

Influence of photoperiod on biology of *Apanteles militaris* (Hymenoptera: Braconidae)

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ABSTRACT

The effects of photoperiod on development time, longevity and progeny of *Apanteles militaris* (Hymenoptera: Braconidae) were investigated using *Mythimna unipuncta* (Lepidoptera: Noctuidae) as host. Three groups of parasitized host larvae were exposed to 15.5 ± 0.5 °C of temperature, 75 ± 0.5 of R.H. Each group was submitted to a different photoperiod: 8:16, 12:12 and 16:8 (L:D). Significant differences were found in the egg-larvae development time, pupal period and in the total development time. The adults longevity was higher and significantly different between 8:16 (L:D) and the others photoperiods. Concerning the progeny, the mean total and the mean number of cocoons per host did not differ significantly. However, the mean number of parasitoids that emerged from host larva but failed to spin a cocoon was significantly different between 8:16 and 16:8 (L:D). Length of photophase did not significantly affect parasitoid sex-ratio but the emergence of adult progeny was different between 8 and 16 hours light.

Key words: Insecta, *Apanteles*, *Mythimna*, photoperiod, lifetime, parasitic capacity, parasitism.

INTRODUCTION

Apanteles militaris (Walsh, 1861) is a gregarious braconid endoparasitoid wasp that mainly parasitizes the larvae of the pastures armyworm *Mythimna unipuncta* (Haworth), the most important pest in the Azorean Islands.

The responsiveness of insects to photoperiod in terms of specific effects on behaviour, grow and form, reproduction, diapause and distribution would seem to imply the existence of physiological functions associated with photoperiodism (BECK, 1968).

Most of research developed in this area aimed to study the influence of photoperiod in the induction of diapause (BRODEUR & McNEIL, 1989, 1990; PAWSON & PETERSEN, 1990; TISDALE & WAGNER, 1990; YONGGYUN &

KRAFSUR, 1994) since some insects exhibit a long-day response to photoperiod: long daylengths result in uninterrupted development whereas short daylengths induce diapause (TRIMBLE, 1994).

In this paper we describe the results of experiments designed to determine the role of photoperiod in the development time of *A. militaris*. Variables analysed were: adults longevity, progeny number, sex-ratio, adult emergence rates of the progeny and the possibility in the induction of overwintering diapause concerning the lower temperature used in this Study.

MATERIAL & METHODS

The *A. militaris* used in this experiment emerged from naturally parasitized *M. unipuncta* larvae, collected in pastures on S. Miguel Island. We used as hosts *M. unipuncta* larvae from laboratory cultures, established from field collected individuals.

On the third day after the parasitoid emergence, one isolated female parasitizes one isolated third instar larvae of *M. unipuncta*. After the first sting, hosts were removed from the parasitoid and individually kept in a plastic container (4.5 x 3 cm) with artificial diet (Poitout & Bues, 1970) without nipagin, until the parasitoids emergence.

After parasitism, three groups of parasitized host larvae were exposed to $15.5 \pm 0.5^\circ\text{C}$ of temperature, $75 \pm 0.5\%$ of R.H. Each group was submitted to a different photoperiod: L8:D16, L12:D12 and L16:D8.

Ten parameters were analysed: egg-larvae development time, pupal period and the total developmental time, the adults longevity, mean number of cocoons per host, mean number of parasitoids that emerged from host larva but failed to spin a cocoon, number of larval parasitoids that fail to emerge from each host, total number of larvae per host, parasitoid sex-ratio and, finally emergence of adult progeny.

Analysis were performed using ANOVA and SCHEFFÉ tests ($p < 0.05$). Data was compared by a discriminant factorial analysis. Data were transformed by $\sqrt{(x+0.5)}$ to stabilise the variances.

RESULTS & DISCUSSION

Photoperiod affected significantly the egg-larvae development time, that was greater at L12:D12 than at L8:D16 and L16:D8 (Table 1). The duration of the pupal period is also significantly different between L16:D8 and L12:D12, and between L16:D8 and L8:D16 (Table 1). Photoperiod also affected the total developmental time that was shorter at L16:D8 than in the others photoperiods. A increase in the total developmental time was observed at L8:D16 when compared with L16:D8. The same was verified between L12:D12 and the others photoperiods (Table 1).

Photoperiod hours light	N	D1 x ± sd	D2 x ± sd	D1+D2 x ± sd
16	44	29.25 ± 2.91 ^a	15.82 ± 1.45 ^{ab}	45.07 ± 3.00 ^a
12	41	39.20 ± 2.68 ^a	18.54 ± 0.93 ^a	57.73 ± 2.60 ^a
8	43	34.05 ± 3.30 ^a	18.51 ± 1.18 ^b	52.56 ± 2.96 ^a
F value		118.626	77.665	211.587
P value		<0.0001	<0.0001	<0.0001

Anova F and P values (p<0.05). ^{a,b} Scheffé test significant difference.

Table 1: Mean (±standard deviation) number of egg-larvae development time (D1), pupal period (D2) and the total developmental time (D1+D2) at three different photoperiods.

Adult longevity was very similar at the three different photoperiods: 6.8, 7.1 and 7.7 days at L16:D8, L12:D12 and L8:D16. The statistical analysis (Scheffé test, p<0.0001) demonstrated a significant difference between the adults longevity at L8:D16 and the others photoperiods.

The number of cocoons per parasitized hosts was superior at L16:D8 and decreased with decreasing daylength (Table 2).

Photoperiod hours light	N° cocoons /host x ± sd	Par. larva not pupated x ± sd	Par. larva not emerged x ± sd	Total larva x ± sd
16	56.36 ± 20.66	5.52 ± 10.83 ^a	3.21 ± 4.85	65.09 ± 19.13
12	53.83 ± 24.55	6.54 ± 9.98	1.22 ± 1.68	61.59 ± 22.29
8	52.58 ± 22.16	11.12 ± 12.73 ^a	3.54 ± 5.34	67.23 ± 20.27
F value	0.330	4.449	3.042	0.848
P value	0.7195	0.0136	0.0513	0.4308

Anova F and P values (p<0.05). ^a Scheffé test significant difference.

Table 2: Mean (±standard deviation) number of cocoons, the number of larvae that failed to spin a cocoon and that failed to emerge from the host, at three different photoperiods.

The mean number of *A. militaris* larvae that emerged but failed to spin a cocoon was minimum at L16:D8. It increased at L12:D12 and reached a maximum at L8:D16 (Table 2). A significant difference was found between L16:D8 and L8:D16.

The mean number of larvae that failed the emergence from the hosts did not differ significantly between the several photoperiods, varying from 1.2 larvae at L12:D12 and 3.5 larvae at L8:D16 (Table 2).

The number of larvae that achieved the third instar was calculated by the assemblage of the three previous parameters. The statistic analysis showed that different photoperiods did not influenced significantly this parameter (Table 2).

There were no significant differences for the observed values regarding the progeny sex-ratio. This last was more propitious to females when the length of the

light period was the same as the dark one (Table 3). The adult emergence rates varied between 87.7 % at L16:D8 and 77.5 % at L8:D16. At L12:D12 the adult emergence rate was 80.8 %. A significant difference was observed between L16:D8 and L8:D16. (Table 3).

Photoperiod hours light	N	Sex-ratio $\bar{x} \pm \text{sd}$	% Emergence $\bar{x} \pm \text{sd}$
16	44	0.35 ± 0.31	$87.67 \pm 13.20^*$
12	41	0.43 ± 0.33	80.83 ± 16.91
8	43	0.38 ± 0.32	$77.53 \pm 15.10^*$
F value		0.538	3.700
P value		0.5852	0.0275

Anova tests F and P values ($p < 0.05$).^a Scheffé test significant difference.

Table 3. *A. militaris* sex-ratios and adult emergence rates (with their respective standard deviations values) at three different photoperiods.

The discriminant factorial analysis (Figure 1), performed to compare the effect of the three different photoperiods upon eight study parameters (egg-larvae development time, pupal period, adults longevity, mean number of cocoons per host, mean number of parasitoids that emerged from host larva but failed to 5pm a cocoon, mean number of larvae that failed the emergence from the hosts, parasitoid sex-ratio and emergence of adult progeny), demonstrated that the population submitted to L16:D8 was separated from the population at L12:D12, while the population under L8:D16 superposed slightly the others two. If we eliminate from the analysis the egg-larvae development time and the pupal period, we observe that the former separation disappears, demonstrating that these two parameters are the most important for the differentiation (Figure 2).

The results of this study suggest that photoperiod can have a role in development time and in the adults emergence rates of *A. militaris* at 15°C. However, it can not be a regulating factor in the induction of diapause for this specie, because the adults that did not emerge had died. PAWSON & PETERSEN (1990) suggest that there are several reasons why diapause may not have occurred: first, *A. militaris* may not have the genes that regulate diapause; second, temperature may have negated photoperiod effects; third, the adult wasps may not have been on the correct age to receive the stimulus or a specific photoperiod may be required over several days to induce diapause.

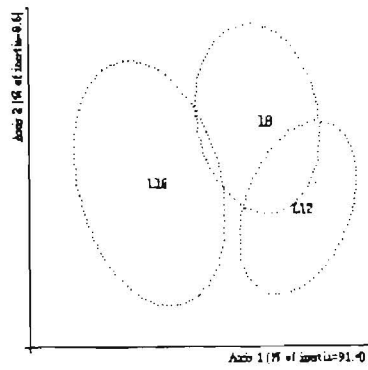


Figure 1 The discriminant factorial analysis effectuated with 8 biological parameters of *A. militaris* (egg-larvae development time, pupal period, adults longevity, mean number of cocoons per host, mean number of parasitoids that emerged from host larva but failed to spin a cocoon, mean number of larvae that failed the emergence from the hosts, parasitoid sex-ratio and emergence of adult progeny) for 3 different photoperiods. Ellipses with 95 % of the observations.

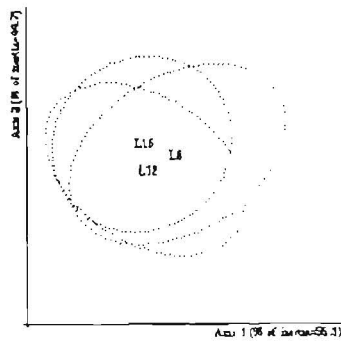


Figure 2 The discriminant factorial analysis effectuated with 5 biological parameters of *A. militaris* (mean number of cocoons per host, mean number of parasitoids that emerged from host larva but failed to spin a cocoon, mean number of larvae that failed the emergence from the hosts, parasitoid sex-ratio and emergence of adult progeny) for 3 different photoperiods. Ellipses with 95 % of the observations.

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