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EVALUATION OF FIELD PARASITISM BY *TRICHOPODA GIACOMELLII* (BLANCH.) GUIMARÃES, 1971 (DIPTERA: TACHINIDAE) ON *NEZARA VIRIDULA* (L.) 1758 (HEMIPTERA: PENTATOMIDAE)[1]

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ABSTRACT

Natural parasitism of adult southern green stink bug *Nezara viridula* (L.) 1758 by *Trichopoda giacomellii* (Blanch.) Guimaraes, 1971, was evaluated in the field. Percentage parasitism and parasitoid egg distribution on the host, were assessed on various host plants in a 3-year study. Validity of parasitoid egg presence on the host surface as an indicator of parasitism was also studied.

Parasitism percentage was higher for *N. viridula* males than for females. This trend was consistent over a variety of host plants.

Mean numbers of parasitoid eggs and larvae were similar on both males and females of *N. viridula*. Supernumerary oviposition by *T. giacomellii* was common on both sexes.

Rates of parasitism varied among different host plants and among years.

Parasitoid egg presence on the host surface was shown to be a valid indicator of parasitism of *N. viridula* by *T. giacomellii*.

RESUMEN

Se evaluó en campo el parasitismo natural de la chinche verde común *Nezara viridula* (L.) 1758 por *Trichopoda giacomellii* (Blanch.) Guimarães, 1971. Durante tres años de estudio en diferentes cultivos se determinó el porcentaje de parasitismo y la distribución de huevos del parasitoide sobre el hospedante. También se estudió la validez de la presencia del huevo del parasitoide sobre la superficie del hospedante como indicador de parasitismo.

El porcentaje de parasitismo fue mayor en machos de *N. viridula* que en hembras. Esta tendencia se manifestó en varios cultivos.

El número medio de huevos y larvas parasitoides fue similar en machos y hembras de *N. viridula*. La oviposición supernumeraria por *T. giacomellii* fue común en ambos sexos.

Las tasas de parasitismo variaron entre los diferentes cultivos y entre años.

La presencia del huevo parasitoide sobre la superficie del hospedante resultó ser un indicador válido de parasitismo.

INTRODUCTION

Trichopoda giacomellii (Blanch.) Guimaraes, 1971, is a natural parasitoid on the adult southern green stink bug, *Nezara viridula* (L.) 1758 in Argentine. In the absence of adults it parasites nymphs of 4^{th} and 5^{th} instars.

Trichopoda deposits its eggs on the body surface of the bug. Although eggs may be deposited on almost any part of the host, including the appendages, wings, eyes, etc., they are placed predominantly either dorsally or ventrally, on the prothoracic margin (La Porta, 1987). After hatching, the larva penetrates into the host and feeds on the internal organs and body fluids of the host. Supernumerary oviposition is common although only one larva develops within the body of the host. At maturity the larva forces its way out at the posterior end of the bug. The host dies within

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a day or two after the emergence of the parasitoid. The parasitoid then pupates in the soil.

Biology and behavior of *T. giacomellii* are similar to the better known and widely distributed *Trichopoda pennipes* Fabricius. Worthley (1924), Shahjahan (1968a, b) and Mitchell & Mau (1971) studied the biology and behavior of *T. pennipes* and Todd & Lewis (1976) determined its incidence on *N. viridula* populations. Numerous attempts on biological control of *N. viridula* have been made with artificially propagated and released adults of *T. pennipes*. Results have generally been favourable but not spectacular (De Bach, 1962; Davis, 1964; 1967).

In Argentine, Liljesthröm (1980), La Porta & Crouzel (1984) and LaPorta (1987) studied biological aspects of *T. giacomellii*, but little information (Molinari *et al.*, 1987) is available in the literature on the impact of this parasite as a natural control agent for *N. viridula*.

Theses studies were conducted to evaluate *T. giacomellii* parasitism on *N. viridula* populations in the field and on different host plants. On the other hand, the validity of estimating percentage parasitism using parasitoid egg presence as an indicator was assessed.

MATERIALS AND METHODS

Adults of *N. viridula* were manually collected from several host plants in different places during 1982, 1983 and 1984. The adult bugs were brought to the laboratory and placed in 33 × 33 × 33 cm cages, made of plastic mesh (0.2 mm #) over a wooden frame. Insects were provided with fresh fruits of *Phaseolus vulgaris* (L.), changed every 48 hours. Dead bugs and emerged parasitoids were removed from the cages daily until all insects died.

Each individual was sexed, examined for the presence of *T. giacomellii* eggs on the tegument, dissected and examined internally for the presence of parasitoid larvae. In every instance the following data were taken concerning each group: date of collection, host plant, total number of individuals of each sex, total numbers of parasitized and non-parasitized individuals of each sex, number of parasitoid eggs per host and number of parasitoid larvae per host. A 't' test was conducted for each variable to determine whether differences existed between males and females. The percentage of insects with parasitoid eggs and the mean number of eggs per host were determined for each sex and for each crop. A 't' test was conducted on males, females, and males plus females collected from different crops to determine if differences existed between rate of parasitism and mean number of eggs per host. The percentage of parasitism was analyzed by Chi-square test (X^2).

Dissected *N. viridula* were examined under a binocular microscope. The classification into truly parasitized or not parasitized was based on the presence of the tracheal funnel, a sclerotized structure which adheres to the host's tracheal trunk and surrounds the posterior end of the larva during the parasitism period. Absence of a tracheal funnel is usually sufficient evidence for absence of parasitism. Other signs taken into consideration were: larvae's presence or their remainders (cephalopharyngeal skeletons); abdomen with empty appearance due to reduction of fat bodies and internal organs. Externally, a black stain in the genital region and genital sclerites distorted (specially in males) are also indicators of parasitism; both characteristics being produced by the larva emergency.

The validity of estimating percentage parasitism of *N. viridula* by *T. giacomellii*, by using the presence or absence of parasitoid eggs was determined by procedures described by Harris & Todd (1981) for *T. pennipes*. Apparent parasitism (determined by egg presence/absence) and actual parasitism (determined by dissection) were compared and the frecuency of right/wrong designations was established. Data were analyzed by Chi-square test.

During the studies the laboratory conditions were maintained at 26° ± 2°C; 70% ± 10% R.H., and a 16 h photophase.

RESULTS AND DISCUSSION

Table 1 summarizes male and female bug collections and percent parasitism by *T. giacomellii* on several host plants in 1982-84. Parasitism percentage on male bugs was higher (42.1%) than on females bugs (30.1%), except on soybean, *Glycine max* (L.) Merril, where the difference between sexes was not significant ($P>0.01$). Similar data were obtained by Mit-

TABLE 1
PARASITISM OF *NEZARA VIRIDULA* BY *TRICHOPODA GIACOMELLII* ON VARIOUS ALTERNATE HOSTS

Location	Collection date	Host crop	N° bugs collected			% parasitism		X^2(a)
			Total	♂♂	♀♀	♂♂	♀♀	
Rafaela	16/IV/82	Sorghum	494	244	250	90.6	82.8	6.4*
Manfredi	21/IV/82	Soybean	122	60	62	30.0	32.0	0.1
Rafaela	27/I/83	Sorghum	240	150	90	20.7	22.2	0.1
Rafaela	4/II/83	Sorghum	344	181	163	49.7	22.1	28.2**
Manfredi	22/II/83	Sorghum	49	20	29	55.0	13.8	9.5**
Rafaela	23/II/83	Sorghum	1 102	513	589	43.7	28.0	29.4**
La Banda	17/III/83	Soybean	75	35	40	25.7	40.0	1.7
La Banda	25/III/83	Soybean	40	17	23	35.3	30.4	0.1
La Banda	6/IV/83	Soybean	75	36	39	8.3	20.5	2.2
Manfredi	17/X/84	Wheat	87	43	44	41.9	18.2	5.8
Manfredi	25/X/84	Flax	209	76	133	62.5	20.5	19.1**
Totales			2 837	1 375	1 462	42.1	30.1	

(a) df=1
*P<0.05
**P<0.01
X^2=Chi-Square.

chell & Mau (1971) and Todd & Lewis (1976) for *T. pennipes*. They postulated the existence of a male stink bug pheromone highly attractive not just to the female stink bug but to the tachinid female parasitoid as well.

The parasitism's percentage of males, females and total of insects captured was significantly different (P<0.01) between the different crops and among years. Total percentages were 45.3%, 42.1%, 29.9% y 27.9% on sorghum (*Sorghum vulgare* L.), flax (*Linum usitatissimun* L.), wheat (*Triticum aestivum* L.) and soybean, respectively.

Parasitism percentage was higher on those crops where the fruiting structures were more exposed. These observations are in agreement with those reported by Todd & Lewis (1976). According to these authors, behavior could be explained by the differential accessibility of the bugs to the parasitoid considering that the fruiting structures are the preferred feeding site of *N. viridula*. This three-trophic level relationship deserves further study.

Table 2 shows results on patterns of parasitoid egg distribution on *N. viridula*. Although the male bugs had a higher percent parasitism and the tendency was towards higher number of parasitoid eggs per male host, the mean number of eggs per host was not significantly different (P>0.01) between sexes. The mean number of parasitoid eggs per host was significantly higher (P<0.05) for the insects captured on sorghum.

Supernumerary oviposition by *T. giacomellii* on *N. viridula* was common on both males and females. Out of 677 males bearing parasitoid eggs, 20.5, 9.9, and 20.1% had 2, 3 and 4 or more eggs, respectively. One male was observed with 26 eggs. Out of 532 parasitized females examined, 19.9, 10.7 and 21.6% had 2, 3 and 4 or more eggs, respectively, and up to 16 eggs were found on a single female. The large number of eggs which sometimes are deposited on individual hosts suggests that the presence of previously laid eggs has little or no deterrent effect on parasitoid oviposition. This tendency would be a disadvantage for the parasitoid since only one adult emerges from each parasitized bug. According to Flanders (1947), an efficient parasitoid must be able to distinguish a parasitized host from a non-parasitized one. Shahjahan (1968b) considers that multiple oviposition may have some positive survival value for the parasitoid tachinid because it would increase the percentage of successful penetration of larvae.

TABLE 2
EGG DISTRIBUTION OF *TRICHOPODA GIACOMELLII* ON *NEZARA VIRIDULA*
COLLECTED FROM VARIOUS HOST PLANTS

Sex	N° bugs collected	N° bugs parasitized	N° $\bar{x}$ eggs/ pst. bug(b)	N° eggs of *Trichopoda*/bug 1	2	3	4	+
				% pst. bugs				
			1982					
♂♂	304	239	3.7	20.1	22.6	13.0	10.5	33.9
♀♀	312	227	3.5	22.5	20.3	15.4	11.4	30.4
			1983					
♂♂	952	374	1.6	66.8	19.0	8.8	2.9	2.4
♀♀	973	256	1.5	68.0	19.1	7.8	3.5	1.6
			1984					
♂♂	119	64	1.9	57.8	21.9	4.7	7.8	7.8
♀♀	177	49	1.9	59.2	22.4	4.1	6.1	8.2
Total ♂♂	1 375	677	2.4(a)	49.5	20.5	9.9	6.0	14.0
Total ♀♀	1 462	532	2.3(a)	47.7	19.9	10.7	7.1	14.5

(a)There is no difference between sexes ('t'=1.66; P>0.01; df=1 207).
(b)pst.=parasitized.

In laboratory, 62.5% ± 0.06% of *T. giacomellii* larvae penetrated successfully. The mean numbers of larvae per host ($\bar{x}$=2.2; $\bar{r}$=1-7) did not differ (P>0.01) between sexes. After pupation, adult successful emergency was about 94.3%. Sex ratio of adult flies emerging was 0.47 ♂♂ to 0.53 ♀♀ (La Porta, 1987).

The simple method of using presence of parasitoid eggs on the host surface to estimate percentage parasitism is demonstrated as valid (Table 3).

Pooling all collections, only 12.7% of designations of bugs bearing parasitoid eggs as parasitized were wrong. Likewise, in designating bugs without parasitoid eggs as not parasitized, the error was 15.1% (X^2=2.3; P>0.01) thus offsetting the first type of error. In agreement with Todd & Lewis (1976) it should be added that the estimates should be based on a reasonably large number of collections, over large areas, to minimize the chance of over or underestimation of actual percentage of parasitism.

TABLE 3
FREQUENCY OF RIGHT/WRONG DESIGNATION
OF *NEZARA VIRIDULA* BEARING
TRICHOPODA GIACOMELLII EGGS A PARASITIZED
AND THOSE WITHOUT EGGS AS NOT PARASITIZED(a)

Designation	Bugs with parasitoid eggs	Bugs without parasitoid eggs	Totales
Right	1 053	1 383	2 436
Wrong	157	244	401
Totals	1 210	1 627	2 837
% wrong designations	12.7%	15.1%	

(a)X^2 was used top test any difference.
X^2=2.3; (df=1).

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