10. Summary.

Studies on the species composition, prevalence and natural parasitism of pupal parasitoids of muscoid flies were carried out in selected localities of Pondicherry for a period of two years.

Of the four species of parasitoids recorded from the puparia of *M. domestica*, *S. cameroni* was the most predominant species (46.64%) followed by *S. nigroaenea* (25.66%), *D. himalayanus* (16.77%) and *P. vindemmiae* (10.94%). Same species of parasitoids were obtained from the pupae of *Hippelates* sp. also in which *S. cameroni* predominated (55.0%).

When the proportion of parasitoids recorded from the two host pupae was analysed, *S. cameroni* was significantly high in *Hippelates* pupae and low in *M. domestica*. *D. himalayanus* was significantly higher in samples with *M. domestica* than *Hippelates* pupae. The difference in the parasitism of parasitoids due to their host preference. The prevalence of *S. cameroni*, *D. himalayanus* and *P. vindemmiae* differ significantly between rural and urban areas, whereas no marked change in the prevalence of *S. nigroaenea* was observed between these two localities.
The natural parasitism of *M. domestica* pupae ranged between 3.99% and 43.3% in different months. The parasitism due to *S. cameroni* and *S. nigroaenea* was recorded throughout the study, whereas *D. himalayanus* and *P. vindemmiæ* were seasonal. The natural parasitism of *M. domestica* pupae was much more than that of *Hippelates* sp. pupae.

The relative density of host *M. domestica* pupae, ranged between 81.17 and 15.27, while the total parasitoids emerged from them varied between 24.92 and 1.25. Though the density of *M. domestica* pupae fluctuated widely without any clear trend, the parasitoid populations exhibited a definite peak during winter season.

In rural farms, *S. cameroni* and *S. nigroaenea* constituted the major proportion and their population showed a decline during the summer months. Whereas the population of *D. himalayanus* was found to increase during summer and rainy months. *P. vindemmiæ* was dominant with periodic peak in their densities during rainy as well as winter months. In urban farms, *S. cameroni* was abundant throughout the study period and others exhibited marked variations in different months.

The host pupal density was observed to be the important factor in determining the abundance of *S. cameroni*, *S. nigroaenea* and *P. vindemmiæ*, while it had no impact on the abundance of *D. himalayanus*. The climatological factors influenced the population
of host and parasitoids. Temperature and host density had a significant correlation with *S. cameroni*, *S. nigroaenea* and *P. vindemmiæ*. Rainfall and pupal density had a significant relationship with abundance of *D. himalayanus* and *P. vindemmiæ*. The relative humidity and host pupae had significantly influenced the population of *S. cameroni*, *S. nigroaenea* and *P. vindemmiæ* whereas they did not affect the population of *D. himalayanus*.

The population analysis had shown that the finite rate of increase of *M. domestica* fluctuated between 0.973 and 1.024. The corresponding figures for the population of *S. cameroni* *S. nigroaenea* *D. himalayanus* and *P. vindemmiæ* were 0.941 and 1.083, 0.939 and 1.070, 0.000 and 1.040 and 0.000 and 1.055 respectively.

The average immature developmental duration of *D. himalayanus* was 19.9±0.19 days for males and 20.0±0.27 days for females. For males and females of *P. vindemmiæ*, the average developmental duration was 14.8±0.3 and 15.5±0.4 days respectively.

In *D. himalayanus*, the average number of total progeny and female progeny emerged per female were 33.59 and 42.54 respectively with an average sex ratio of 1 : 4.17. While *P. vindemmiæ* produced the average total progeny and female progeny emerged per female were 10.0 and 13.6 respectively with an average sex ratio of 1 : 2.78.
The survival of *D. himalayanus* was significantly different with different foods but the survival of the males and females were not significantly different. However the longevity of *D. himalayanus* had a significant relationship with different types of foods. The female adults fed with a combination of honey and *M. domestica* pupae had the highest longevity followed by those fed with only honey or *Hippelates* pupae in combination with honey. On the other hand the male adult parasitoids fed with honey followed by both honey and *M. domestica* pupae exhibited the highest longevity. The survival of *P. vinjenniiae* had shown a significant difference with different food. But the longevity had a significant relationship with type of food. The female adults fed with honey and *M. domestica* pupae had the highest longevity followed by those fed with honey or *Hippelates* pupae and honey. The males showed a higher longevity when fed with honey followed by the combination of honey and either *M. domestica* or *Hippelates* pupae.

The life table analysis on *D. himalayanus* had shown that the average proportion of survival of female was 0.6. The mean total progeny and female progeny per female was 42.54 and 33.59 respectively. There was a significant negative correlation between the age of females with fecundity. The cumulative values of average daily m for the cohort showed that the growth rate of m per female increased exponentially. The age specific total progeny production and host destruction showed a significant relationship between the age of the female parent.
The life table statistics of *P. vindemniae* have shown that the average number of total and female progeny was 13.6 and 10 per female respectively with a maximum on second day of its emergence. The fecundity showed that there was a significant negative correlation between female age and fecundity. The cumulative average daily $m_x$ for the cohort and the regression statistics have shown that the growth rate of $m_x$ per female increased exponentially. The age specific total progeny production and host destruction indicated that there was a significant correlation between the female age.

The mean generation time ($T$) of *D. himalayanus* and *P. vindemniae* was 26.1 and 17.9 days respectively. The net reproductive rate ($R_0$), host destruction rate ($R_d$), finite rate of natural increase ($\lambda$) and finite rate of natural increase of total progeny ($\lambda_t$) were 1.137, 1.156, 1.137 and 1.156 and 9.9, 13.4, 1.132 and 1.153 respectively for these two species.

The age specific fecundity curves of *D. himalayanus* and *P. vindemniae* are skewed to right indicating that females in older classes produced lesser number of female progenies. The host destruction activity of *D. himalayanus* and *P. vindemniae* differ markedly, the former possesses greater endurance for destruction than the latter.

The total progeny production rate, net reproductive rate and net
host destruction rate were very high in *D. himalayanus* when compared to *P. vindemniae*. However intrinsic and finite rates of increase of total progeny, female progeny and host destruction did not differ markedly between these two species.

The average host destruction activity of *D. himalayanus* studied with *M. domestica* and *Hippelates* sp. as host pupae it varied from 116.8 to 63.4. The corresponding values for *P. vindemniae* were 34.3 and 14.1 respectively.

The effect of density and temperature on average survival, fecundity and host destruction of *D. himalayanus* and *P. vindemniae* were studied by providing *M. domestica* pupae. As host density increase, the mean generation time decreased from 28.3 days (5 host pupae/day) to 26.1 days (40 host pupae/day). But the progeny production decreased when 40 host pupae per day were offered though an increase was observed in the host destruction. Similar results were obtained in *P. vindemniae* also.

The survival was maximum at lower but declined at higher temperature. The total progeny production and host destruction were higher at lower temperature but declined with higher temperature. There was a significant negative correlation between the progeny production and temperature but the host destruction did not show any correlation. The proportion of females decreased at higher
temperature but there was no correlation. The total progeny production, female progeny production and host destruction of *P. vindemniae* decreased at higher temperatures with the maximum at 24 C. The life table parameters of *P. vindemniae* cohorts exposed at the varying temperature showed a decline with increase in temperature.

The virgin females of *D. himalayanus* produced male progeny and survived for a maximum of 22 days. This confirms the arrhenotokous parthenogenesis in this species. The maximum average host destruction activity was noticed on 4th day of adult emergence and it continued till the death of female. The net total progeny increase (R) was 24.4 per female and the intrinsic rate of total progeny increase was 0.123. The net host destruction (R) and the intrinsic rate of host destruction were 96.6 and 0.163 respectively. The above values obtained for mated individuals were more higher than that of virgins.

The virgin females of *P. vindemniae* survived for a maximum of 7 days and produced male progeny arrhenotokously. The progeny production and host destruction activities were maximum on the second day of emergence. The net total progeny (R) was 5.6 per female and the intrinsic rate of increase was 0.100. The net host destruction (R) and the intrinsic rate of host destruction were 12.1 and 0.141 respectively, which were comparatively higher than that of mated individuals.
Weekly collections of synanthropic muscoid flies from different resting and feeding sites by using a hand net yielded a total of 33,185 flies of which *M. domestica* was the predominant constituting 91.46% of the total. Other species obtained in order of their abundance were *Musca sorbens* (3.17%), *Stomoxys calcitrans* (1.84%), *Fannia canicularis* (0.63%), *Muscina stabulans* (0.47%), *Chrysomyia sp.* (2.28%), *Hippelates sp* (0.69%), *Sarcophaga sp.* (0.57%) and *Ophyra sp.* (0.02%).

The fecundity of *M. domestica* varied from 68 to 130 with a mean of 114.6±21.6 eggs per female. The duration of first, second and third instar larvae have the mean duration of 1.0 (1-2), 1.0 (1-3) and 2.5 (2-5) days, respectively. The pupal duration was 3.5 days (3-6) days. The emergence was maximum during the early hours of the day and continued till noon with a decline in the afternoon. The mean sex ratio (Male : Female) was 1 : 0.97. The longevity of adults ranged from 5-25 days in the laboratory conditions and a maximum of 4 gonotrophic cycles were observed with the first on the fifth day of emergence.

The relative density of immature stages of *M. domestica* fluctuated between 956.2 and 424.2. The pupal density ranged between 137.4 and 50.3. During the summer months, the pupal density was maximum suggesting the highest survival of immatures. In the rainy season the lowest pupal density was recorded.
The per man hour density of flies collected by sweep net in various months in the study area ranged between 4137 and 784 during the study period. The density showed a peak during the month of August and declined during rainy months and the lowest density was recorded in the winter season.

The density of flies as estimated by Scudder's grill fluctuated between 7.8 and 2.4/grill/30 sec. The hotter months of the year recorded a peak density, followed by a decline during rainy months and with the lowest numbers during the post rainy months. The various meteorological factors influence the seasonal abundance of house flies. The probability of daily survival of adults was maximum (0.907) during the summer and minimum (0.857) during pre-monsoon period.

The average natural parasitism of *M. domestica* pupae in the experimental farm during pre-release period was 18.73% while 32.22% in the check farm. During the release period, it was 50.14%, and 30.76% in the experimental and check areas respectively. Increase in the parasitism in experimental area might be due to the inundative releases of *D. himalayanus*. During post release period, the natural parasitism was 70.78% in experimental and 33.41% in check farms respectively. The percentage increase of parasitism of *M. domestica* pupae in experimental area, during release and post release periods were 167.74% and 277.85% than that of pre-release period. Whereas in the check area during the corresponding periods it fluctuated with a decrease of 4.55% and an increase of 3.68% respectively.
A significant variation in the natural parasitism of parasitoids was obtained in the experimental area \( X^2 = 894.163, P=0.000 \) whereas in the check area it was not significant \( X^2 = 3.506, P=0.1732 \). The relative density of host pupae was 38.0, 62.3 and 71.5 per litre of manure during pre-release, release and post-release periods in the experimental farm while it was 13.29, 20.86 and 26.3 respectively during the corresponding periods in check area.

The relative density of adult populations of *M. domestica* during pre-release period was 3.50/grill/30 sec. in the experimental and 2.64/grill/30 sec. in check farms. During the release period the density was 2.30/grill/30 sec. in experimental and 4.97/grill/30 sec. in check areas. While during the post-release period it was 2.08/grill/30 sec. and 3.93/grill/30 sec. in the experimental and check farms respectively. During the release and post release periods there was a reduction of 34.17% and 40.47% of the pre-release density in the experimental area. While in the check area, there was an increase in the density of flies during the corresponding period. The t test was performed on the mean fly grill counts obtained during pre-release, release and post-release periods in the experimental farm. A significant reduction was obtained during the release period and post-release periods than pre-release period in the experimental farm \( (P<0.005) \). The decrease in the experimental farm was significantly higher than that of the check farm during the corresponding periods \( (P<0.005) \).