal upper and lower limits of egg development.

Male and female adult *D. abbreviatus* were obtained from a laboratory colony at the U.S. Horticultural Research Laboratory, Orlando, FL, now located at Ft. Pierce, FL. Approximately 20 male/female pairs were placed in a screened cage (30 by 30 by 30 cm) and provided with bouquets of citrus foliage as food and strips of wax paper for oviposition (Wolcott 1933). Eggs on wax paper strips were collected from cages twice daily and placed in plastic vials with plastic caps in temperature-controlled growth chambers with a photoperiod of 12:12 L:D and constant temperatures of 12, 15, 18, 19, 21, 22, 26, 30, and 32°C. Vials were misted periodically with sterile water and re-capped to avoid desiccation of the eggs. The wax paper strips were gently separated 2 to 3 d after oviposition to facilitate emergence of the neonate larvae. Vials were checked daily for neonate larvae and time to hatch was recorded. After egg hatch commenced, the number of eggs that failed to hatch after 7 consecutive days of no neonate emergence in the vial was recorded. The mean and median number of days to egg eclosion and 95% confidence intervals were calculated (Snedecor & Cochran 1967). The developmental rate (inverse of median no. days to eclosion) was plotted against temperature and a linear regression was calculated (Legg et al. 2000).

Wolcott (1936) reported that eggs of *D. abbreviatus* hatched 7 d after oviposition and suggested that this was unaffected by temperature. In this study, no eggs hatched when held at constant temperatures of 12 or 32°C. The percentage of unhatched eggs ranged from 6% at 18°C to 43% at 30°C (Table 1). For the constant temperatures regimes tested here, there was a positive linear relationship ($y = 0.009x - 0.108$, $r^2 = 0.99$) between developmental rate based on median values and temperature between 15 and 30°C (Fig. 1). Extrapolation based on the regression equation yielded a median functional lower developmental threshold of 12.0°C. The upper thermal limit for

TABLE 1. SURVIVAL OF EGGS AND NUMBER OF DAYS (MEDIAN AND MEAN ±95%CI) REQUIRED TO COMPLETE DEVELOPMENT OF EGGS OF THE DIAPREPES ROOT WEEVIL AT 9 CONSTANT TEMPERATURES.

Temperature (°C)	n	Survival (%)	Days to hatch: Median	Days to hatch: Mean
12	1150	0.0		
15	736	no data	27.0 ± 0.03	26.8 ± 1.04
15	818	78.0	28.1 ± 0.03	27.7 ± 1.07
18	2367	93.5	18.5 ± 0.01	18.0 ± 0.11
19	938	84.6	14.4 ± 0.05	13.9 ± 0.44
21	671	87.3	11.4 ± 0.07	10.9 ± 0.56
22	622	76.5	11.4 ± 0.15	11.3 ± 1.13
26	1045	80.8	7.1 ± 0.06	6.7 ± 0.67
30	566	57.4	5.8 ± 0.12	5.5 ± 0.69
32	750	0.0		

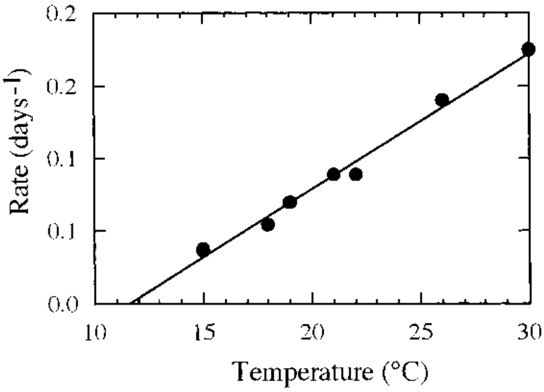

Fig. 1. Relationship of egg development rate versus constant temperature for the Diaprepes root weevil including extrapolation to the median functional lower developmental threshold.

constant temperatures occurred between 30 and 32°C because no eggs survived at 32°C. This is somewhat surprising since mean daily maximum air temperatures in Florida citrus groves exceed 32°C from May through September (Lapointe 2000). On Puerto Rico, Wolcott and Martorell (1943) observed seasonality in occurrence of egg clusters in sugarcane, with greatest abundance occurring in June and a secondary peak in September and October.

It has been observed that female *D. abbreviatus* prefer to oviposit on mature, fully expanded citrus leaves and avoid flush or tender foliage. Various explanations can be put forth to explain this preference. First, the feeding preference of *D. abbreviatus* for tender foliage may have contributed to a separate preference for oviposition substrate (older leaves) to avoid egg consumption by feeding adults. Second, the shear forces exerted by expanding leaves may dislodge egg masses cemented between leaf surfaces, thereby exposing the egg mass. Finally, temperature experienced by eggs of *D. abbreviatus* sandwiched between actively transpiring citrus leaves may vary from ambient air temperatures, particularly mature leaves within a shaded canopy, thereby protecting eggs from lethal temperature extremes.

Lower thermal limits for neonate larvae and pupae were estimated to be 15°C (Lapointe 2000). In this study, egg survival at 15°C was 78% and development time was 4.8 times greater at 15°C compared with that at 30°C. There appeared to be an increase in mortality at 30°C but the mean time to hatch continued to decrease compared with cooler temperatures (Table 1). Of the temperatures tested, 26°C appears optimal based on survival and development rate. This information should be useful for those interested in rearing the Diaprepes root weevil or its egg parasitoids.

SUMMARY

No eggs of the Diaprepes root weevil survived constant temperatures of 12 or 32°C. There was a positive linear relationship ($y = 0.009x - 0.108$, $r^2 = 0.99$) between developmental rate and temperature between 15 and 30°C. Extrapolation based on the regression equation yielded a median functional lower developmental threshold of 12.0°C and the upper thermal limit for constant temperatures occurred between 30 and 32°C.

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