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Effects of Super-parasitism on the Development of the Pupal Parasite *Tetrastichus israeli* M. and K. (Eulophidae : Hymenoptera) in Different Hosts

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Though super-parasitism of a high order has a deleterious effect on the biology and size of the parasite, these effects are highly influenced by the host species also. For mass culturing the eulophid *Tetrastichus israeli* M. and K., maximum number of 10 parasites per pupa of *Corcyra cephalonica* St., 20 per pupa of *Nephantis serinopa* Meyrick, and *Margaronia indica* S., and 25 per pupa of *Plusia peponia* F. can be utilised without any adverse effect on the biology and size of the parasite.

Tetrastichus israeli M. and K. is an important pupal parasite utilised for the control of coconut black headed caterpillar, *Nephantis serinopa* Meyrick in South India. Though it is mass reared in different Parasite Breeding Stations on different alternate hosts, no information is available regarding the effects of super-parasitism on this parasite. Hence studies were made on the effect of super-parasitism on the development of the parasite in different hosts in order to suggest a suitable parasite density level for its mass culturing in four lepidopterous hosts, viz. *N. serinopa* Mayrick., *Margaronia indica* S., *Plusia peponis* F. and *Corcyra cephalonica* St.

MATERIALS AND METHODS

The stock culture of the parasite *T. israeli* was maintained on the pupae on rice moth *C. cephalonica*. From this culture, gravid females numbering 1,5,10,15,20,25 and 30 were allowed to an 1-day old pupa of the host insect in 7.5x2.5 cm tubes for parasitisation. Each treatment was replicated five times and this was repeated for different host species. The dates of oviposition, emergence of parasites, the total number of parasites emerged, the sex ratio, the longevity and the size of the parasites in each replication were recorded.

RESULTS

I) Effect on the total development period

Significant difference was noted in the total development period of the parasite in different hosts, but the superparasitism *per se* did not affect significantly the development period. In the lowest as well as in the highest parasite density, there was very little variation in the total development period (Table I).

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TABLE I. Effect of super-parasitism on the emergence and sex ratio of the parasite *T. israel.*

Number of Parasites allowed	Total Number of parasites emerged — Hot Species					Sex Ratio (Male/Female)				
	N. serinopa	*P. peponis*	*M. indica*	*C. cephalonica*	Mean	*N. serinopa*	*P peponis*	*M. indica*	*C. cephalonica*	Mean
1	30.67	59.00	31.00	30.33	37.75	0.07	0.06	0.07	6.07	0.07
5	34.67	175.00	36.00	39.00	71.25	0.07	0.13	0.09	0.08	0.09
10	51.67	226.00	48.00	56.33	95.50	0.15	0.13	0.10	2.06	0.61
15	60.67	301.33	51.67	74.33	122.00	0.17	0.20	0.13	2.43	0.73
20	81.00	290.33	81.33	69.00	130.42	0.20	0.20	0.16	4.48	1.26
25	92.33	428.00	139.00	64.00	180.83	0.37	0.88	0.97	7.52	2.42
30	87.00	405.33	115.33	59.00	166.69	1.06	0.81	2.73	6.70	2.62
Mean	62.57	269.29	71.06	56.05		0.30	0.34	0.61	3.34	

C.D. (P=0.0)	Between hosts	26.77	0.78
	Between number of parasites allowed	35.43	0.83
	Interaction	7.08	2.09

II) Effect on the total number of parasites emerged

A distinct variation was noted in the total number of parasites emerged from different hosts. As many as 269.3 parasites emerged from *P. peponis*, as against only 56 to 71 from other hosts. Superparasitism had a marked effect on the emergence of the parasite. At the parasite density of 25, in all hosts except *C. cephalonica*, a maximum of 180.8 parasites emerged (Table I). In *C. cephalonica*, the maximum number of emergence i.e. 74.3 was noted at a parasite density of 15, which was reduced with a further increase in the density level. In all the other hosts after a density of 25 parasites, there was a reduction in the number of parasites emerged.

III) Effect on the sex ratio (Male/Female)

The sex ratio of the parasite was highly influenced both by the host species and also by superparasitism. In *N. serinopa* at the density of 30 parasites the number of males are slightly more than the females (Table II) The sex ratio in *P. peponis* F,, though increased as the parasite density increase, was always less than one at all density levels, But there were more males at the density of 30 parasites in *M. indica*, and the sex ratio was as high as 2.06 in *C. cephalo-*

TABLE II. Effect of super-parasitism on the longevity of the parasite *T. israeli*

Number of Parasites allowed	Male					Female				
	Host species					Host species				
	N. serinopa	*P. peponis*	*M. indica*	*C. cephalonica*	Mean	*N. serinopa*	*P. peponis*	*M. indica*	*C. cephalonica*	Mean
1	2.00	2.60	2.00	1.80	2.04	15.30	10.30	10.00	8.30	11.00
5	2.00	2.60	2.00	1.50	2.04	15.00	10.00	9.00	8.30	10.56
10	1.80	2.00	1.80	1.50	1.79	12.00	10.00	8.00	6.60	9.25
15	1.80	2.30	1.70	1.20	1.75	11.00	9.00	8.00	5.00	8.33
20	1.70	2.30	1.50	1.20	1.67	9.30	9.00	8.00	5.00	7.84
25	1.50	2.30	1.30	1.30	1.33	8.00	6.00	6.00	4.30	6.08
30	1.30	1.70	1.00	1.00	1.21	7.00	6.00	6.00	4.00	5.83
Mean	1.71	2.29	1.62	1.36		11.20	8.62	7.86	5.95	

C.D.	Between hosts	0.29	1.00
(P=0.0)	Between number of parasites allowed	0.40	1.38
	Interaction	0.78	N. S.

nica even at level of 10 parasites indicating the male preponderance.

iv Effect on the adult longevity

a) *Male :* There was a significant difference in the longevity of males emerged from different host species and also due to the superparasitism. The males fom *P. peponis* lived longer, i.e., 2.29 days as against 1.36 to 1.71 days in other hosts (Table II). The male parasites emerged from all the hosts at a parasite density level of 30, lived for shortest duration.

b) *Female*: The adult life span of female parasites was varying markedly in different hosts with a mean of 11.2 days in *N. serinopa*, 8.62, 7.86 and 5-95 days in *P. peponis*, *M. indica* and *C. cephlonica* respectively (Table II). As the density of the patasite was increased, the longevity of female parasites was decreased.

v) Effect on the body size

a) Male : Bigger males emerged from *N. serinopa* and *P. peponis* and the smallest male (0.96 x 0.26 mm) was from *M. indica* at a level of 80 parasites. Though there was a reduction in the size of the parasite in *C. cephalonica* upto a density of 20 parasites, the size showed slight increase with the further increase in the density. In the hosts like *P. peponis* and

N. serinopa, there was a reduction in size as the density of parasite was increased.

b) Female: As in the case of the males, bigger females emerged from *P. peponis* and *N. serinopa*. In all the cases, there was a general reduction in the body size of the female for a corresponding increase in the parasite density level, except in the case of *C. cephalonica* where there was an increased trend in size of the female parasites, from the parasite density of 20 onwards.

DISCUSSION

i) **Total development period:** There was a significant difference in the development period of the parasite due to different hosts and there was not much influence on the development period due to super parasitism. The reduction in the development period at the highest and the lowest parasite density could be explained in terms of the availability of food. In a population level, the availability of food for the larvae was more leading to their rapid growth and early pupation thereby reducing the development period. At a higher population level, the depletion of food occurred much sooner and forced pupation resulted in early emergence. Force and Messenger (1965) also recognised in the case of superparasitism by the braconid *Praon exoletum* in aphids, that the larvae from superparasitised aphids developed quickly than that of from the non-superparasitised aphids.

ii) **Total number of parasites emerged :** Considering the effects of superparasitism on the total number of parasites emerged, a decrease was noted after the density level of 25 and 30, indicating that a greater mortality of the parasites in all hosts and possibly some of the parasites might have restrained from laying eggs further on the highly superparasitised host (Wylie, 1966a). In *C. cephalonica* even at a level of 15, the parasite emergence decreased and it is better not to allow more than ten parasites per pupa. In *Plusia*, which is the largest host among the four, even at a level of 25 parasites per pupa, there was a corresponding increaseing in the number of parasites emerged which was not the case with the other hosts. The explanation given by Salt (1961) for the types of competition like physical attack, physiological suppression, accidental injury and selective starvation could be applicable here also. Wiackowski (1962) mentioned about the lack of oxygen and food while the host was superparasitised. Wylie (1971) attributed the death of the parasite *Nasonia vitripennis* (W.) inside the host pupa if the number of larvae exceeded 25 in a medium sized pupa, due to the death from starvation and also due to the attack of the larva that hatched first on all the parasite eggs while moving.

Sex ratio: The value of the sex ratio was highly influenced due to hosts and superparasitism. Among the three hosts at the density level of 25, the male population was high. In *Corcyra* even at the level of 15

parasites the male preponderance was noted. This alteration in sex could be attributed to the differential mortality of sexes during development as suggested by Wiackowski (1962) and valid explanation was given by De Bach (1964) that males could attain maturity on less food than the females.

Longevity and size of the parasite: The longevity of adult parasites of both sexes was decreased as the parasite density increased since the parasites emerged from highly superparasitised pupae were not active compared to the other due to less nutrition.

The reduction in size noted both in male and female parasites confirms the earlier findings by Wylie (1966a) in *N. vitripennis* (W.). The length of the addomen of parasite was positively correlated with the total number of parasites emerged from the same sized pupa of *C. cephalonica* ($r = 0.87$; $y = 105.1\ x - 41.3$) and so the fecundity would be increasing with the increase in the size of the parasite length (Wylie, 1966b). The increase in size of both male and female parasites after a level of 20 parasites in *C. cephalonica* could be attributed to the higher mortality rate and hence the remaining larvae had a better nutrition which led to an increase in size.

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