BIOLOGY AND DEVELOPMENT OF *LESPESIA ALETIAE* (DIPTERA: TACHINIDAE) IN TWO LEPIDOPTERAN SPECIES IN THE LABORATORY

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ABSTRACT

The tachinid *Lespesia aletiae* (Riley) was obtained from parasitized larvae of *Syntomeida epilais* (Walker), which is an arctiid pest of oleander, *Nerium oleander* (L.). Development of *L. aletiae* in fifth and sixth instars of *S. epilais* and of a noctuid, the fall armyworm, *Spodoptera frugiperda* (Smith) was determined in laboratory studies. Female *L. aletiae* flies lived an average of approximately 24 d, 14 days longer than males, and were observed to oviposit membranous eggs directly on the host body. First instars cut their way out of the egg and into the host within 2 min of oviposition. The percent of successful parasitism in laboratory assays ranged from 36% in fifth instar *S. epilais* to 65% in sixth instar fall armyworms. Puparial size was found to increase with increasing host instar and to decrease with increasing number of maggots per host. The time between exposure to parasitoids and host death was longer in fifth than sixth instars of the same host, and was significantly longer in fifth instar *S. epilais* than in any other combination of host instar and species tested. The parasitoid puparial stage was approximately one day longer for females than it was for males. Both the fifth and sixth instars of the fall armyworm and *S. epilais* were suitable for the parasitoid's development, however, parasitism levels and parasitoid survival were higher in fall armyworms.

Key Words: tachinid fly, parasitoid, biocontrol, Lepidoptera host, rearing

RESUMEN

El tachinido *Lespesia aletiae* (Riley) fué encontrado parasitando larvas de *Syntomeida epilais* (Walker), un arctiido plaga del narciso, *Nerium oleander* (L.). El desarrollo de *L. aletiae* en quinto y sexto estadios de la palomilla del narciso, *Syntomeida epilais*, y del gusano soldado, *Spodoptera frugiperda* (Smith) fué evaluado bajo condiciones de laboratorio. Las hembras del *L. aletiae* vivieron un promedio de 24 días, 14 días más que los machos, y fueron observadas depositando huevos membranosos directamente sobre el hospedero. El primer estadío del parasitoide cortó su camino fuera del huevo y hacia dentro del hospedero en menos de dos minutos después de ser depositados. El porcentaje de parasitismo, en los ensayos de laboratorio, varió desde 36% en el quinto estadío de *Syntomeida epilais*, hasta 65% en el sexto estadío de *Spodoptera frugiperda*. Se observó que el tamaño de las pupas tendió a aumentar en relación al estadío del hospedero, y a disminuir en relación al número de larvas por hospedero. El tiempo transcurrido entre la ovoposición de los parasitoides y la muerte del hospedero fue más largo para el quinto que para el sexto estadío dentro del mismo hospedero, y fue significativamente más largo para el quinto estadío de *Syntomeida epilais* que para las otras combinaciones de estadío/hospedero evaluadas en este estudio. La duración de lestadío de pupa fue aproximadamente un día más largo para

las hembras que para los machos. Ambos, quinto y sexto estadios de *Spodoptera frugiperda* y *Syntomeida epilais* demostraron ser buenos hospederos para el desarrollo de *L. aletia*; sin embargo, el porcentaje de parasitismo y la tasa de sobrevivencia del parasitoide fueron más altas en *Spodoptera frugiperda*.

Lespesia aletiae (Riley) (Tachinidae) is recorded from most states of the continental USA, and from southern Canada. It has been found parasitizing species in the lepidopteran families Arctiidae, Hesperiidae, Lasiocampidae, Lymantriidae, Megalopygidae, Noctuidae, Notodontidae, Nymphalidae, Pieridae, Pyralidae and Sphingidae, and the coleopteran family Coccinellidae (Benneway 1963). Reported hosts include agricultural pests such as the salt-marsh caterpillar, *Estigmene acrea* (Drury), *Helicoverpa* and *Heliothis* spp., the fall armyworm, *Spodoptera frugiperda* (J. E. Smith); the cabbage looper, *Trichoplusia ni* (Hübner) and the imported cabbageworm, *Pieris rapae* (L.). It has also been reported to parasitize *Syntomeida epilais* (Walker) (Patton 1958, Benneway 1963, McAuslane & Bennett 1995), a serious pest of oleander, *Nerium oleander* (L.), which is a flowering ornamental shrub that is grown in much of Florida.

The distribution of *S. epilais* extends from south Florida and Mexico in North America to northern South America (Bratley 1932). Oleander is the primary host for the immature stages of *S. epilais* in Florida, although *Echites umbellata* (Jacquin) was earlier reported as its native host (Grossbeck 1917). Except for one specimen of *Chetogena* (=*Euphorocera*) *floridensis* (Townsend), *L. aletiae* was the only larval parasitoid recovered from field collections of *S. epilais* caterpillars made in Gainesville and Tampa, Florida. Although *L. aletiae* has been reported as a parasitoid of the larval stages of *S. epilais*, no studies have been made on the biology and immature development of this tachinid.

Studies were initiated to obtain information on the potential use of fall armyworm larvae as a laboratory host for *L. aletiae*. Oviposition activity of adult flies was observed, and longevity of adult flies reared from fall armyworms was determined. Comparative laboratory studies were conducted on parasitoid development in fifth and sixth instars of the original host, *S. epilais*, and in fifth and sixth instars of the laboratory host, the fall armyworm.

Materials and Methods

The colony of *L. aletiae* was initiated from parasitized *S. epilais* larvae collected from oleander bushes in Tampa, Florida, in January 1994. Adults were maintained in screen cages (25 by 25 by 25 cm) and were provided with water, an aqueous sucrose solution (20% wt/vol) and hydrolyzed brewer's yeast as a protein source. Subsequent generations were reared on sixth instar fall armyworms obtained from a laboratory colony maintained at the Center for Medical, Agricultural and Veterinary Entomology, USDA/ARS, Gainesville, Florida. All stages of the *L. aletiae* colony were maintained in laboratory rearing conditions with a photoperiod of 12:12 (L:D) h at 25°C and 80% relative humidity. Flies were provided with fall armyworms twice a week for oviposition (Bryan et al. 1968). Caterpillars were exposed for twenty minutes and then set individually in plastic cups (25 ml) half filled with pinto bean diet as food for the hosts, and were maintained throughout parasitoid development until puparia appeared. Fly puparia were placed in plastic cups (25 ml) within a screen cage for adult emergence. Additional *L. aletiae* maggots were obtained from *S. epilais* larvae collected from oleander bushes in Gainesville, Florida during the fall of 1994, and adult flies were added to the laboratory colony.

After ill-fated attempts to rear *S. epilais* on artificial diet, larvae used for the parasitoid development studies were field-collected in Gainesville during October - December 1994 as third, fourth and fifth instars. All rearing was conducted in a greenhouse under natural light conditions. Larvae were reared on potted oleander bushes until the last instar, and then were transferred to plastic containers with screened lids (either 18 by 13 by 9.5 cm or 30 by 22 by 9.5 cm) and given freshly cut oleander leaves. Leaves were replaced every other day.

Parasitoid Oviposition and Adult Longevity

Sixth instar fall armyworm larvae were introduced individually into a cage with five adult female flies for observations on host-parasitoid interactions. The introduced host was watched continuously from time of introduction and was removed immediately after oviposition contact by a female fly. The larva was then observed under a stereo microscope at 10-30× magnification to confirm oviposition, and to determine the time periods from oviposition to egg hatch and host penetration by the first instar maggot. This was repeated for 20 host larvae.

Adult longevity was determined by placing ten flies (5 females and 5 males) that emerged within a 24-h time period into a screen cage with food and water as above. Flies were provided with fall armyworms twice a week for oviposition. The number and sex of dead flies were recorded daily and the adult longevity determined. The experiment was replicated five times.

Parasitoid Development

Sexually mature male and female *L. aletiae* (10-25 d old) were placed in acrylic cages (15 by 15 by 15 cm) with a wire screen (15 mesh) top and provided with food and water as above. Host larvae were confined under the lid of a petri dish (15 cm diam.) placed on the screened top of a cage containing six female flies for 10-20 min. The *L. aletiae* females have long ovipositors, so they were able to reach and parasitize the caterpillars through the mesh. After exposure to the parasitoids, fall armyworm larvae were placed individually in plastic cups (25 ml) containing pinto bean diet, and *S. epilais* caterpillars were placed together in a plastic container and given fresh oleander leaves daily. Host larvae were exposed in separate groups of 20 fifth or 20 sixth instars for the fall armyworm and *S. epilais*. Since *S. epilais* were field-collected, control groups of ten non-exposed fifth and sixth instar *S. epilais* were placed under the same conditions as the parasitoid-exposed caterpillar groups for each replicate. When *S. epilais* died or pupated, they were moved from collective containers to individual plastic cups. The experiment with fifth instar *S. epilais* was replicated four times. There were five replications of each of the other instar/host combinations.

Host larvae were checked daily. Fly maggots and puparia were placed individually in dry microcentrifuge tubes with a hole in the cap to facilitate ventilation, and the microcentrifuge tubes were checked daily. The following data were recorded: date of host death and host stage at death, date of maggot emergence from the host, date of maggot pupariation, date of adult fly emergence and sex of adult fly. Within 24 h of pupariation, puparial length and width were measured under a stereomicroscope with an ocular micrometer, and puparial weight determined. Number of maggots per host cadaver, parasitoid sex ratio and percent parasitism were recorded.

Statistical Analysis

Longevity of female and male adult *L. aletiae* was compared with a two sample *t*-test using Proc TTEST (SAS Institute 1985). Chi-square analysis using Proc Freq (SAS Institute 1985) of a contingency table of number parasitized was used to compare

percentage parasitized for each host and host instar combination. Time period for parasitoid development from initial host exposure to adult emergence was divided into three separate response variables for statistical analysis. These developmental response variables were time until host death, time from host death until maggot emergence from the host cadaver, and time from maggot emergence until adult emergence. Effect of host and host instar on developmental response variables and puparial size were tested with two-way analysis of variance (ANOVA) with interaction using Proc GLM (SAS Institute 1985). Significant ANOVAs were followed by Tukey's mean separation tests ($P = 0.05$). Data were assessed by the Box-Cox procedure (Box et al. 1978) and were transformed when necessary to stabilize the variance prior to analysis. Differences in the developmental response variables and puparial size between male and female parasitoids were tested with two sample *t*-tests. Separate comparisons were conducted within each host species and host age group. Finally, correlations among the puparial size parameters were tested using Proc CORR (SAS Institute 1985).

RESULTS

Parasitoid Oviposition and Adult Longevity

Adult flies mated within the first day after emerging. However, females did not begin ovipositing until 5-10 d after emergence. After host larvae were introduced into a cage of adult flies, the flies became very active. Females moved aggressively and flew in circles around the host until physical contact was made. They then extended the ovipositor and laid several eggs along the host body. Females attached membranous, macrotype eggs to the host body. First instar maggots cut their way out of the egg and into the host within 2 min of oviposition. Female flies lived longer than males ($t = 7.19$, df = 48, $P < 0.0001$). Adult longevity (± SD) averaged 23.9 (± 7.27) d for females and 10.3 (± 6.03) d for males.

Parasitoid Development

Parasitized hosts became increasingly sluggish prior to death. Approximately 95% of parasitized hosts died as larvae. Percent parasitism was higher in fall armyworm than in *S. epilais* regardless of instar exposed to the parasitoid (Table 1). There was 23 and 16% parasitism in control (field-parasitized) fifth and sixth instar *S. epilais*, respectively. An effort was made to differentiate between field- and laboratory-parasitized *S. epilais* caterpillars by comparing the time periods until host death. Time until host death ranged from 5 to 14 d and from 2 to 12 d for laboratory-exposed fifth and sixth instar *S. epilais*, respectively; and from 5 to 12 d and from 1 to 12 d for control fifth and sixth instar *S. epilais*, respectively. Because of the overlap in the time periods, no further attempt was made to separate field-parasitism from lab-parasitism in laboratory-exposed *S. epilais*. Therefore, all data from *L. aletiae* obtained from laboratory-exposed *S. epilais* were assumed to be due to laboratory parasitism and were used for statistical analysis.

There was a significant interaction between host and host instar for both the time period from exposure to the parasitoid until host death and the time period from host death until maggot emergence ($F = 65.39$; df = 1, 381; $P = 0.0001$; $F = 6.20$; df = 1, 381; $P = 0.0132$, respectively). Therefore, the two two-level factors of host and host age were combined to a single four-level factor of host-host age combination and the effect was tested with oneway ANOVA. The time period from exposure to parasitoids until host death was the shortest in sixth instar fall armyworm and the longest in fifth instar *S. epilais* (Table 1). Time period from host death until maggot emergence, however, was longer in sixth instar fall armyworms than in any other host-host age group (Table 1). After the host's death, maggots developing in fall armyworms were found

TABLE 1. PARASITISM LEVEL AND PARASITOID DEVELOPMENTAL TIMES (MEANS ± SD) IN LEPIDOPTERAN LARVAE EXPOSED TO *L. ALETIAE* IN LABORATORY TRIALS[1].

Host and Host Instar	No. of Hosts Exposed	No. of Hosts Parasitized (%)[1]	Time Period from Parasite Exposure to Host Death (d)[2]	Time Period from Host Death until Maggot Emergence (d)[2]	No. of Maggots per Host[2]
S. frugiperda					
5th instar	100	62 (62%)b	6.2b ± 1.78	1.8a ± 0.93	1.7ab ± 0.89
6th instar	100	65 (65%)b	5.5a ± 2.08	2.4b ± 0.94	2.0b ± 1.45
S. epilais					
5th instar	80	29 (36%)a	11.2c ± 1.64	1.9a ± 1.09	1.5a ± 0.41
6th instar	100	49 (49%)a	5.9ab ± 3.64	1.8a ± 1.18	1.5a ± 1.37
		$\chi^2 = 18.597$ df = 3 $P < 0.001$	$F = 73.88$ df = 3, 382 $P = 0.0001$	$F = 10.75$ df = 3, 382 $P = 0.0001$	$F = 3.53$ df = 3, 183 $P = 0.016$

[1]Means within a column followed by the same letter are not significantly different (2 × 2 contingency tables [df = 1] of 2-at-a-time comparisons within host or instar, $P < 0.05$).
[2]Means within a column followed by the same letter are not significantly different (Tukey's mean separation test; $P = 0.05$).

associated with respiratory funnels and/or the host's spiracles. No such association was observed in parasitized *S. epilais*.

Parasitoids formed puparia within three to six hours after exiting the host's cadaver, whether they emerged from the fall armyworm or from *S. epilais*. The number of maggots per host ranged from one to seven, and about 48% of the hosts had more than one parasitoid maggot. Average number of maggots per host was higher in sixth instar fall armyworm than in either instar of *S. epilais* (Table 1).

Puparia from sixth instar hosts were larger than puparia from fifth instar hosts for both host species (Table 2). There were positive correlations between puparial weight and both length (r =0.88, P = 0.0001) and width (r = 0.78, P = 0.0001). Therefore, weight could be used as a single indicator of puparial size. Puparial weight decreased as the number of maggots per host increased (Fig. 1). Survival percentage to adult was greater for parasitoids from sixth instar hosts than for those from fifth instar hosts for both host species (Table 2), and there was no difference in the weight of puparia of individuals that survived to adult versus those that did not (t =0.9792, df = 384, P = 0.3281). Information on parasitoid progeny from field-parasitized *S. epilais* is presented for comparative purposes (Table 3). Only one maggot per host was obtained from field-parasitized sixth instar *S. epilais*. The puparia from sixth instars tended to be larger than those obtained in laboratory parasitism of either host, but this was not the case for puparia from fifth instars.

Puparial stadium was affected by host (F = 180.34; df = 1, 261; P = 0.0001) but not by host instar (F = 1.57; df = 1, 261; P = 0.2109), and the interaction between those factors was not significant. Time from maggot emergence until adult emergence from *S. epilais* was longer than from fall armyworm (12.9 ± 1.72 d versus 10.2 ± 1.02 d). The sex ratio of parasitoid adults ranged from 1:0.8 female:male from 5th instar *S. epilais* to 1:1.7 female:male from 6th instar *S. epilais* (Table 2).

For individuals that successfully completed development to the adult stage, developmental response variables and puparial size of males versus females could be compared. Puparial stadium for females was one day longer than for males for parasitoids from fifth instar fall armyworms (17.7 ± 2.24 versus 16.7 ± 2.1, respectively; t = 2.2943, df = 126, P = 0.0234). No other differences were found in the developmental times of male versus female flies within any of the host-host instar combinations. The puparial width of males that emerged from fifth instar *S. epilais* was greater than for females from that host (3.1 ± 0.36 versus 2.8 ± 0.37, respectively; t = 2.0868, df = 25, P = 0.0473), but there were no other differences in puparial size.

Although most of the parasitized hosts died as larvae, ten hosts were able to pupate. All of these hosts had been parasitized as late sixth instars. In each case, a single robust maggot emerged from the host pupa. Nine of these hosts died as pupae and parasitoids from those hosts became adults. The remaining pupa, an *S. epilais*, completed development to the adult stage after parasitoid emergence. However the adult emergence was not completely successful as pupal exuviae remained on the host abdomen. The parasitoid from this host died in the pupal stage.

DISCUSSION

The *L. aletiae* females readily accepted fall armyworms for oviposition after a 5-10-d pre-oviposition period. Pre-oviposition periods, similar to that of *L. aletiae*, have been reported for other tachinid parasitoids including *Drino munda* (Wiedemann) (Chauthani & Hamm 1967), *Lespesia archippivora* (Riley) (Bryan et al. 1968), *Voria ruralis* (Fallen) (Elsey & Rabb 1970), *Panzeria ampelus* (Walker) (Arthur & Powell 1990) and *Winthemia fumiferanae* (Clemens) (Hebert & Cloutier 1990). We found that *L. aletiae* females lived an average of 14 days longer than males. Hughes (1975) ob-

TABLE 2. *LESPESIA ALETIAE* PUPARIAL SIZE (MEAN ± SD) AND SURVIVAL TO ADULT IN LABORATORY TRIALS[1].

Host and Host Instar	n	Weight (mg)	Length (mm)	Width (mm)	No. Surviving to Adult (%)	Female:Male Ratio
S. frugiperda						
5th instar	108	31.5a ± 14.17	5.9a ± 0.80	2.9a ± 0.44	54 (50)	27:27 (1:1)
6th instar	159	35.4b ± 13.48	6.1b ± 0.72	3.0b ± 0.42	128 (81)	65:59 (1.1:1)
S. epilais						
5th instar	43	31.2a ± 13.90	6.0a ± 0.71	2.9a ± 0.51	27 (63)	15:12 (1.2:1)
6th instar	76	36.4b ± 12.21	6.3b ± 0.70	3.2b ± 0.51	56 (75)	21:35 (0.6:1)
		F = 10.52 df = 1, 382 P =0.0013	F = 6.98 df = 1, 382 P =0.0086	F = 10.84 df = 1, 382 P =0.0011		

[1]Means within a column followed by the same letter are not significantly different (Tukey's mean separation test; P = 0.05). Host age was the only significant factor from two-way analysis of variance on host and host age, and those statistics are presented.

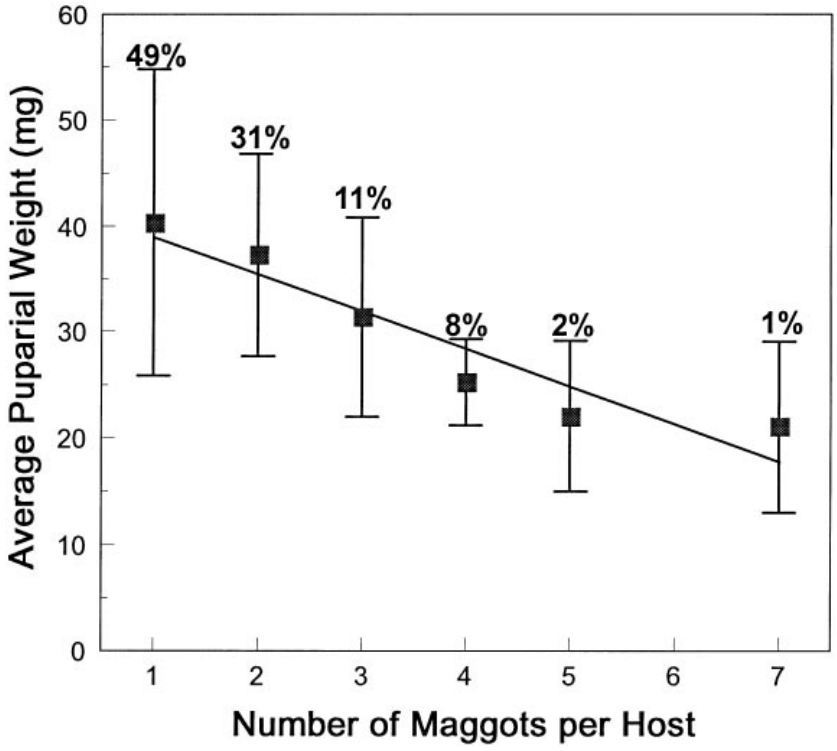

Fig. 1. Average and standard deviation of puparial weight of parasites from hosts with 1-7 maggots per host (n = 209). Number above each mean indicates the percentage of hosts parasitized at each number of maggots per host level. Regression was determined from average puparial weight for each number of parasitoids per host (r^2 = 0.89, y = 42.5 - 3.53 [± 0.608]x).

served that *Archytas marmoratus* (Townsend) females lived approximately twice as long as the males. It has been suggested that temperature, crowding, superparasitism and host suitability may influence adult lifespan and reproductive capacity (Salt 1941, Bryan et al. 1969, Mason et al. 1991). No efforts were made during this experiment to evaluate the effect of any of these factors on the longevity of adult flies.

Oviposition of membranous macrotype eggs along the host body has been previously reported for the genus *Lespesia* and other genera of Tachinidae (Benneway 1963). Time period between larval hatch and penetration into the host has been reported to occur immediately in *D. munda* (Chauthani & Hamm 1967) and in *V. ruralis* (Elsey & Rabb 1970), which is similar to the time period observed for *L. aletiae* maggots in our study. *Athrycia cinerea* (Coquillet) eggs hatched after 10 min of oviposition and entered their host within 1 min after hatching (Arthur & Powell 1989) and Bryan et al. (1968) reported that the eggs of *L. archippivora* hatched within 20 minutes postoviposition.

Syntomeida epilais larvae remained motionless when approached by parasitoid adults. Fall armyworm larvae, however, moved aggressively from side to side and tried to remove the flies and eggs by grooming them off their bodies and by covering

TABLE 3. PUPARIAL SIZE (MEAN ± SD) AND SURVIVAL TO ADULT FOR *L. ALETIAE* FROM FIELD-PARASITIZED *S. EPILAIS*.

Host Instar	n	No. of Maggots per Host	Weight (mg)	Length (mm)	Width (mm)	No. Surviving to Adult (%)
5th instar	12	1.3 ± 0.52	28.2 ± 13.18	5.9 ± 0.92	2.9 ± 13.18	5 (42)
6th instar	8	1.0 ± 0.00	46.9 ± 11.08	6.7 ± 0.46	3.6 ± 0.51	6 (75)

themselves with regurgitated substances. Grooming interactions, in which caterpillars would bite parasitoid eggs off each other, were also noted on several occasions. Danks (1975) observed similar responses by *H. zea* and *H. virescens* (F.) towards the attack of *Winthemia rufopicta* (Big.). Miles and King (1975) observed that *Lixophaga diatraea*e (Townsend) maggots showed a tendency to enter through their host's intersegmental membranes. We observed no oviposition preference when *L. aletiae* flies had to lay eggs through the wire mesh and eggs were laid wherever physical contact was made. However, when host larvae were introduced into a cage of flies and direct contact was possible, there was a clear preference for the intersegmental and ventral regions of the host's body. The observation that *L. aletiae* females prefer specific sections of the host's body contrasts with the reports on its congene, *L. archippivora* (Bryan et al. 1968).

Fall armyworms appeared to be better hosts for *L. aletiae* than *S. epilais*. The overall parasitoid developmental cycle was shorter and the parasitism and parasitoid survival levels were higher for individuals that parasitized fall armyworms versus *S. epilais*. *Syntomeida epilais* were reared on oleander foliage, which contains cardiac glycosides (Harborne 1982), and the caterpillars have the aposematic coloration typical of chemically defended organisms. Allelochemicals in host food may be deleterious to parasitoid development if the chemicals are present in host tissue (Thurston & Fox 1972). Fall armyworms were reared on artificial diet, which has a higher nutrient content than plant foliage, and this may also contribute to improved parasitoid development (House & Barlow 1961, Beach & Todd 1986). There are nutritional differences between larvae that consume artificial diet versus larvae that consume plant foliage (Cookman et al. 1984).

When parasitizing fall armyworms, *L. aletiae* maggots were observed to be associated with spiracles and/or respiratory funnels approximately one day after host death. Miles and King (1975) noticed that *L. diatraeae* maggots either attached directly to the host's spiracles or to the tracheal trunks nearby. Ziser and Nettles (1978) observed that when *Eucelatoria* spp. maggots attached themselves directly to the host cuticle there was no formation of a respiratory funnel, and the same was true when maggots penetrated the host's tracheal system. This could have been the case of *L. aletiae* maggots developing in *S. epilai*s where no respiratory funnel or spiracle association was observed.

The level of parasitism by *L. aletiae* and parasitoid survival as well as puparial size tended to increase directly with host instar, whereas developmental time tended to decrease with increasing host instar. Similar results have been found with other tachinids (e.g., Miles & King 1975, King et al. 1976, Beland & King 1976). When given the choice, *L. aletiae* flies exhibited no preference between the fifth and the sixth instars of either the fall armyworm or *S. epilais* (Y. J. C., unpublished data). Female *W. fumiferanae* showed a clear preference for sixth instars over fifth instars of the spruce budworm, *Choristoneura fumiferana* (Clemens), and survival from egg until pupariation was five times higher in sixth than in fifth instars (Hebert & Cloutier 1990). Maggots of *L. diatraeae* were more efficient seeking fourth and fifth instars of the sugar cane borer, *Diatraea sacharalis* (F.) (Miles & King 1975), and the early fifth instar was the most suitable host for parasitoid development (King et al. 1976).

The number of maggots per host had an adverse effect upon puparial weight. Ziser et al. (1977) found that the average puparial weight of *Eucelatoria spp.* decreased as number of maggots per host increased. Similar results were found for puparial weight of *L. diatraeae* (King et al. 1976). Miles and King (1975) observed that female *L. diatraeae* had longer maggot and puparial periods than their male counterparts; however in our study females differed from males only by having a longer puparial period. Mason et al. (1991) observed that older *Lydella thompsoni* (Herting) males tended to

mate with newly emerged females. Thus, it may be advantageous for males to have a shorter puparial period than females. This was also observed in the parasitoids *D. munda* (Chauthani & Hamm 1967) and *A. marmoratus* (Hughes 1975).

The information presented herein on the biology and development of *L. aletia*e may provide the basis for the consideration of this parasitoid as an environmentally safe tool for use in insect pest management. However, rearing in other hosts or under other rearing conditions should be investigated to further evaluate the potential for mass-rearing of this insect. Further experiments are needed to assess the effect of natural parasitism by *L. aletiae* on populations of *S. epilais* and the fall armyworm, and to evaluate the potential use of laboratory-reared *L. aletiae* for control of these and other pest lepidopterans.

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