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REGULATION OF FECUNDITY, PROGENY PRODUCTION AND FEMALE-MALE COMPOSITION OF *BRACON BREVICORNIS* WESMAEL (HYMENOPTERA : BRACONIDAE)

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The black headed caterpillar *Nephantis serinopa* Meyr, is a major pest of coconut which is widely distributed throughout the coastal plantations of Kerala. *Bracon brevicornis* is an important component in the natural enemy complex of *N. serinopa*. A major handicap of this parasite is the preponderance of males in the progeny. In orderto build up and sustain iarge stocks of the parasite in the insectary, a satisfactory level of progeny production consistent with optimum sex-ratio levels in the succeding generations will have to be ensured. The present studies were carried out to obtain precise information on the influence of different levels of host larval density, weight of host larvae and sex-ratio of the parent parasite population on the sex-ratio, fecundity and progeny production of the parasite.

Materials and Methods

The parasite cultures were maintained on fourth instar larvae of the rice meal moth *Corcyra cephalonica* bred on crushed *Jowar*. The parasite stock cultures were maintained on specimen tubes of size 10×2.5 cm and fed with a mixture of equal volumes of honey and 10% glucose solution. In all treatments, the parasites were similarly fed. The fecundity of the parasite was counted by examining the host larvae on successive days after confinement. The total number of males and females which emerged out from each replicate was recorded as the F_1 progeny production. The female-male composition of the F_1 progeny produced under each treatment was recorded by pooling the data on the parasites of both sexes emerging on successive days.

The studies were conducted at three temperature-humidity combinations, namely, 28°C-75% RH, 30°C-60% RH and 32 C-50% RH to ascertain the feasibility of manipulating ambient conditions for sustenance of laboratory cultures with adequate female populations. The humidity was maintained in desiccators containing potassium hydroxide solutions (Buxton, 1 931), while the required temperatures were maintained in BOD incubators.The following were the levels at which the effect of host larvae of the same age and sex-ratio of the parent parasite populations were studied:

Host larval density (A)

Levels a_0-1 host larva per female parasite, a_1-2 host larvae per female parasite a_2-3 host larvae per female parasite

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Weight of host larvae of the same age (B)

Levels b_0-Larval weight 30-35 mg, b_1-Larval weight 8-10 rog, b_2-Half of the hosts of the 'b_0' type and the other half of the 'b_1' type,

Sex-ratio of the parent parasite population (C)

Levels c_0 - 1 : 1 (Female : Male),
c_1 - 2 : 1 (,,),
c_2 - 3 :1 (,,),
c_3 - 1 :2(,,),
c_4 - 1 : 3 ( ),

There were altogether 45 treatment combinations and these were replicated thrice. in order to obtain the required number of females and males for different treatment combinations, the parasites were drawn from the nucleus cultures immediately after emergence, after anaesthetisation with chloroform. The parasites were then sexed and used for the experiments after recovery.

For all experiments, *Corcyra* larvae of the fourth instar were used. Larvae of this age were classified on the basis of their weights into two categories, namely, those with a weight range of 30-35 mg and those with a weight range of 8-10 mg.

The data were analysed by employing the chi-square technique after appropriate transformations.

Results and Discussion

Fecundity

Mean fecundity realised at different levels of the main factors and the ranking based on Chi-square values are given in Table 1.

influence of host larval density (A)

Significantly higher number of eggs were obtained at all the three temperature-humidity levels when the host larval density was maintained at two per female parasite. This finding closely agrees with the results obtained by Subba Rao *et al.* (1974) in the case of *B.hebetor*. In this case, maximum fecundity was registered with two *Corcyra* larvae per parasite pair. The increased fecundity at high host density levels might be partly due to increase in the density of available ovipositional sites (Flanders, 1946) and partly due to increase in the availability of food for the female parasite (Ullyett, 1943, 1945).

Influence of weight of host larvae (B)

When heavier host larvae were used, maximum fecundity was obtained at 32°C and 50% RH. When heavier and lighter larvae were used in equal proportions, egg production was found to be better both at 28°C-75% RH and 30°C-60% RH. It is thus revealed that the preferred levels of temperature-humidity combinations for oviposition by *B. brevicornis* varies with the weight of host larvae. At high temperature-low humidity levels, the host body fiuid exuding from oviposition wounds is likely to get dried up faster and hence heavier hosts might be essentiai for ensuring sufficient body fluid exudates in the required consistency for adult feeding.

Influence of sex-ratio of parent parasite population

At all the three temperature-humidity levels, the maintenance of parental sex-ratio of 2:1 (c_1–female : male) and 3:1 (c_2-female : male) led to the production of higher number of eggs than under the sex-ratio levels of 1:1, 1:2 and 1:3. This clearly indicates that a dominance of females in the parent parasite population is essential for ensuring higher fecundity, perhaps for ensuring effective mating and successful fertilisation and to improve ovipositional stimulus.

Progeny production

The number of F[progeny produced at different levels of the main factors and the ranking are furnished in Table 2.

Influence of host larval density (A)

The maximum number of progenies were produced when two host larvae were exposed per female parasite (a_1) at 28 C and 75% RH and this was higher than in three host larvae (a_2). But at 32°C and 50% RH, the progeny production was higher at the density level of three host larvae (a_2) than at a_0 and the a_1 levels (Table 2). Abraham and Mathew (1978) reported that the number of exposed host larvae is very important in the regulation of progeny production in *B. brevicornis*.

Influence of weight of host larvae

Higher number of progenies were produced when heavier larvae (b_0) were exposed for parasitisation, both at 28°C–75% RH and 30 C–60% RH conditions. However, at 32°C–50% RH, an admixture of heavier and lighter (b_2) larvae in equal proportions and the heavier ones (b_0) were on par with reference to progeny production. The variation in the trend of progeny production at different temperature–humidity levels with host weight changes is probably due to differential impact of these conditions on the host nutritional status indicated *by* host weight.

Influence of sex-ratio of parent population

A sex-ratio of 1 :2 (c_3–female : male) in the parent parasite population has produced signficantly higher progeny at 28°C-75% RH. Abraham and Mathew (1978) also reported that the number of males in the parental population is important in determining the progeny production at 28 + 1 °C. But, at 30°C–60% RH and 32°C-50% RH, better progeny production was obtained under 2:1 (c_1) sex–ratio than with 1:3 (c_4) ratio and this indicates that a dominance of females is desirable at these combinations. It is thus indicated that the required sex dominance for progeny production is shifted under diverse temperature-humidity combinations,

Female–male composition of the F_1 progeny

The sex-wise counts of the parasites under different levels of the factors and ranking based on Chi-square values are indicated in Table 3.

Influence of host larval density on the female-male composition

The host larval density had no significant effect on the female-male composition of F_1 ptogeny at 28°C–75% RH and 30°C–60% RH. But at 32°C–50% RH, sex-ratios of F_1 progeny were significantly influenced by the host larva! density and the highest percentage of females were obtained when two host larvae per female parasite (a_1) were offered for parasitisation.

The female-mate composition of progeny is largely influenced by the proportion of diploid eggs laid by the inseminated females and also by the differential moftality of immature stages of the two sexes during embryonic and post-embryonic development. The influence of host larval density on the sex-wise composition of the F_1 progeny at 32°C–50% RH is - perhaps due to the effect of the level of temperature and humidity in modifying the stimulus of depositing haploid and diploid eggs. This is substantiated by the finding of Abraham and Mathew (1978) that host larval density is relatively important among other factors, in the regulation of sex-ratio of the offsprings.

Influence of weight of host larvae

The sex-ratio of the F_1 progeny was significantly influenced by the weight of host larvae at 28°C–75% RH and 32°C–50% RH. The highest percentage of female was recorded with a mixture of heavier and lighter larvae in equal proportions (b_2) at 28°C–75% RH. At 32°C–50% RH, heavier host larvae have recored a significantly better sex-ratio. The influence of host weight on female progeny production in *B. brevicornis* might either be due to differences in the nutritional status of larvae of different weights or due to differences in the nutritional requirements of immature stages of the male and female parasites. This influence may also be due to the sex of the host larvae as reported by Sithananatham and Subramanian (1977) in the case of *Stenobracon deesae* developing on *Chilo partellus*. The sex-ratios of 5. *deesae* was in favour of males in male hosts while these shifted significantly in favour of females in the female hosts. In *B. brevicornis,* it is probable that the relatively heavier host larvae are the females and the lighter ones are males. The better female progeny producfion from heavier hosts might then be explained on the basis of the Influence of host sex perhaps in inducing selective mortality of the opposite sex due to some antagonistic ihfluence. It is observed that when the changes in ambient temperature and humidity conditions are varied, the preferred level of the host weight also changes.

Influence of sex-ratio of the parent parasite population

A sex-ratio of 1:3 (c_4–females:males) has produced a significantly better proportion of females at 30°C-60% RH (48.94%) and 32°C-50% RH (56.13%) while the parental sex-ratios were not influencing the female-male compositicn of the progeny at 28°C-75% RH. Mathew and Nair (1977) reported that certain sex-ratios among the parents ensured similar sex-ratios among the F_1 progeny and 1:3 ratio of females and males is one such parental ratio. In the present studies it is found that under high temperature-low humidity ambient conditions the 1:3

Table-1.

Mean fecundity of *B brevicornis* at different levels of the main factors and their ranking at different temperature-humidity levels

Levels of factors A, B & C	28°C—75% RH Mean fecundity	28°C—75% RH Ranking	30°C—60% RH Mean fecundity	30°C—60% RH Ranking	32°C—50% RH fecundity	32°C—50% RH Ranking
* a_0	51.33		47.53		54.27	
a_1	63.20	a_1, a_0, a_2	56.84	a_1, a_0, a_2	68.18	a_1, a_2, a_0
a_2	49.50		45.86		57.00	
** b_0	50.98		53:47		81.31	
b_1	46.40	b_2, b_0, b_1,	42.42	b_2, b_0, b_1,	31.61	b_0, b_2, b_1,
b_2	66.67		54.04		66.76	
*** c_0	31.24		31.87		33.20	
c_1	42,56		37.47		44.33	
c_2	39.40	c_1, c_2, c_0 c_3, c_4	25.00	c_1, c_2, c_0, c_3 c_4,	44.78	c_2, c_1, c_0, c_4, c_3,
c_3	25.82		27,11		28.18	
c_4	25.02		18.49		28.96	

* a_0—1 host larva per female parasite
a_1—2 ,, ,,
a_2—3 ,, ,,

** b_0—larval weight 30—35mg
b_1— ,, ,, 8—10mg
b_2—half of the hosts of the 'b_0' type and the other half of the 'b_1' type.

*** c_0 — Sex-ratio of parent parasite population— 1 : 1 (female : male)
c_1— ,, ,, -2 : 1 (,,)
c_2 ,, ,, ,, -3 : 1 (,,)
c_3 ,, ,, -1 : 2 (,,)
c_4 ,, ,, -1 : 3 (,,)

Table 2

Mean number of female progeny of *B. brevicornis* produced at different levels of the main factors and their ranking at different temperature-humidity levels

Levels of factors A, B, C	28°C—75% RH Progeny eroduction	28°C—75% RH Ranking	30°C—60% RH Progeny production	30°C—60% RH Ranking	32°C—50% RH Progeny production	32°C—50% RH Ranking
a_0	11.22		12.78		17.36	
a_1	12.31	a_1, a_0, a_2	14.73	a_1, a_2, a_0	18.62	a_2, a_1, a_0
a_2	9,20		14.62		22 31	
b_0	12,11		15.78		23.76	
b_7	10,09	b_0, b_2, b_1	12 47	b_0, b_2, b_1	9.42	b_2, b_0, b_1
b_2	10.53		13.89		25.11	
c_0	6.53		10,71		14.69	
c_1	7.04		11.73		15.80	
c_2	6.53	c_3, c_1, c_0, c_2, c_4	7.16	c_1, c_0, c_2, c_3, c_4	10.33	c_1, c_0, c_2, c_3, c_4
c_3	7.31		7.00		10.11	
c_4	5.31		6.13		7.26	

Table 3

Female—male composition of B. *brevicornis* at different temperature—humidity combinations

Levels of main factors	28°%—75%RH			30°C—60%RH			32°C—50%RH		
	Females	Ranking	Males	Females	Ranking	Males	Females	Ranking	Males
a_0	251 (49.70)		254 (50.30)	239 (41.57)		336 (58.43)	393(50.32)		388 (49.68)
a_1	248 (44.80)	NS	306 (55.20)	304 (45.85)	NS	359 (54.15)	445 (53.10)	$\overline{a_1, a_0, a_2}$	393 (46 90)
a_2	187 (45.20)		227 (54.80)	291 (44.22)		367 (44.22)	407 (40.54)		597 (59 64;
b_0	243 (44.60)		302 (55,40)	333 (46.90)		377 (53.10)	553 (51.73)		516 (48.27)
b_1	195 (42.95)	b_2, b_0, b_1	259. (57,05)	248 (44.21)	NS	313 (55.79)	194 (45.75)	$b_0, \overline{b_1, b_2}$	230 (54.25)
b^2	248 (52.32)		226. (47.68)	253 (40.48)		372 (59.52)	498 (44.07)		632 (55.93)
c_0	128 (43.54)		166 (56.46)	188 (39.00)		294 (61.00)	324 (49.02)		337 (53.02)
c_1	164 (34.10)		317 (65.90)	232 (46.31)	$\overline{c_4, c_3, c_1}$	269 (53.69;	334 (46.98)	$\overline{c_4, c_0}$,	377 (50.93)
c_2	136 (46.86)	NS	158 (53.74)	128 (39.75)		194 (60.25)	199 (42.80)	c_3, c_2,	266 (57.20)
c_3	141 (42.86)		188 (57.14)	151 (47.94)	c_2, c_0	164 (52.06)	205 (45.05)	c_1	250 (54.95)
c_4	115(48.12)		124 (51.88)	135 (48.94)		141 (51.09)	183 (56.13)		143 (43.87)

Figures in parenthesis indicate the related percentage values.

parental ratio gives progeny compising of 48.94-56.13% females. The variations might be due to the ambient conditions under which the two sets of experiments were conducted. The dominance of males required for ensuring higher proportion of the females in the offsprings is perhaps explicable on the basis of inviability in males due to unfavourable ambient conditions. Since the proportion of females in the progeny is of critical Importance in the sustenance of the culture, it is found essential to maintain dominance of males at 1:3 among the parental population at relatively high temperature low humidity levels,

Summary

The fecundity, progeny production, female-male composition of the progeny of *Bracon brevicornis* Wesmael as influenced b/ density and weight of host larvae of *Corcyra cephalonica* Stainton and the sex-ratio of the parent parasite population were studied at three temperature-humidity combinations, namely, 28°C-75% RH (TH_1), 30°C-60% RH (TH_2) and 32°C-50% RH (TH_3). The effect of the main factors on parasite development was found to be modified by the temperature humidity conditions of rearing.

The maximum fecundity of the parasite was registered consistently at all the three TH levels at a host density level of two larvae per female parasite and when the parental parasite sex ratio was kept at 2.1 and 3:1 (female:male).

The highest progeny production was attained at the TH_1 and TH_2 levels under a host density level of two heavier (30-35 mg) larvae per female parasite,

The influence of host larval density on the proportion of females was pronounced only at the TH_3 level and a density of two larvae per female parasite was found to be better for the production of higher proportion of females.

The parental sex-ratios of 1:3 (female : male) produced higher proportion of females at the TH_2 and TH_3 levels.

സംഗ്രഹം

തെങ്ങോലപ്പുഴുക്കളുടെ എതിർപ്രാണികളായ ബ്രേക്കോണുകളെ വളർത്തുന്നതിനു ആവശ്യമായ ഘടകങ്ങളെ സംബന്ധിച്ച പരീക്ഷണങ്ങളിൽ ഏററവും കൂടുതൽ raiocsn\uoi8j1'o_i3 ദനം ലഭിയ്ക്കുന്നതിന് ഓരോ പെൺ പ്രാണിയ്ക്കും രണ്ടു കോർസൈറാ പുഴുക്കൾ വീതം നൽകുന്നതാണ് നല്ലതെന്നു കണ്ടു. എതിർ പ്രാണികളുടെ rauEj^o<ajg1(Oi പെൺ ജീവികളുടെ സംഖ്യാബലം നിശ്ചിTO തോതിൽ ഉറപ്പു വരുത്തുന്നതിന്, അന്തരീക്ഷത്തിലെ ഊഷ്മാവിന്റെ അടിസ്ഥാനത്തിൽ പ്രത്യേക അനുപാതത്തിൽ ആൺ-പെൺ പ്രാണികൾ ആവശ്യമാണെന്നും തെളിഞ്ഞു.

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