EFFECTS OF HOST AVAILABILITY ON THE REPRODUCTION OF *Trichogramma platneri* NAGARKATTI (HYMENOPTERA: TRICHOGRAMMATIDAE)[1]

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RESUMO

Efeitos da disponibilidade do hospedeiro sobre a reprodução de *Trichogramma platneri* Nagarkatti (Hymenoptera: Trichogrammatidae)

Foram estudados os efeitos de retardar o fornecimento de hospedeiros e/ou o acasalamento por diferentes períodos de tempo, e da densidade do hospedeiro disponível sobre a reprodução de *Trichogramma platneri* Nagarkatti usando-se como hospedeiro ovos de *Trichoplusia ni* (Hübner). Quanto maior o período em que as fêmeas foram mantidas sem hospedeiros tanto menor o número de descendentes produzidos. A razão sexual manteve-se inalterada. À medida que o intervalo entre a emergência das fêmeas e o acasalamento aumentou, o número de ovos parasitados, progênie total por hospedeiro e a proporção de machos aumentaram, respectivamente. O número de hospedeiros parasitados e da progênie produzida aumentou quando o suprimento de ovos do hospedeiro foi maior. Foi observada uma relação inversa com o aumento da densidade do hospedeiro tanto para o número de progênie por hospedeiro como para a proporção de machos.

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ABSTRACT

The effect of withholding host eggs, delaying mating for different periods of time, and varying host densities on the reproduction of *Trichogramma platneri* Nagarkatti was studied using eggs of *Trichoplusia ni* (Hübner) as the host. The longer females were deprived of hosts the lower the number of progeny produced. The sex ratio was not altered when host eggs were withheld for varying periods of time. As the time between emergence of females and mating increased, the number of hosts parasitized, total progeny produced per host, and proportion of males increased accordingly. The number of host parasitized and progeny produced increased with a corresponding increase in the number of hosts available. There was an inverse relationship between number of progeny emerging, % of males obtained, and host egg density.

INTRODUCTION

Certain Hymenoptera in the absence or scarcity of hosts refrain from ovipositing and conserve their egg complement by ovisorption. The ability of such females to retain their reproductive potential when adverse environment conditions prevail is advantageous. It permits them to use the energy stored in the eggs for maitenance.

FLANDERS (1942) observed that when certain hymenopterous parasitoids are deprived of hosts, ovisorption and oogenesis occur synchronously and enables the female to deposit viable eggs after a period of inhibited oviposition. Sometimes, however, low host density or absence of host for different periods of time affects both the parasitoids fecundity (LUND, 1938) and sex ratio (KING, 1961; WILKES, 1963) In order to evaluate these effects on the reproduction of *Trichogramma platneri* Nagarkatti, a series of experiments were conducted. The effects of delayed mating of females kept without host eggs also were investigated.

MATERIALS AND METHODS

A laboratory culture of *T. platneri* was initiated from parasitized codling moth, *Cydia pomonella* (L.) eggs collected by Dr. E.R. Oatman from an apple tree in Riverside, California (July, 1979). The parasitoids were cultured on eggs of the cabbage looper, *Trichoplusia* ni.

T. ni eggs were obtained from a culture maintained on an artificial diet developed by SHOREY & HALE (1965) as modified by PAK & OATMAN (1982).

T. platneri culture was maintained in polyethylene containers (0.47 l), the open ends being covered with filter paper disks. The disks were secured by polyethylene lids from which the center had been removed. Twenty-four-hours-old parasitoids, which had been fed on honey, were exposed to a large supply of host eggs (24 hr old) for one day. The host eggs then were held for progeny development. Cultures were started on different days to provide material for the experiments as needed. Virgin females were obtained by isolating a parasitized (darkened) egg in a gelatin capsule (# 000) streaked with honey.

Glass shell vials (9.5 x 2.5cm) were used as oviposition units, as described by OATMAN & PLATNER (1973). All experiments were conducted at room conditions (24±1°C, RH 50 ± 15%).

To study the effect of withholding *T. ni* eggs for different periods of time on the reproduction of *T. platneri* two experiments were designed. In one experiment the females were allowed to mate after emergence. In the second experiment mating was delayed for 1, 2, 3, 5, and 10 days. In both cases, hosts eggs were withheld 0, 1, 2, 3, 5, and 10 days. Seventy *T. ni* eggs were provided for each female parasitoid.

To evaluate the effect of different host densities on the reproduction of *T. platneri*, 1, 5, 10, 20, 40, and 80 *T. ni* eggs were exposed to individual mated females 24 hours old. Each experiment was initiated by placing 10 females in separated ovipositional units. Honey was streaked on the inner walls of the vials.

In all studies, the host eggs were 24 hours old and the females were alowed to oviposit for 24 hours. The parasitoids then were removed and the host eggs held for progeny development. Following emergence the number of parasitized eggs and the number, and gender of the progeny were recorded.

RESULTS AND DISCUSSION

Effects of withholding hosts

The length of time mated females were deprived of hosts had important consequences on their reproduction. As the period of time without hosts increased, fecundity decreased (Table 1). A Duncan's multiple range test shows that higher progeny production was obtained when females were deprived of hosts eggs for 24 or 48 hours ($F = 4.26$, $P < 0.01$, d.f. = 5, 46). Newly emerged females produced about the same number of progeny as females which were deprived of eggs for three days. Possibly, newly emerged females do not have many mature eggs and need to feed in order to complete oogenesis. This fact is in accordance with the results obtained with females 24 and 48 hours old. After two days without hosts, the number of parasitoid progeny decreased substantially.

Table 1 - Effects of witholding host eggs for different lengths of time on the progeny produced by mated *T. platneri* females during 24 hours.

Length of time (days)	Mean number host eggs parasitized	No. offspring mean	(Sd)	Mean number parasites/ host egg	Sex ratio (F:M)
0	24.30 b*	39.00 b	± 16.7	1.627a	1:0.15
1	44.70a	59.00a	± 10.8	1.345 bc	1:0.16
2	28.80 b	54.25a	± 22.7	1.527ab	1:0.20
3	27.60 b	38.77 b	± 9.3	1.196 c	1:0.15
5	29.000b	36.78 b	± 13.3	1.247 c	1:0.16
10	24.90 b	31.89 b	± 10.8	1.286 c	1:0.19

* Means followed by the same letter are not significantly different at 1% level.

In relation to the number of progeny emerging from parasitized host eggs (Table 1), older females tended to allocate fewer eggs per host ($P < 0.001$). The sex ratio was not altered significantly.

Effect of delaying mating

The time of mating also had important consequences on the reproduction of *T. platneri*. Except for ten-day-old females, the number of host eggs parasitized and number of progeny produced increased proportionally as the time between female emergence and mating increased (Table 2). The values obtained, however, were not significantly different. The number of parasitoids emerging per host egg also tended to increase with time, the highest number (1.445) being recorded at 10 days and the lowest (1.214) at 0 days (newly emerged). These differences were significant. The number of male progeny also increased with time (Table 2).

The older females in this experiment produced more offspring than similary aged females in which host eggs were withheld. This suggests that ovisorption was not the main factor causing the reduced fecundity.

Effects of host density

The number of host eggs parasitized increased significantly ($F = 65.33$, $P < 0.0001$, d.f. = 5, 54) as well as the number of progeny produced per female parasite ($F = 51.17$, $P < 0.0001$, d.f.=54) with an increase in the number of hosts available (Table 3). The proportion of host eggs parasitized increased rapidly between 1 and 10, remaining the same at 20 and declining slowly thereafter (Fig. 1).

An inverse realtionship was obtained with increasing host density for both the number of progeny per host and the sex ratio. The number of progeny per host decreased from 2.3 at the lowest density (1 host egg) to 1.3 at the highest density (80 eggs). The number of progeny per host egg at the 80 host egg density was significantly less than that at any other density (Table 3).

The sex ratio declined from 1:1 when one host was available to 1:0.23 when 80 hosts were available (Table 3). The relationship between mean progeny per egg and % of males (Fig. 2) was significant ($F = 10.19$, $P < 0.05$, d.f.-1,3).

As the length of time mated females were deprived of host eggs increased, fecundity decreased accordingly (Table 1). In studying the effects of withholding host eggs on *Trichogramma evanescens* Westwood, LUND (1938) found a significant reduction in the number of progeny when virgin females were deprived of hosts for 48 or 72 hours. Working with *Dahlbominus fuliginosus* (Nees), WILKES (1963) reported that older females pro-

TABLE 2 - Effects of delaying mating for different lenghts of time on the progeny produced by *T. platnery* during 24 hours.

Lenght of time (days)	Mean number host eggs parasitized	No. offspring*			Mean number parasites/ host egg	Sex ratio (F:M)
		mean		(Sd)		
0	30.50	34.30	±	19.2	1.214 c**	1:0.20
1	32.37	41.75	±	29.6	1.328abc	1:0.35
2	42.00	55.60	±	16.4	1.415ab	1:0.31
3	44.40	58.80	±	18.1	1.444a	1:0.51
5	52.50	62.60	±	25.8	1.260 bc	1:0.53
10	40.00	54.50	±	18.5	1.445a	1:0.52

* F test not significant for number of host eggs parasitized and offspring.

** Means followed by the same letter are not significantly different at 5% level.

TABLE 3 - Mean number of progeny produced by *T. platneri* at various host egg densities during 24 hours.

Host egg density	Host parasitized		No. progeny	Mean number parasites/ host egg	Sex ratio (F:M)
	No.	(%)	Mean (Sd)		
1	0.6 e*	60.0	1.4 ± 0.7 e	2.333a	1:1
5	3.5 de	70.0	5.9 ± 3.7 de	2.106a	1:0.32
10	7.8 d	78.0	13.0 ± 2.6 d	1.702a	1:0.24
20	15.6 c	78.0	27.2 ± 6.3 c	1.910a	1:0.32
40	26.1 b	64.5	43.8 ± 13.0 b	1.712a	1:0.18
80	46.3a	57.9	58.6 ± 17.3a	1.340 b	1:0.23

* Column means followed by the same letter are not significantly different at 5% level.

duced more progeny. VELTHUIS *et al.* (1965) reported the same results with *Nasonia vitripennis* (Walker). KING (1969) reported that ovisorption is more common in older individuals than in younger ones at a given time of host deprivation.

In contrast, when females were deprived of host eggs and kept unmated until the time host eggs were provided, both the number of host eggs parasitized and the total number of progeny produced, during the 24-hours ovipositional period, increased as the time between female emergence and mating increased. This suggests that ovisorption was not the only factor causing the reduced fecundity as observed in the first host deprivation experiment. The time between emergence and mating or between mating and oviposition apparently also affected progeny production and sex ratio.

The number and gender of progeny produced varied with the size of the host patcth. As the host density declined the number of progeny per host egg and sex ratio increased (% males). Similar results were reported by PAK & OATMAN (1982) with *Trichogramma brevicapillum* Pinto and Platner. Although an increase in male progeny at low host density has been reported for different species of parasitoids (SALT, 1936; WILKES, 1963; WAAGE, 1982a; WAAGE & MING 1984), the reasons for such a shift in the sex ratio is not completely understood. However, some data have been presented to help explain this phenomenon. WIKES (1963) reported and increase in the sex ratio of *D. fuliginosus* at low host densities due to selective mortality of larvae which favored males. While studying host distribution and its effects on the sex ratio of different parasitoids, including *T. evanescens*, WAAGE (1982b) reported that the parasitoids with female-biased sex rations often lay male eggs first in a sequence of eggs laid consecutively. While comparing the pattern of sex and progeny allocation for *T. evanescens* attacking two sizes of host patch (1 and 10 eggs), WAAGE & MING (1984) observed that one male was consistently included in each host egg when the patch size was one egg. In the patch containing ten host eggs, the frequencey of males decreased rapidly. This is consistent with the high proportion of males observed in the present experiment when a low number of hosts were available.

Host-parasitoid density influences mass rearing. Under insectary conditions of high parasitoid to host ratios (i.e. a food shortage), superparasitism increases. As a result, the proportion of females decline and the number of males increase. Small or malformed females also increase in successive generations. Superparasitism can be reduced materially by providing sufficient hosts of good quality to ensure the production of adequate numbers of females with high fitness.

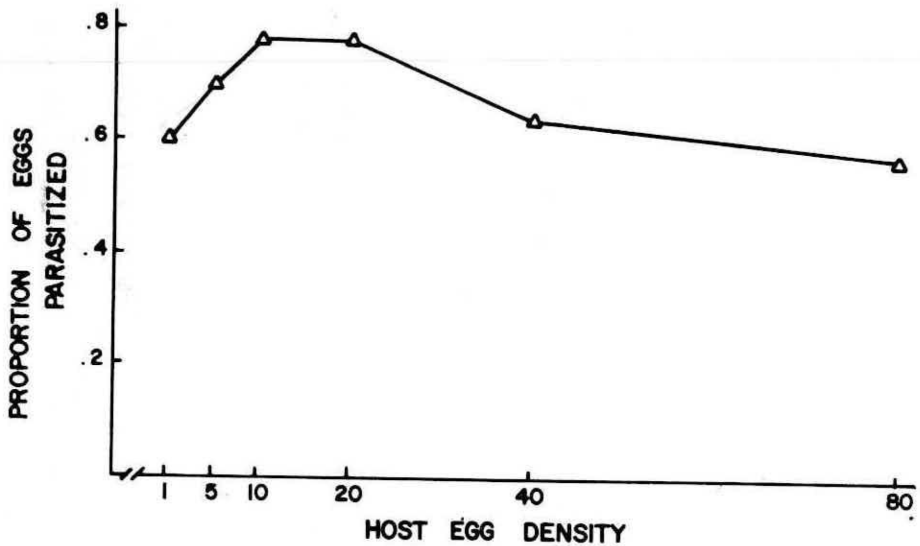

FIG. 1 - Effect of host density on the proportion of eggs parasitized by *T. platneri* during 24 hours.

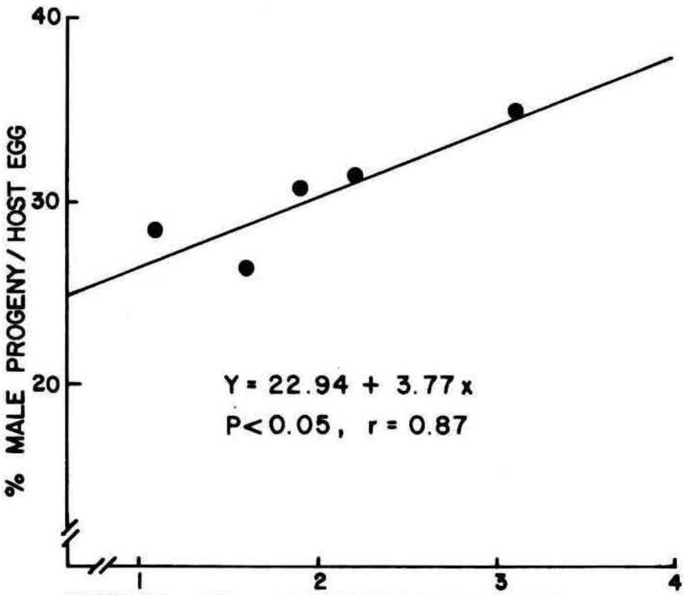

FIG. 2 - Relationship between number of *T. platneri* progeny and % of males emerging per host egg after a 24 hours period of exposure.

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