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SUMMARY

For potential utilization of *M. rufiventris* wasps against *S. littoralis* larvae, the present study was confined on some factors that affect the reproductive capacity of wasp's female. Of these are the host size, parasitoid size, adult longevity, initial egg load, host availability and its timing.

I. Effect of host stage at parasitism on host and parasitoid growth

The effect of the parasitoid *M. rufiventris* parasitizing the first four larval stages of *S. littoralis* on maximum host weight prior parasitoid emergence has been investigated. The results suggested that regardless of host stage parasitized, *S. littoralis* larvae gained very little weight (i.e., developmentally arrested). Larvae parasitized during early fourth instars reached the heaviest maximal weight (50.23±4.33 mg) compared with those hosts parasitized during earlier stages. For instance, hosts parasitized during early-, mid-, late-2nd larval instars attained maximal weights of 15.18±1.82, 14.86±1.48 and 31.53±1.39 mg prior to emergence of parasitoid larvae, respectively.

Effect of different aged host larvae at parasitism on the size (fresh weight) of resulting parasitoid adults was also investigated. In all cases, female cocoons were, on average, larger than those produced by male parasitoids for any given host life stage parasitized. Cocoon size of *M. rufiventris* increased with the increase of the initial size of host at time of parasitism. Emerging adult parasitoid size varied significantly ($P<0.05$) with size of host stage at parasitism time. Parasitoid size increased with wasps emerging from larger sized hosts than

counterparts developing in smaller sized hosts. Adult wasp derived from large host larva was larger in size than adult wasp derived from small host larva. For instance, wasps derived from fourth instar hosts averaged 1.5±0.02 mg for males and 1.7±0.05 mg for females, vs. 1.3±0.02 and 1.4±0.01 mg, respectively, for wasps derived for first instar hosts.

II. Effect of host stage at parasitism and host deprivation on the longevity of resulting adult parasitoids

Mean longevity of non-ovipositing *M. rufiventris* wasps derived from different aged host larvae was studied. The size of *S. littoralis* larvae (fresh weight, mg) at the point of parasitism had strong effect on parasitoid's longevity. The life span of adult wasps increased significantly with increase of host size at parasitism. For instance, adult wasps derived from the fourth instar host larvae recorded the largest mean of adult longevity (16.5±0.8 days for males and 16.2±1.1 days for females) compared with those derived from preceding larval host instars.

Four groups of *M. rufiventris* females derived from first four larval *S. littoralis* instars were each subjected to various periods of host deprivation. Generally, the average longevity of ovipositing females was significantly shorter than the non-ovipositing females. For ovipositing females, as the duration of initial host deprivation increased, the longevity of adult females increased significantly ($P<0.05$). For female wasps, derived from fourth host instars, as the duration of the initial host deprivation increased to 5, 6, 7 or 8 days, the longevity significantly increased to 14.6±1.1, 13.4±0.7, 14.4±0.8 and 16.8±1.1

days, respectively, vs. 9.8±0.3 days for wasps with no privation of host larvae.

III. Effect of age and size of host-deprived *M. rufiventris* females on egg production

The internal reproductive organ of newly emerged *M. rufiventris* female was investigated and discussed. The number of mature ovarian eggs of various ages of host-deprived females derived from the first four instars of *S. littoralis* were studied in details. Mature eggs occupied the distal portion of each ovariole (egg reservoir) and the swollen portion of the commencement of lateral oviducts "calyces". The results suggested that the number of mature ovarian eggs varied with the age of *M. rufiventris* females and with the size of the host *S. littoralis* stage within which the parasitoid has been developed. Female wasps derived from eggs oviposited in late first, early second, early third or early fourth *S. littoralis* larvae (L_1, L_2, L_3 or L_4) emerged with almost no eggs in the calyx region, but with a good amount of egg load (55.6±1.1, 61.0±1.8, 62.9±3.4 and 57.5±1.6 eggs, respectively) in the egg-reservoir. However, significantly smaller number of eggs were observed on younger (0.13 and 1.0 day old) and older (7 and 8 days old) parasitoid females than middle aged females (3 to 6 days old). Egg production thus increased 3 to 6 days after emergence and declined thereafter. Also, it is clear that size of the host on which an immature *M. rufiventris* developed could indirectly affect egg production of the resulting adult female. The data suggest that when *M. rufiventris* females maintained without hosts, the mature eggs accumulate in the oviducts and the day of maximum count was wasp size-dependent. Day of maximum count (125.5±4.0, 129.9±4.4, 127.3±2.7 and 130.3±4.7, respectively) of ripe

eggs was day 6, 3, 3 and 6 for females derived from eggs oviposited in L_1, L_2, L_3 and L_4 host instar larvae, respectively. It is clear that host deprivation changed the internal physiology of the female wasps and thus reduced the egg production.

In the course of the present study, during dissections of *M. rufiventris* host-deprived females for egg count determination, live first instar larvae and/or over-sized eggs were observed in excised calyx or ovarial reservoir of their mothers. This phenomenon was observed in host-deprived females (5-8 days old) derived from eggs oviposited in L_3 and L_4 hosts.

IV. Effect of host access on the egg production by previously host-deprived parasitoid females

The effect of host access on the egg production by previously host-deprived females derived from eggs oviposited in L_1, L_2, L_3 or L_4 was studied in details. Three variables of egg production were measured: 1) initial egg load (IEL) = No. of mature eggs at emergence of adult female wasp, 2) realized fecundity (RF) = No. of eggs laid for entire life, and 3) potential fecundity (PF) = No. of eggs laid for entire life + No. of remaining eggs in the oviducts of wasp female at death.

Observation on wasps for 3-5 minutes following eclosion showed that the IEL reached a good amount of mature eggs (56-63 eggs/female) in the ovarial reservoir with almost no eggs in the calyx region. *M. rufiventris* females fail to parasitize host larvae before the 25 minutes following eclosion. Thus, results of parasitization activity of *M. rufiventris* females suggested that the age-dependent parasitization of female's wasp only includes two main general periods: 1) parasitization plateau (i.e., steady increase in parasitization), and 2) declining

parasitization. Also, host-deprived parasitoids reabsorb present eggs causing failure of adult female to develop new eggs. In all cases, the onset of egg reabsorption was detectable 3 days after emergence of host deprived wasps. Therefore, female insect parasitoids should not be kept in the insectary more that three days from eclosion.

Results of effect of host access on the egg production by previously host-deprived females suggest that as the duration of the initial host deprivation increased the RF decreased and, in most trials, when deprivation lasted 7 or 8 days, the RF was half that of control females. For females derived from fourth instar hosts, the RF for control female was 98.7±7.6 eggs versus 34.0±2.2 eggs for those of host deprivation that lasted 8 days. Generally, the reduction in the RF was significant for deprivation lasted 3 days or more. Thus, the pattern of egg production in *M. rufiventris* females depended on the availability of hosts for parasitization. Also, the parasitization plateau in most tests was on the 2nd time after host availability. Declining parasitization started at the 3rd time of host availability. However, at the death of parasitoid females, their ovaries contained different quota of mature eggs. The number of remaining eggs was host size-dependent from which the parasitoid female was derived. For control females derived from L_1, L_2, L_3 and L_4; the number of remaining eggs/female reached 39.4±4.8, 58.1±2.5, 69.0±4.7 and 58.2±3.4 eggs, respectively.

V. Egg load and egg production in *M. rufiventris*

The newly emerged wasps contain significant amount of mature eggs that are available for oviposition after few minutes of eclosion day, i.e., eggs resulting from pre-imaginal vitelogensis.

- Egg load increases during the early phase of adult life.

- The sequence of egg production in *M. rufiventris* wasps may be in continuous mobility (ovigensis, ovulation and oviposition).
- When host-deprived females were given access to *S. littoralis* larvae they matured additional eggs at higher rates than those kept without hosts.
- Egg maturation in *M. rufiventris* females continued after wasp eclosion until the carrying capacity of the oviducts was reached at which point öogensis was inhibited.
- The presence of a range mature eggs from 56.0±1.2 to 63.1±3.5 eggs/female in the oviducts of newly emerged females and the ability of wasps to mature additional eggs during their life time indicated that *M. rufiventris* wasp is a weakly synovigenic* species.
- The present data suggest that the potential utilization of *M. rufiventris* female is at a narrow age range for augmentative releases against *S. littoralis* to insure highest parasitization in the field. In other words, this study proved that adult parasitoid females should be released in the field before 3 days after their eclosion.

More work is needed to be carried out on the physiology of egg production and oviposition in order to determine conclusively whether physiological constraints play a role in host selection behaviour of the parasitoid.

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* - Synovigenic wasps - those which can mature new eggs during adult life.
- Pro-ovigenic parasitoid species - those which do not mature new eggs during adult life.