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## DURATION OF THE LARVAL, PUPAL, AND MOTH STAGES OF THE SOUTHERN PINE CONEWORM *DIORYCTRIA AMATELLA* (HULST)<sup>1</sup>

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**ABSTRACT.**—The day's duration of each developmental stage of the southern pine coneworm, *Dioryctria amatella* (Hulst), when reared on artificial medium was determined under controlled laboratory conditions. These results will provide a method for estimating the availability of the different stages during rearings without the necessity of measuring larval-head capsule widths or closely observing colonies for evidence of larval ecdysis, pupation, or moth emergence.

**Keywords:** Duration, head capsule, life stage, pupation.

The southern pine coneworm, *Dioryctria amatella* (Hulst), is one of the most destructive insect pests in pine seed orchards of the Southeastern United States. Larval feeding on the flowers, conelets, cones, and shoots of southern pines can reduce yields of pine cones by as much as 35 percent. The life history of *D. amatella* has been reported in part by Ebel (1963, 1965), Neunzig and others (1964), Coulson and Franklin (1970), and Ebel and others (1975).

When reared on artificial medium at 27° C under a diel photoperiod of 12 h light: 12 h darkness, the average day's duration for stages of *D. amatella* was: egg, 5.4 days; larval, 27.8 days; pupal, 14.5 days; and moth, 11.4 days with a total generation time<sup>3</sup> of 47.9 days.<sup>4</sup> The duration of each of the five larval stages (Fatzinger 1970) has not been reported.

In this study, we determined the day's dura-

tion of each of the larval stages when reared on artificial medium as well as the day's duration of the pupal and adult stages. This information will be useful for studies requiring insects of a given stage of development.

### METHODS

Eggs of *D. amatella* were obtained from the 39th successive generation of a laboratory colony reared on the AUTOWG+S medium (see footnote 4) at Olustee, Florida. First-stage larvae (Jones 1978), collected on the day they hatched from eggs, were reared individually under a diel photoperiod of 12 h light: 12 h darkness at 27°C on the AUTOWG+S medium in 29.6 ml plastic condiment cups fitted with snap-on lids. Daily observations were made and the duration of each stage of development was recorded. The appearance of a moulted larval-head capsule was used as evidence of a change in larval stage. To avoid damage to the tender newly formed pupae, they were left in the larval-rearing containers from 2 to 3 days until they changed color from an initial greenish white to a dark tan (Fatzinger and Asher 1971). The tan-colored pupae were transferred to individual 59.2 ml plastic cups equipped with snap-on lids and a small piece of sponge (about 1 × 1 × 1 cm) that was moistened daily with water to maintain humidity. Upon emergence, moths

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<sup>3</sup>Generation time was calculated as the average of the durations of larval and pupal stages for female insects plus the average number of days from female moth emergence to egg deposition and egg hatch.

<sup>4</sup>Fatzinger, C. W. A method for rearing the southern pine coneworm on artificial medium, with observations on mating behavior. (In preparation.)

were transferred to 4.7-liter jars fitted with wire screen tops. They were provided with a 5-percent sucrose-water solution for feeding from a small sponge moistened daily in each jar.

## RESULTS AND DISCUSSION

Our observations on larval ecdyses during rearings confirmed Fatzinger's (1970) findings that *D. amatella* has five larval stages. The first four larval stages were about equal in duration (table 1) with an overall average duration of 3.7

different for males and females during larval stages I, IV, V, and for pupae (table 2). In general, mean duration of stages for females was slightly longer than that for males. The total time from average egg hatch to average moth death was also significantly different ( $P < 0.01$ ) between males (49.5 days) and females (51.4 days).

The numerical differences observed between sexes for duration of the first three larval stages ranged from 0.03 to 0.07 days and increased from 0.20 days for stage IV larvae to 0.88 days for stage V larvae. The total difference of 1.9 days between

Table 1.—Duration of the larval, pupal, and moth stages of *D. amatella* reared on an artificial medium at 27°C

Developmental stage	Insects observed (No.)	Duration of stages		Cumulative duration of stages
		Mean <sup>1</sup> (days)	Range	Mean <sup>2</sup> (days)
I	800	3.98 ± 0.02	2-7	3.98 ± 0.02
II	724	3.26 ± 0.04	2-7	7.26 ± 0.04
III	630	3.91 ± 0.03	2-9	11.11 ± 0.05
IV	586	3.51 ± 0.08	3-14	14.59 ± 0.10
V	485	9.14 ± 0.25	3-22	23.70 ± 0.26
Pupa	427	15.30 ± 0.21	5-27	38.94 ± 0.31
Moth	408	11.58 ± 0.46	1-28	50.52 ± 0.53

$$^1\bar{X} \pm t_{0.05} S_{\bar{X}}$$

days each. The duration of larval stage V, however, was at least 2.3 times longer than any of the previous stages. This increased duration was probably attributable to the additional time required after the larva ceased active feeding to construct the pupal cocoon and for the pharate pupal instar to form before pupal ecdysis. Total duration of the larval stage was about 4 days shorter than that observed by Fatzinger (*see* footnote 4) for *D. amatella* reared under the same laboratory conditions. The duration of the pupal stage was about 1 day longer, and duration of the moth stage was about equal to that found by Fatzinger.

The mean duration of stages was significantly

sexes for average colony duration from egg hatch to moth death was only 3.8 percent of the average colony duration for both sexes combined. The differences in durations of stages between colonies reared, i.e., those reported by Fatzinger (*see* footnote 4) and those reported here, are also small. Thus, the average duration of stages listed in table 1 should provide accurate estimates of the stage of development of *D. amatella* when reared as described above. These data provide a means for estimating the availability of the different stages in rearings without the necessity of measuring larval-head capsule width or closely observing colonies for evidence of larval ecdyses, pupation, or moth emergence.

Table 2.—Comparison of duration of stages for male and female *D. amatella* reared on an artificial medium at 27°C

Developmental stage	Insects observed (No.)	Duration of stages		Insects observed (No.)	Duration of stages		Significant difference <sup>2</sup>
		Mean <sup>1</sup> (days)	Range		Mean <sup>1</sup> (days)	Range	
		MALE			FEMALE		
I	226	3.98 ± 0.02	2-4	254	4.01 ± 0.02	4-6	*
II	226	3.19 ± 0.06	3-6	253	3.16 ± 0.05	3-5	
III	226	3.87 ± 0.04	3-4	253	3.94 ± 0.06	2-9	
IV	224	3.39 ± 0.09	3-6	254	3.59 ± 0.15	3-14	*
V	223	8.68 ± 0.37	3-22	254	9.56 ± 0.33	5-19	**
Pupa	196	15.07 ± 0.29	8-20	228	15.56 ± 0.29	5-27	*
Moth	186	11.31 ± 0.66	2-23	219	11.79 ± 0.64	1-28	

$$^1 \bar{X} \pm 0.05 S_{\bar{X}}$$

<sup>2</sup> A *t*-test was used to test the differences between means (\* =  $P \leq 0.05$ , \*\* =  $P < 0.01$ ).

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