CHAPTER 5
DISCUSSION

The incidence pattern of aphids is generally known to be governed directly or indirectly by abiotic (temperature, relative humidity, rainfall, sunshine hours etc.), as well as biotic factors (predators, parasites, host age and quality etc. Dixon, 1985). A cumulative effect of two or more factors and in certain cases even the effect of one becomes responsible fluctuation of aphid populations.


Regular sampling of the predator and aphid prey *L. erysimi* in four cultivated crops revealed that the incidence of both the prey and predator commenced from November and continued up to March in both the cropping seasons i.e. (2009-2011). Similar observations were also reported by Singh & Rawat (1979); Bakhetia et al (1986), Phadke (1986), Singh (2005); Kalra (1988); Devi et al (1997) and the Biradar & Dhamorkar (2004) on the different species of *Brassica*. Murali Baskaran et al (2009) also reported similar pattern of incidence of *E.balteatus* associated with *A.gossypii* on guava in Tamil Nadu.

In the present observation maximum population of both *E.balteatus* and its prey *L. erysimi* was observed during the early part of February on *Brassica juncea* cv M27. Similar peak period of the predator and the prey aphid *L. erysimi* also observed by Devi et al (1997) on a local variety of mustard, *Brassica juncea* var. *rugosa* in Manipur. Bijaya; Singh and Sudersana (1997) also reported the peak activity of the predator, *E.balteatus* coinciding with maximum incidence of aphid, *Myzus persicae* in December to January on cabbage. Thereafter, the numerical abundance
of both the predators and the prey showed a declining trend with rise in temperature. Similar peak period of *E. balteatus* and prey aphid, *L. erysimi* was also observed by Devjani *et. al* (1997) during the month of December / January on cauliflower.

Likewise, Kumar *et. al* (2000) reported the appearance of *L. erysimi* at the last week of January with the maximum increase in population upto seventh standard week of February. This findings are conformity with that of Gami *et. al* (2002) who had observed the maximum population of *L. erysimi* during the third week of January on mustard crop in Gujarat.

In the present investigation the peak activity of the predator *E. balteatus* (1.2 predator/ sample) was observed at the first week of February, coinciding with the maximum infestation of the aphid (114.74 aphids / plant) in cauliflower in the first cropping season (2009-2010). Again, in the second cropping season (2010-2011), similar trend of population incidence of *L. erysimi* occurred in the second week of November, attaining its maximum abundance in the first week of February (45.85 aphids / plant), coinciding with peak activity of predator. *E. balteatus*. Usually maximum activity period of the predator coincided with the peak period of its prey in different ecosystems. Likewise, Romabai *et. al* (2011) recorded the maximum population of *E. balteatus* (105 predator/sample) at the first week of February coinciding with the infestation of *L. erysimi* (101.45 aphids/sample) on *Brassica oleracea* var. capitata during (2008-2010). Moreover, Romabai *et. al* (2012) observed the peak populations of *L. erysimi* and *Episyrphus balteatus* during the month of February in both the cropping seasons (2009-2011) on *Brassica oleracea* var. gongylodes in Manipur.

Although most of the aphid species are generally found throughout the year, their maximum numbers are recorded during specific period as also evident in other species of aphids such as *R. padi* (Dhaliwal & Singh, 2004), *M. persicae* (Devi *et. al*, 2002; Satpathi, 2002 and Bijaya *et.al.* 2006); *A. craccivora* (Malik
et.al, 1991; Singh 2002; Lokeshori et. al., 2007; and Devikarani Kh. 2013); A. gossypii (Rai et al., 1989, Devi et al. 2009); Likewise, Singh & Singh (2004) observed the peak activity of *L. erysimi* in the month of last week of February. This findings are in conformity with those of Sharma and Vanna et. al. (1997), Chitra Devi et. al (1997); Bilashini et.al (2007). Moreover, Romabai, et. al. (2011) observed the peak infestation of *L. erysimi* on *Brassica oleracea* var. *gongylodes* in the first week of February i.e. (70.6 aphids/ plant) in 2009-2010 and (85.65 aphids/ plant) in the second week of February in 2010-2011. Further, they reported that the peak infestation of the aphid prey *L. erysimi* coincided with the maximum activity of the predator, *E. balteatus* (1.35 predator/ sample) in 2009-2010; and (2.25 predator / sample ) in 2010-2011.

5.1.1. Correlation co-efficient of *E. balteatus* with *L. erysimi* and abiotic factors.

Analysis of correlation coefficient of *E. balteatus* with *L. erysimi* and abiotic factors show a highly significant positive correlation (value of ‘r’ ranging from 0.712 to 0.963) (table 1a) was obtained between population of the predator and prey aphid for two cropping seasons during (2009-2011) on all the four cultivated crops. A high positive correlation between aphids and predator reflected that as the aphid density increased, proportionately the population of the predator was also enhanced. The present results in general are in conformity with the findings of Chandra & Khushwaha (1987), Kalra (1988), Bakhetia et. al (1989), Reddy et. al. (2001a); Satpathi (2002) and Nonita et.al. (2003)

The present study on the effect of abiotic factors such as temperature, wind speed and sunshine hours had revealed highly significant positive correlation with the population of prey aphid and predator, *E. balteatus*, whereas relative humidity and rainfall show weak negative correlation. Similar observations were also reported by Butani and Kapadia (1997), Bijaya et.al. (2001), Biradar and Dhanarkar (2004) and Bilashini et.al (2011). However, Paul and Konar (2005)
reported that the predator had negative correlation with the temperature and rainfall, while Jalali et.al, (2004) had reported positive correlation between the temperature and predator. As such, when the temperature become high, the density of the aphids attained maximum which in turn was conducive for population build up of the predator (Romabai et.al. 2012).

5.2 Predatory potential of syrphid, *E. balteatus* at different prey densities of *L. erysimi*.

5.2.1 Functional reponse of *E. balteatus*:

Several studies have demonstrated the effect of Prey quantity on the consumption, survival and reproduction of aphidophagous predators (Ives et. al, 1993, Radhakrishnan and Muraleedharan, 1993; Murali Baskaran et. al 2009 and Raina et. al 2013). Results obtained from the present investigation revealed that the prey consumption by the predatory stages of *E. balteatus* increases with an increased in the prey density from 5 to 75 aphids per day. Thereafter, the rate of consumption tends to level. The present findings suggest that the prey density has a significant influence on the rate of prey consumption, which conforms to the Type II model of Holling (1965). Agarwala et. al (2001) suggested such a response, as typical of predators foraging in unstable prey populations. Numerous studies have also demonstrated the effects of prey quantity on the consumption of predators and most of them are reported to show similar functional response (Bijaya et. al, 1997, Singh and Mishra, 1988; Verma and Sharma, 2006).

The present findings are in close conformity to those recorded on other syrphids (Chitra et. al, 1996, Agarwala and Saha, 1986). Several workers (Baskaran et. al, 2009; and Romabai et. al, 2012) have also reported Type II functional response in predators to be characterised by a predetion rate that increases at a decreasing level with increasing prey density until a plateau was reached. The effect of variable prey densities on the life cycle parameters of *E. balteatus* showed a progressive increase in prey density resulted in corresponding decrease in larval period but not the pupal period, (Samuel, 2000). At lower prey
density the aphids were more spaced out, therefore the predator expended more time and energy in foraging which included searching, locating, attacking, subdueing and handling of prey. The findings are in conformity with those recorded on *P. dissecta* (Pervez, 2002). Thus at low prey density, searching efficiency of predatory stages of the larvae increased which are in close agreement to that recorded by Tamaki & Long (1978). Meanwhile, at higher prey density, prey encounters were more frequent and the predator continued to feed till satiation even beyond. This findings support that searching is affected by the dispersion pattern (Hassell, 1992) as well as density of aphids (Omkar & Pervex, 2004 a).

It was also interesting to accentuate that the predator after attaining satiation, did not completely devour the prey but ate only the soft portion, leaving behind the harder appendages. This tendency of a predator to increase pre mortality even after attaining satiation found the basic aspect of predator – prey interaction and sustainable biocontrol programme.

Moreover, from the results obtained it was confirmed that the third instars larva of *E. balteatus* was the most voracious predatory stage, in compare with other larval instars at different prey densities offered. The maximum consumption of prey by third instars larva have been attributed to several factors, they have been opined to be more efficient in detecting and consuming larger proportions of the prey (Hassell, 1992). A major factor which tends to make the third instars larva more voracious than the other stages is the stress of high energy requirement for the completion of its development and attainment for critical weight for pupation. Similar inference was also drawn by (Bargen, & Scholz, 2001, Verma *et. al* 2005; and Romabai *et. al* 2012; and Raina, 2013).
5.2.2. Somatic growth rate of *E. balteatus* larvae at different prey densities of *L. erysimi*.

5.2.2. (a) Duration of different life stages of *E. balteatus* (at different prey densities of *L. erysimi*).

The results on the growth and development of *E. balteatus* at varying prey densities 5, 15, 30, 45, 60, 75 and 90 individuals of aphid prey, *L. erysimi* showed that prey density of 75 individuals per day was the most suitable and considered as optimum for its growth and development.

The successive instars developed fastest at prey density of 75 aphids per day. The present studies revealed that decreasing in the food rates increases development time and delayed larval growth. It is interesting to note that at prey densities of 5 aphids per day, the larval mortality was 100 per cent. However, there was no larval mortality at 15 aphids per day and onwards. The total larval period was shortest at prey density of 75 individuals. Thus it can be inferred that the quality and quantity of food (aphid prey) consumed has substantial influence on growth and development of the larva. The findings are in conformity with those recorded on several syrphids, viz, *B. serarius*, *E. balteatus*, *I. scutellaris* and *M. confrator* (Agarwala, Bhaumik and Gilbert, 1989); *E. balteatus* (Raina et al., 2006); *E. balteatus* and *I. scutellaris* (Chitra et al., 1996); *P. serratus*, *E. balteatus*, *I. scutellaris* and *D. aegrota* (Murali Baskaran et al., 2009) and *E. balteatus* (Romabai et al., 2011-2012).

The pupal duration of *E. balteatus* was recorded to be shortest (6.12 ± 0.8) when the larva were reared at the prey density of 75 individuals per day and longest (8.25 ± 0.46) at prey density of 15 aphids per day. The larva when reared at prey densities of 5 aphids per day occurred 100 per cent mortality before entering the pupal stage. Kawauchi (1979) opined that decreased consumption may lead to a state of semi-starvation which may leads to slower pre-imaginal development and decreased immature survival. An enrichment of nutrients in the pupa offered with higher density of prey aphids probably increased the metabolic activities in it.
which expedited the development thereby resulting in decreased pupal duration. Similar inferences were drawn in case of coccinellids also by several workers (Dimetry, 1976, James, 2001, Omkar and Srivastava, 2002).

The total developmental period was shortest at prey density of 75 individuals per day and longest at prey density of 15 individuals per day. Hence, the development period of the syrphid instars was found to be proportionate to the amount of food eaten by them. Reduced consumption probably led to reduced nutritional levels thus having a substantial effect on total period of development of *E. balteatus*. Thus, the quantity of prey aphid offered revealed a great effect on the period of larval development of syrphids. Similar observations were also recorded on *Hippodamia quinquesignata* (Kaddu, 1969, *E. balteatus* and *I. scutellaris* (Chitra et. al 1996), *E. balteatus* (Singh & Mishra, 1988); *E. balteatus* and *M. confrator* (Bijaya et. al, 1997); *E. balteatus* (Samuel et. al, 2005), *E. balteatus*, *I. scutellaris* (Devjani et. al, 2006) and *E. balteatus* (Romabai et. al 2013).

Longevity of *E. balteatus* adults were affected to a certain extent by varying prey densities offered to them. Highest longevity irrespective of sexes was observed at prey densities of 75 individuals per day and lowest at prey density of 15 individuals per day. These may possibly result in the increased storage of food reserves in the form of fat in females.