EFFECT OF TEMPERATURE ON THE DEVELOPMENT AND VIABILITY OF *Gryon gallardoi* (BRETHES) (HYMENOPTERA: SCELIONIDAE) PARASITIZING *Spartocera dentiventris* (BERG) (HEMIPTERA: COREIDAE) EGGS

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(With 2 figures)

ABSTRACT

The development and viability of *Gryon gallardoi* (Brethes) (Hym.: Scelionidae) in *Spartocera dentiventris* (Berg) (Hem.: Coreidae) eggs were studied under four temperatures: 15, 20, 25, and 30 ± 1°C, with a 12-h photophase. No parasitoid developed at 15°C. Otherwise, viability reached 98.8% without varying significantly over the temperature range tested. The duration of development for males and females was inversely proportional to the temperature increase, varying respectively from 46.2 ± 0.13 and 47.1 ± 0.11 days (20°C) to 13.3 ± 0.07 and 13.4 ± 0.06 days (30°C). Males developed faster than females. The values estimated for the lowest thermic thresholds of development and the thermic constants were 15.5°C and 185.19 DD for males and 15.6°C and 192.31 DD for females, respectively. Given the average weather conditions in Porto Alegre, RS (30°01'S and 51°13'W), Brazil, *G. gallardoi* could annually produce 8.54 and 8.07 generations of males and females, respectively. The low rates of parasitism observed in the field during the first generation of its host may be due to the small number of *G. gallardoi* generations in this period.

Key words: insecta, tobacco, gray-tobacco-bug, parasitoid, thermal requirements.

RESUMO

O efeito da temperatura no desenvolvimento e na viabilidade de *Gryon gallardoi* (Brethes) (hym.: scelionidae) parasitando ovos de *Spartocera dentiventris* (Berg) (Hem.: coreidae)

Foram avaliados o desenvolvimento e a viabilidade de *Gryon gallardoi* (Brethes) (Hym.: Scelionidae) em ovos de *Spartocera dentiventris* (Berg) (Hem.: Coreidae) sob 4 temperaturas constantes: 15, 20, 25 e 30 ± 1°C e fotofase de 12 h. Nenhum parasitóide desenvolveu-se à 15°C. A viabilidade dos parasitóides na faixa de 20 a 30°C não diferiu significativamente, alcançando 98,8%. O tempo de desenvolvimento ovo-adulto de machos e fêmeas foi inversamente proporcional ao aumento da temperatura, variando, respectivamente, de 46,2 ± 0,13 e 47,1 ± 0,11 dias (20°C) a 13,3 ± 0,07 e 13,4 ± 0,06 dias (30°C). Os machos apresentaram período médio de desenvolvimento significativamente mais curto que as fêmeas. Os valores estimados para o limite térmico inferior de desenvolvimento e para a constante térmica foram 15,5°C e 185,19 GD para machos e 15,6°C e 192,31 GD para fêmeas. Dadas as médias climáticas de Porto Alegre (30°01'S e 51°13'O), RS, Brasil, *G. gallardoi* poderia apresentar 8,54 e 8,07 gerações anuais de machos e fêmeas, respectivamente. Sugere-se que as baixas taxas de parasitismo observadas em campo na primeira geração do percevejo resultem do número reduzido de gerações do parasitóide nesse período.

Palavras-chave: insecta, fumo, percevejo-cinzento-do-fumo, parasitóide, exigências térmicas.

INTRODUTION

The gray-tobacco-bug, *Spartocera dentiventris* (Berg) (Hemiptera: Coreidae), is a species potentially harmful to tobacco crops in Rio Grande do Sul, since it may cause leaves to wither and curl up (Parseval, 1937; Costa, 1941; Schaefer & Panizzi, 2000). In spite of their high reproductive potential (Caldas *et al.*, 1999), populations of this bug under field conditions are drastically reduced by various environmental factors (Canto-Silva, 1999). Among these, parasitoid action causes significant loss in the egg stage. *Gryon gallardoi* (Brethes) (Hymenoptera: Scelionidae) is the main parasitoid species (Santos *et al.*, 2001) and was first reported for Brazil in eggs of *Spartocera lativentris*, a coreid which attacks various cultivated and non-cultivated plants (Loiacono, 1980; Becker & Prato, 1982). The species is also cited as a parasitoid of eggs of the coreid *Leptoglossus zonatus* (Dallas), a significant pest in citrus and corn in southeast Brazil (De-Souza & Amaral-Filho, 1999). Despite the importance of these crops, little is known about *G. gallardoi*. Studies on its biology and ecology are fundamental in evaluating the potential that this species may have as a biological control agent.

One study showed that two generations of *S. dentiventris* develop during the tobacco cycle: the first from the end of August to December, and the second from the end of December to February (Jesus & Romanowski, 2001). Parasitism occurs in eggs of both generations, but the rate is low during the first generation (Canto-Silva, 1999). There are many factors that may determine the levels of parasitism observed in the field; however, as emphasized by Doutt *et al.* (1976), settlement of entomophagus insects is largely influenced by the effect of temperature on developing individuals. Thus, the understanding of interaction dynamics in the field involves evaluating thermic requirements by the developing organisms. This knowledge is a fundamental element in building populational models (Powell *et al.*, 1981).

Thermic requirements have been determined for a number of Scelionidae parasitoids (James & Warren, 1991; Cividanes & Figueiredo, 1996; Torres *et al.*, 1997). However, information of this nature is still rare for the genus *Gryon* (Nechols *et al.*, 1989), and non-existent for *G. gallardoi*. Thus, this study was proposed to investigate the viability and development time of *G. gallardoi* from eggs of *S. dentiventris* under various constant temperatures to estimate the lower thermic limit for development (t_o), the thermic constant (K), and the number of generations monthly and yearly possible for this species under the temperature conditions prevailing in Porto Alegre, RS, Brazil.

MATERIAL AND METHODS

The present study was carried out in the Departamento de Fitossanidade, Faculdade de Agronomia, Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre (30°01'S and 51°13'W), RS, Brazil, from November 2000 to February 2001. *G. gallardoi* individuals were obtained from *S. dentiventris*-parasitized eggs collected from tobacco areas in Venâncio Aires (29°60'S and 52°19'W), RS, where the species occurs abundantly.

After emergence and identification of the parasitoids, they were reared in the laboratory in 500 ml transparent plastic bottles, containing *S. dentiventris* eggs, and sealed with cotton. These bottles were kept horizontally at 25 ± 1ºC, with a 12-hour photophase. The parasitoids were fed *ad libitum* on a 10% aqueous honey solution daily.

Non-parasited *S. dentiventris* eggs were obtained from an experimental crop grown close to the laboratory. *S. dentiventris* females were kept in the tobacco plants within voile cages that impeded access by parasitoids. Groups of less than 24-hour-old eggs were collected daily together with the part of the plant (leaf, stem) in which they were laid. These were then placed in the breeding bottles and exposed to parasites at 25 ± 1°C for ca. 15 hours. After this period, the eggs were transferred to Petri dishes and reared at one of the following temperatures: 15, 20, 25, and 30 ± 1°C, with a 12 h photophase. Parasitized eggs differed from eggs with normal bug embrionic development (Caldas *et al.*, 1999), by becoming darker after a few days (Santos *et al.*, 2001). Parasitoid viability was only estimated from eggs old enough to evidence parasitism. Therefore, replications amounted to about 340 parasited eggs for each temperature. Parasitoid emergence was checked daily and individuals were sexed based on antennae dimorphism (Loiacono, 1980).

The lower thermic limit of development (t_o) and the thermic constant (K) were estimated by the hyperbole method (Haddad & Parra, 1984). The possible number of generations per month was calculated by taking the estimates for thermic requiriments (t_o e K) and the total of degrees-day (DD) during the considered period, using the formula adapted from Torres *et al*. (1997): NG = [T (t_c – t_o)]/K, where NG = number of generations, T = period considered (30 days), and t_c = monthly average temperatures from 1991 to 2000 in Porto Alegre, RS. The number of generations per year was obtained by adding the estimates per month.

Differences in the observed length of development for males and females were assessed by ANOVA and the Tukey test. The viability at different temperatures was compared by goodness of fit to the chi-square distribution.

RESULTS AND DISCUSSION

No parasitoid developed at 15°C. Eggs presumably parasitized were kept at this temperature for as long as 90 days and neither darkening in color nor eclosion of *S. dentiventris* nymphs was ever observed. The viability of the development of *G. gallardoi* egg-adults in a range from 20 to 30ºC was virtually total, reaching up to 98.8% at 20ºC (Table 1). Only a very slight decrease was observed with the increase of temperature, but this was not significant (χ^2 = 4.1127; df = 2; p = 0.1279; Table 1). Similar results were obtained by Corrêa-Ferreira & Moscardi (1994), who recorded approximately 100% viability for Scelionidae *Trissolcus basalis* (Woll.) parasitizing eggs of the pentatomid *Nezara viridula* (L.) at temperatures from 18 to 30ºC in southern Brazil and by Torres *et al.* (1997) who reported approximately 90% viability for the scelionids *Trissolcus brochymenae* (Ashmead) and *Telenomus podisi* Ashmead parasitizing eggs of the pentatomid *Podisus nigrispinus* (Dallas) in Minas Gerais, Brazil, in ranges from 17 to 32ºC and 20º and 28ºC, respectively. On the other hand, in a study about parasitoids of the coreid *Anasa tristis* DeGeer in the central part of the USA, Nechols *et al.* (1989) observed a viability of only 36% for *Gryon pennsylvanicum* (Ashmead) at 18.3ºC and over 80% in the range from 21.1 to 29.4°C. In the southeastern USA, Yergan (1980) reported no male and only 43.5% of the females of *T. podisi* parasitizing eggs of the pentatomidae *Podisus maculiventris* (Say) emerged at 15.5ºC.

The length of development of *G. gallardoi* in *S. dentiventris* eggs significantly diminished with temperature increase (p > 0.05; Fig. 1). The average length of development from egg to adult for males and females varied respectively from 13.3 ± 0.07 and 13.4 ± 0.06 days (30ºC) to 46.2 ± 0.13 and 47.1 ± 0.11 days (20ºC) (Table 1). Females bred at 25ºC presented an average development period 5.7 days longer than that at 30ºC, while a decrease of 5ºC more in temperature (20°C) resulted in an average development period of about 28 days longer (Table 1). There was a sharp decrease in the rate of development at temperatures below 25ºC (Fig. 1). Males presented development periods significantly shorter than those of females at all temperatures above 15°C (p > 0.05; Table 1).

TABLE 1

Mean development length (days) and viability (%) of *Gryon gallardoi* on *Spartocera dentiventris* egg at different temperatures.

Temperature (°C)	Mean length of development (days) ± S.E.		% viability (n)
	Male (n)	Female (n)	
15	–	–	0.0 (300)
20	46.2 ± 0.13 Aa (190)	47.1 ± 0.11 Ab (146)	98.81 (340)
25	18.6 ± 0.07 Ba (101)	19.1 ± 0.05 Bb (231)	97.41 (341)
30	13.3 ± 0.07 Ca (110)	13.4 ± 0.06 Cb (214)	96.41 (336)

Values followed by same capital letter within columns and lower case within lines are not significantly different (p < 0.05; Tukey test). [1]Values are not significantly different (χ^2 = 4.1127; df = 2; p = 0.1279).

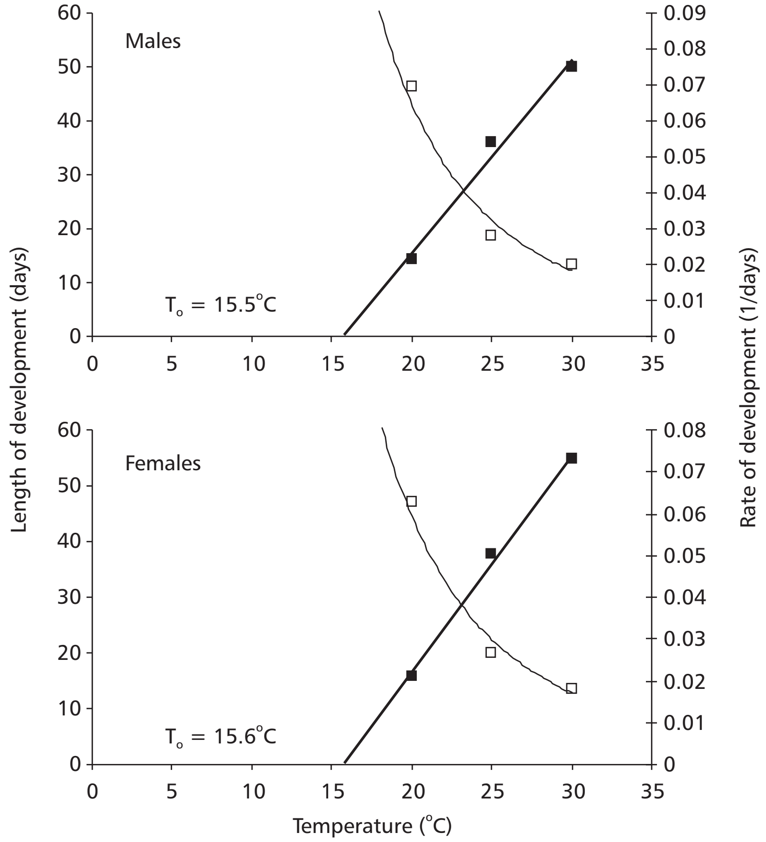

Fig. 1 — Relationship between length of development (open squares), developmental rate (black squares), and temperature for immature stage of *Gryon gallardoi* parasitizing *Spartocera dentiventris* eggs. (T_o= lower threshold temperature.)

More than 98% of the decrease observed for male and female rates of development could be explained by the temperature increase (Table 2). The lower thermic thresholds for development and the thermic constants estimated were 15.5°C and 185.19 DD for males and 15.6°C and 192.31 DD for females respectively (Table 2). The fact that parasitized eggs bred at 15ºC did not change color indicates a halt in the initial development phase, corroborating the estimated t_o values.

The estimated lower thermic thresholds of development for *G. gallardoi* may be considered high when compared to those reported for other Scelionidae species. *G. pennsylvanicum* in *A. tristis* eggs in the northeastern United States (Nechols *et al.*, 1989) and *Trissolcus oenone* Dodd in the *Biprorulus bibax* Breddin in southern Australia (James & Warren, 1991) both showed a value of 12.4ºC as the basal temperature for development. These values are similar to that of 15ºC obtained for scelionids *Telenomus chloropus* Thomson and *T. basalis* em *N. viridula* in Louisiana (USA) and closely approximate the values of 14.1ºC and 13.2ºC obtained by Cividanes & Figueiredo (1996) for *T. brochymenae* and *T. podisi*, respectively, in *Piezodorus guildinii* (West.) eggs in southeastern Brazil and 14.1ºC obtained for *Telonomus reynoldsi* Gordh & Coker in *Geocoris punctipes* (Say) (Heteroptera; Lygaeidae) eggs in the southern USA (Cave & Gaylor, 1988).

TABLE 2

Lower threshold temperature, thermal requirement and regression equation of *Gryon gallardoi* male and female development parasitizing *Spartocera dentiventris* egg.

Sex	Lower threshold temperature (°C)	Thermal requirement (DD)	Regression equation	r2	p
Male	15.5	185.19	1/D = –0.0837 + 0.0054T	0.987	0.07
Female	15.6	192.31	1/D = –0.0812 + 0.0052T	0.995	0.04

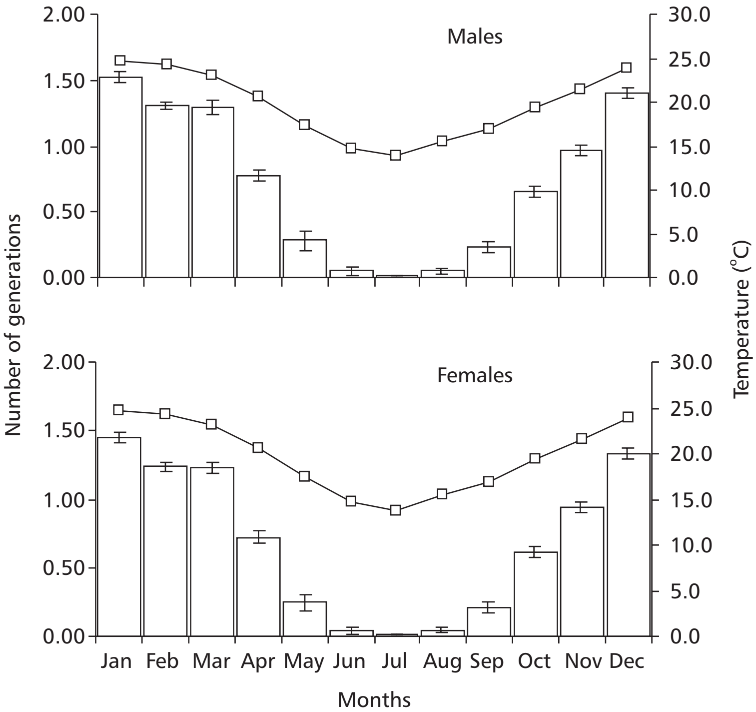

Fig. 2 — Estimated number of generations per month (blocks) of *Gryon gallardoi* parasitizing *Spartocera dentiventris* eggs and monthly average temperatures (line) in Porto Alegre (30°01'S and 51°13'W), RS, Brazil.

The values calculated for the thermic constant (K) for *G. gallardoi* development resulted in values close to those estimated for *T. brochymenae* and *T. podisi*, in *P. guildinii*: 199.1 and 150.7 DD, respectively (Cividanes & Figueiredo, 1996). In studies made in the Brazilian southwest for the same parasitoid species, Torres *et al.* (1997) also obtained similar values for *P. nigrispinus*: 189.2 and 214.7 DD, and 177.6 and 205.3 DD for males and females, respectively. However, they are below that obtained for *G. pennsylvanicum*: 281 DD (Nechols *et al.*, 1989). The values of t_o and K associated with the high survival rate observed for *G. gallardoi* at all temperatures suggest that the species may be adapted to high temperature environments, typical of tropical regions.

Extrapolating from the average temperatures per month in Porto Alegre over the last 10 years, *G. gallardoi* could develop 8.54 and 8.07 annual generations of males and females, respectively. The possible number of generations per month estimated for both sexes is presented in Fig. 2. This figure indicates that in winter (May to July) temperature can be a limiting factor in parasitoid development, which suggests a diapause strategy in this species. Considering the initial infestation period of tobacco by *S. dentiventris* (from August on), only in November the temperatures would be high enough for the first generation of parasitoids to develop, thus explaining the low rates of parasitism observed in the field in this bug's first generation (Canto-Silva, 1999). On the other hand, the estimated number of parasitoid generations (approximately 7) during the tobacco cycle is much higher than that observed for the bug (2 generations), which would increase parasitism efficiency. It must be emphasized that following the end of the tobacco cycle, which occurs in March, prevailing temperature conditions do not as yet limit the development of additional generations of bugs. This suggests that other plants might be used to favor continuity in the host-parasitoid interaction.

In conclusion, *G. gallardoi* seems to have great potential for controlling populations of *S. dentiventris* because of the great number of generations it can develop per season as well as its high viability at the various temperatures studied. However, its susceptibility to low temperatures (high threshold of lower development) may be a limiting factor in cold-climate regions.

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