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EFFECTS OF TEMPERATURE ON THE DEVELOPMENT AND SURVIVAL OF *METRIONA ELATIOR* (COLEOPTERA: CHRYSOMELIDAE) IMMATURES

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Tropical soda apple (TSA) *Solanum viarum* Dunal (Solanaceae) was first recorded in Florida in 1988, and it has been spreading fast in improved pasture lands and natural areas in Florida and other southeastern states. In 1994 losses to Florida's cattle industry attributed to TSA were estimated at $11 Million (Mullahey et al. 1996). TSA is native to north-eastern Argentina, Paraguay, eastern Uruguay, and southern Brazil, but also occurs in Asia, Africa, and Central America (Medal et al. 2004; Coile 1993; Mullahey et al. 1993).

The genus *Solanum* is a very large group that probably includes more than 1000 species worldwide, and of these over 30 species of them are considered native or naturalized in the USA (Nee 1991; Soil Conservation Service 1982).

Because TSA causes problems in dairy/beef pastures and natural areas where conventional chemical control practices are prohibited or are too labor intensive to be cost effective, this weed was targeted for biological control (Medal et al. 1999b; Habeck et al. 1996). One of the most promising candidate insects for classical biocontrol of TSA is the leaf-feeding chrysomelid beetle *Metriona elatior* Klug that was first discovered on TSA in South America (Medal et al. 1996). *Metriona elatior* seems to prefer TSA plants growing in shady areas. The release of *M. elatior* will complement the defoliation effects that the leaf-feeder beetle *Gratiana boliviana* Spaeth is making of TSA plants growing in sunny and semi-shady areas in Florida since it was released in the summer 2003. The host range of *M. elatior* was studied in Florida quarantine (Medal et al. 1999a), and its final approval for field release is pending. The biology of *M. elatior* under laboratory condition is reported herein.

Studies on the biology of *M. elatior* were conducted at the USDA-ARS Biological Control Laboratory in Hurlingham, Buenos Aires Province, Argentina. Adults of *M. elatior* were collected on TSA in Misiones province (Argentina) in Nov 1996, and in Rio Grande do Sul and Santa Catarina states (Brazil) in Apr 1997. Adult insects were kept on TSA caged potted plants. Egg clusters were daily removed and incubated in 28-mL plastic cups filled with moist tissue paper, and checked daily for emergence. Neonate larvae were individually reared on excised TSA leave placed in 0.5-L transparent plastic containers with small perforations in the lid. Leaves were replaced as needed. The larvae were daily checked to determine the number and duration of the individual instars. To determine the development of immature stages, 5 egg masses and 16 neonate larvae were reared in each of 3 growth chambers at 20°, 25°, and 30°C, with a photoperiod of 14:10 D:L and a relative humidity of 60-80%.

In general, the biology (number of instars and developmental time) of *M. elatior* on its primary host *S. viarum* is similar to the biology of *Gratiana lutescens* (Boh.) and *Gratiana pallidula* (Boh.) on *Solanum elaeagnifolium* Cav. (Siebert 1975), and that of *Gratiana spadicea* Klug on *S. sisymbriifolium*, under similar environmental conditions (Hill & Hulley 1995; Albuquerque & Becker 1986). Morphological descriptions of all the developmental stages of *M. elatior* were published in Uruguay by Morelli & Ponce de León (1993).

Adult females deposited eggs in clusters or egg masses on the lower surface of the leaves, on the angle formed by the midvein and secondary leaf-veins. Each egg mass contained 8.47 ± 2.33 eggs (range: 5-13). The incubation periods averaged 11.3, 6.9, and 5.6 d at 20°, 25°, and 30°C, respectively (Table 1) (n = 5 egg masses at each temperature; all eggs in the cluster usually eclosed within a 24-h period). The average number of eggs (8.47) laid by *M. elatior* at 25°C in this study was less than the average number (13.0) reported by Morelli & Ponce de León (1993) for the same insect reared on *S. viarum* However, the host plant in the study by Morelli & Ponce de León (1993) was misidentified as *S. elaeagnifolium*, and Gandolfo, Medal, and Ponce de León (unpublished data) later confirmed the identity of the plant as *S. viarum*.

The larval stage of *Metriona elatior* has 5 instars which can be distinguished mainly by the head capsule width. Means and standard deviation (in d) for each instar are as follows: 0.40 ± 0.08, 0.54 ± 0.03, 0.71 ± 0.04, 0.89 ± 0.03, and 1.16 ± 0.05 mm (n = 22 larvae per instar). Similar results were obtained in South Africa by Hill & Hulley (1996) with the same insect species on *S. sisymbriifolium*. After emergence, the first instars usually feed on the same leaf where the cluster was deposited, but they are not gregarious. As in most tortoise beetles, larval exuviae and feces are carried in the anal forks and the posterior apex of the larvae is bent forward. After approximately one third of the duration of the last instar has passed, larvae stop feeding and attach themselves to the lower surface of the leaves with a secretion released by the abdominal sternites.

TABLE 1. DEVELOPMENTAL TIME OF *METRIONA ELATIOR* IMMATURES AT DIFFERENT TEMPERATURES.

	Duration (d)					
	20°C		25°C		30°C	
Stage	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
Egg	11.3 ± 0.96	10-12	6.9 ± 0.38	6-7	5.6 ± 0.55	5-6
1st instar	4.5 ± 0.50	4-5	3.7 ± 0.59	3-5	2.9 ± 0.15	2-4
2nd instar	4.2 ± 0.58	3-5	2.9 ± 0.74	2-4	3.1 ± 0.93	2-5
3rd instar	4.5 ± 0.67	4-6	2.7 ± 0.46	2-3	3.9 ± 1.16	2-6
4th instar	5.2 ± 1.90	2-8	3.8 ± 0.80	3-5	5.6 ± 1.14	4-7
5th instar	12.2 ± 2.37	10-19	8.0 ± 1.13	7-11	—	—
Pupa	11.4 ± 0.67	10-12	7.1 ± 1.31	5-8	—	—

Pupae are yellowish and black. As in the larvae, pupae have triangular, flat, lateral processes on the margin of the 5 anterior abdominal segments and cylindrical processes on the posterior segments. The anterior margin of the pronotum has a fringe of small cylindrical processes. Two pairs, near the medial line are approximately 3 times as long as the others. The pupal stage lasted on average 11.4 d (range:10-12) at 20°C, and 7.1 d (range 5-8) at 25°C (Table 1). The duration of the pupal stage of *M. elatior* on *S. viarum* did not differ from that reported by Hill & Hulley (1996) when the insect was reared on *S. sisymbriifolum*.

Figure 1 summarizes the results of the cohorts reared at different temperatures in the laboratory. At 20° and 25°C, the percent survival from first instar to adult was 75 and 73%, respectively. A constant temperature of 30°C had a detrimental effect on the larvae and none reached the pupal/adult stages (Fig. 1). Developmental time, except for the egg stage and first instar, was faster for larvae reared at 30°C compared with those reared at 25°C. However, the survival of each instar was lower at 30°C than it was at 20° or 25°C (Fig. 1).

Teneral adults are pale brown to yellow. After a few days, the color of the pronotum and elytra changes to green. Adults are almost conical shaped with body length of 0.7 to 0.9 cm, and a maximum width of 0.5 to 0.7 cm. Female body lengths tend to be larger than those of males. The pre-oviposition period of *M. elatior* was from 7 to 14 d (n = 20 pairs of male and female). The number of egg clusters deposited per female ranged for 32 to 98, and each cluster contained from 1 to 9 eggs. At a constant temperature of 25°C, longevity of the females ranged from 92 to142 d, and for males from 52 to 90 d. This is contrary to the results reported by Albuquerque & Becker (1986) with *G. spadicea*, a closely related cassidine species, where males lived longer (198 d) than females (84 d) on *S. sisymbriifolium*.

Based on the duration of the *M. elatior* life cycle obtained under laboratory conditions and the occurrence of overlapping generations, we anticipate this species can undergo multiple generations per year in TSA infested areas of the USA.

SUMMARY

The larval developmental rate of the tortoise beetle *Metriona elatior* Klug (Coleoptera: Chrysomelidae), a potential biocontrol agent of tropical soda apple (TSA) *Solanum viarum* Dunal (Solanaceae), was studied in the laboratory at 3 constant temperatures (20°, 25°, and 30°C), photoperiod (14:10 L: D), and relative humidity 60%-80% in growth chambers. Sixteen neonate larvae were individually reared on excised TSA leaves placed in 0.5-liter transparent-plastic containers for each temperature treatment. Larvae were daily checked to determine the number and duration of larval instars at each of the temperature tested. At 20° and 25°C, the percent survival from first instar to adult was 75 and 73%, respectively. A constant temperature of 30°C had a detrimental effect on the larvae and none reached the pupa/adult stages. The general life cycle of this beetle is discussed.

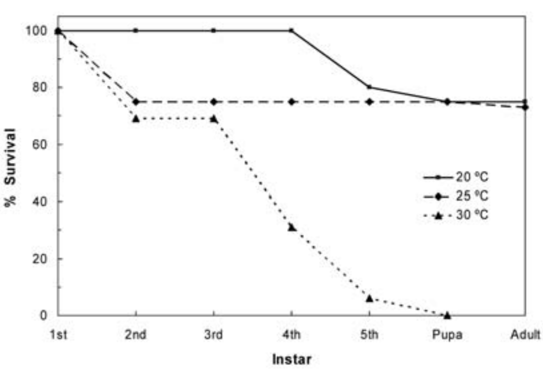

Fig. 1. Survival of *Metriona elatior* immatures at different temperatures.

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