BIOLOGICAL CONTROL

Biology of *Microplitis mediator* Haliday (Hymenoptera: Braconidae) Parasitizing the Wheat Armyworm *Mythimna* (*Pseudaletia*) *sequax* Franclemont (Lepidoptera: Noctuidae)

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Biologia de *Microplitis mediator* Haliday (Hymenoptera: Braconidae) Parasitando a Lagarta do Trigo *Mythimna* (*Pseudaletia*) *sequax* Franclemont (Lepidoptera: Noctuidae)

RESUMO - O endoparasitóide larval *Microplitis mediator* Haliday é descrito pela primeira vez na Região Neotropical, parasitando a lagarta do trigo *Mythimna* (*Pseudaletia*) *sequax* Franclemont. Fêmeas parasitaram com sucesso hospedeiros do primeiro ao quarto instar, com preferência pelo segundo e terceiro instares. Parasitóides não emergiram de lagartas de quinto e sexto instares ofertadas para o parasitismo. O desenvolvimento de *M. mediator* foi determinado em quatro temperaturas constantes entre 15ºC e 30ºC. A duração dos estágios de ovo-larva variou entre 32,3 dias e 15ºC e 8,0 dias a 30ºC. A duração do estágio pupal foi entre 24,3 e 5,1 dias, a 15ºC e 30ºC respectivamente. O desenvolvimento do parasitóide da oviposição ao estágio adulto requereu o total de 251,3 graus-dia, acima da temperatura-base de 10,3ºC. A 20ºC, a longevidade das fêmeas mantidas em atividade de oviposição (16,8 ± 1,81 dias) foi significativamente menor em comparação a fêmeas mantidas na ausência de hospedeiros (29,7 ± 1,83 dias). Fêmeas do parasitóide permaneceram ativas reprodutivamente até um dia antes da morte, e parasitaram em média 60,6 ± 8,40 hospedeiros de segundo instar durante a vida, com a média de 3,9 lagartas parasitadas por dia.

PALAVRAS-CHAVE: Insecta, endoparasitóide, exigência térmica, controle biológico

ABSTRACT - The larval endoparasitoid *Microplitis mediator* Haliday is described for the first time in the Neotropical Region, parasitizing the wheat armyworm *Mythimna* (*Pseudaletia*) *sequax* Franclemont. Females successfully parasitized the four first instars of the host, with a significant preference for the second and third, in relation to either the first or fourth instars. No parasitoids emerged from caterpillars parasitized in the fifth and sixth instars. Development of *M. mediator* was determined at four constant temperatures between 15°C and 30°C. The duration of the egg-larval stages varied from 32.3 days at 15°C to 8.0 days at 30°C. The pupal stage lasted 24.3 and 5.1 days at 15°C and 30°C, respectively. Development of the parasitoid from oviposition to adult emergence required the total of 251.3 degree-days (DD) above the threshold of 10.3ºC. At 20°C, longevity of females was significantly shorter when kept in oviposition activity (16.8 ± 1.81 days) in comparison to females kept without hosts (29.7 ± 1.83 days). Parasitoid females remained reproductively active until one day before death, and parasitized an average of 60.6 ± 8.40 second instar hosts during their adult life, with an average of 3.9 parasitized caterpillars/day.

KEY WORDS: Insecta, endoparasitoid, thermal requirement, biological control

The solitary larval endoparasitoid *Microplitis mediator* Haliday is a palaeartic species, distributed from Central Europe to China (Arhur & Mason 1986). In the early 1990's it was introduced in Canada for the control of the armyworm *Mamestra configurata* Walker, a pest of rapeseed and canola crops (Mason *et al*. 1998). Field surveys conducted in 1996 on wheat in Southern Paraná State, Brazil resulted in the capture of *Mythimna* (*Pseudaletia*) *sequax* Franclemont larvae parasitized by *M. mediator*. In Southern Brazil, the larval stage of *M. sequax* hosts more than ten species of dipterous and hymenopterous parasitoids (Gassen 1986), of which only *Glyptapanteles muesebecki* (Blanchard) (Hymenoptera: Braconidae) and *Euplectrus ronnai* (Brèthes) (Hymenoptera: Eulophidae) have been investigated (Doetzer & Foerster 1998; Yamamoto *et al*. 1998; Foerster *et al*. 1999a, b). Data on the biology of *M. mediator* are given by Tanaka

et al. (1984) on larvae of *Leucania separata* (Walker) and by Arthur & Mason (1986) on *M. configurata*. Due to the lack of knowledge on the subject, we report results on the development of *M. mediator* in relation to temperature, host instar preference and adult longevity and reproduction, when the parasitoid was reared on larvae of *M. sequax*.

Material and Methods

A culture of *M. mediator* was established in laboratory from parasitized larvae of *M. sequax* collected on a wheat crop in Lapa, PR, Brazil. Parasitoids were maintained in the laboratory on the same host at 20 ± 1ºC, 65 ± 5% RH and a photophase of 12h. Host larvae were reared individually and fed with kicuyo grass *Pennisetum clandestinum* Hochts. (Foerster 1996), at similar climatic conditions as for the parasitoids.

To determine the host instar range of *M. mediator*, two-day old mated females of the parasitoid were exposed for 6h to 18 host larvae in a 14-cm diameter petri dish. Each dish contained three *M. sequax* larvae from first to sixth instar and one female parasitoid. The free-choice tests were conducted in a climatic chamber at 20°C, photophase of 12h and were repeated 10 times. After the exposure period, the females were removed and the larvae reared individually in 80 ml polythene flasks and fed with kicuyo grass. The number of parasitized caterpillars in each instar was recorded and the results were submitted to analysis of variance. Differences in the proportion of parasitized hosts in relation to the instars were compared by Tukey's test ($P < 0.05$).

The effect of temperature on the developmental time of *M. mediator* was determined from oviposition to pupation and from pupation to adult emergence at the temperatures of 15º, 20º, 25º and 30ºC ± 1ºC and photoperiod of 12h. Second instar hosts were individually exposed to mated females of the parasitoid at each temperature for 1h. After this period, the female was removed and the larvae were reared as described by Foerster (1996). The lower threshold temperature (T_o) and the thermal constant (K) in degree-days above T_o were calculated for egg+larvae, pupae, and total immature stages by the linear regression equation $Y = a + bX$, where "Y" is the reciprocal of the developmental time (days) and "X" is the temperature in ºC (Campbell *et al*. 1974).

Adult longevity and age-specific oviposition rate of *M. mediator* females were determined at 20ºC. Longevity was evaluated both in the presence and absence of hosts; a total of 27 newly emerged couples were maintained separately in 2 x 10 cm test tubes and fed with undiluted honey streaked on the wall of the tubes. In one of the treatments (n = 17) longevity of males and females was recorded without the exposure of hosts to the parasitoids, and in the other treatment (n = 10) 15 second instar *M. sequax* larvae were offered each day to the parasitoids, from adult emergence until the death of the female. After 24h of exposition, the caterpillars were removed and a new batch of hosts was introduced into the tubes. After the exposition period, the caterpillars were reared individually as described to determine the number of parasitized hosts at each day. The longevity of males and females in both treatments was compared by the 't' test for differences between means ($P < 0.05$).

Voucher specimens of *M. mediator* are deposited in the entomological collection "Padre Jesus Santiago Moure", Departamento de Zoologia, Universidade Federal do Paraná, Brazil.

Results and Discussion

Females of *M. mediator* successfully parasitized first to fourth instar *M. sequax* larvae, as observed by Tanaka *et al*. (1984) for the same species parasitizing *L. separata*. On larvae of *M. configurata*, successful parasitism by *M. mediator* occurred only in the first three instars (Arthur & Mason 1986). A significant preference for second and third instar hosts was recorded in free-choice tests in relation to the first and fourth instars (Fig. 1). Fifth and sixth instar hosts failed to produce parasitoids; however no attempts were made to determine whether females oviposited in such hosts.

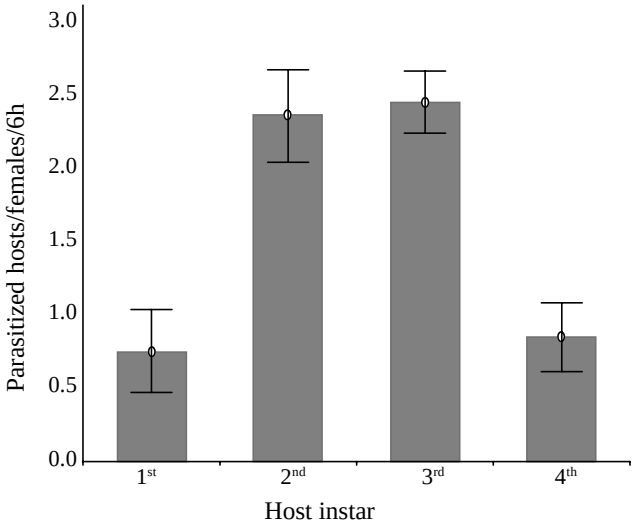

Figure 1. Host instar preference of *M. mediator* in free-choice tests. (Mean number ± SE of parasitized *M. sequax* larvae in each instar).

Unlike parasitism by *E. ronnai* (Yamamoto *et al*. 1998), another larval parasitoid of *M. sequax*, caterpillars parasitized by *M. mediator* continued to molt, and a single parasitoid larva emerged from the host to pupate, before the host completed the larval stage.

Time of development of the egg+larval stages ranged from 8.0 to 32.3 days at 30ºC and 15ºC, respectively (Table 1). The pupal stage of *M. mediator* lasted 5.1 days at 30ºC and 24.3 days at 15ºC, and total development from oviposition to adult emergence ranged from 13.1 days to 56.6 days at 30ºC and 15ºC, respectively (Table 1).

The internal stages of *M. mediator* were more cold tolerant (T_o = 9.9ºC) than the pupal stage (T_o = 10.8ºC), and development from oviposition to adult emergence required a total of 251.3 DD above a lower threshold of 10.3ºC (Table 2). Compared to other hymenopterous parasitoids of *M. sequax*, the rate of development of *M. mediator* is faster than

Table 1. Developmental time (mean ± SE) of the immature stages of *M. mediator* at different temperatures.

Temperature (ºC)	N	Duration (days)		
		Egg+larva	Pupa	Total
15	28	32.3 ± 0.21a	24.3 ± 0.18a	56.6 ± 0.26a
20	28	15.2 ± 0.15b	10.4 ± 0.12b	25.6 ± 0.11b
25	31	10.0 ± 0.05c	6.1 ± 0.05c	16.1 ± 0.07c
30	8	8.0 ± 0.00d	5.1 ± 0.14d	13.1 ± 0.14d

Means followed by the same letter in the columns do not differ by Tukey's test (P < 0.05).

that of *G. muesebecki*, which requires 397.4 DD to reach the adult stage (Foerster *et al*. 1999b), and slower than *E. ronnai*, which completes its development in 211.4 DD (Yamamoto *et al*. 1998).

The longevity of female *M. mediator* at 20ºC was significantly shorter when in oviposition activity (mean of 16.8 days) in comparison to those not exposed to hosts (29.7 days). Males were significantly shorter lived than females in the absence of hosts, but lived longer than females in activity of oviposition (Table 3). Similar results were reported by Browning & Oatman (1985) for *Microplitis brassicae* Muesebeck, which attributed the shortened longevity of females exposed to hosts to the expenditure of energy in searching and oviposition and to injury due to host defensive reaction.

Females remained reproductively active until one day before death, and only after the eight day following emergence the daily oviposition rate decreased significantly in relation to the initial eight days (Fig. 2). On average, females parasitized almost four hosts/day and more than 60 caterpillars were parasitized during the lifetime of the females (Table 3). Browning & Oatman (1985) recorded for *M. brassicae* an average of 73.2 progeny per female at 21.1ºC during a lifetime of 19.0 days in the presence of hosts. The capacity of parasitism by *M. mediator* is ca. three times higher than that of *G. muesebecki*, a gregarious endoparasitoid of *M. sequax* in Brazil, which at 21ºC parasitized an average of 20.8 caterpillars during the female lifetime (Foerster *et al*. 1999a).

Table 2. Temperature-dependent mean rate of development and thermal requirements for the immature stages and for total development from oviposition to adult emergence of *M. mediator* parasitizing the armyworm *M. sequax.*

Stage	Regression of rate of development on temperature	r^2	Thermal requirements	
			Lower threshold (ºC ± SE)	Degree-days (± SE)
Egg+larval	Y = - 0.066590 + 0.006587X	0.99	9.9 ± 0.09	157.4 ± 1.64
Pupal	Y = - 0.129763 + 0.011458X	0.98	10.8 ± 0.09	94.5 ± 1.58
Total cycle	Y = - 0.044833 + 0.004205X	0.99	10.3 ± 0.02	251.3 ± 2.71

Table 3. Mean daily and total fecundity of *M. mediator* parasitizing second instar *M. sequax* and longevity (days) of males and females in the presence or absence of hosts.

Parameter	Mean ± SE	Interval
Total progeny production	60.6 ± 8.40	30 – 105
Number of parasitized hosts/day	3.9 ± 0.58	1.7 – 7.5
Female longevity in activity of oviposition	16.8 ± 1.81c	9 – 28
Female longevity without hosts	29.7 ± 1.83a	17 – 45
Male longevity	22.9 ± 1.68b	11 – 36

Means of longevity followed by the same letter do not differ by Student's 't' test (P < 0.05).

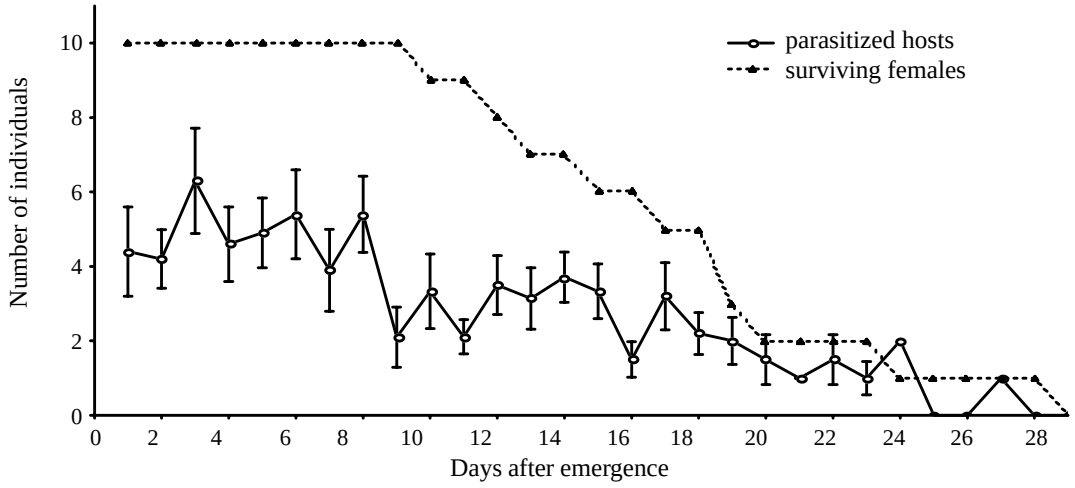

Figure 2. Daily mean number ± SE of second instar *M. sequax* parasitized and daily survival of female *M. mediator*.

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