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Population Dynamics of the Introduced Ladybird Beetle, *Curinus coeruleus* Mulsant in Relation to its Psyllid Prey *Heteropsylla cubana* Crawford in Bangalore

J.DIRAVIAM* and C.A.VIRAKTAMATH
Department of Agricultural Entomology
University of Agricultural Sciences
Bangalore - 560 065

ABSTRACT

***Curinus coeruleus* Mulsant, a ladybird beetle has been introduced into India for the control of the subabul psyllid *Heteropsylla cubana* Crawford. It has established itself in the subabul fields of the University of Agricultural Sciences, Bangalore. In the present investigation, population dynamics of the predator and the prey along with weather parameters were studied. The study revealed the dependence of *H. cubana* on weather parameters particularly rainfall. The population of psyllids gradually declined during summer (May) which was followed by the decline of predator population. Build up of the psyllid population started with the onset of rains, which favoured emergence of new flush of subabul during the third week of May. *C. coeruleus* population also gradually increased after the psyllid build up. Partial regression coefficient revealed a strong negative correlation between adult predators and wind speed. Predator adult population had a significant positive relationship with maximum temperature (r=0.6958), minimum temperature (r=0.5378) and hours of sunshine (r=0.6273) but significant negative, relationship with relative humidity (r=-0.7352), psyllid nymphs (r=-0.4250) and wind speed (r=-0.9093). Multiple regression equation was also fitted to predict the predator adult population.**

Key Words : Population dynamics, *Curinus coeruleus, Heteropsylla cubana*, subabul

The exotic ladybird beetle, *Curinus coeruleus* Mulsant has been introduced into India following the outbreak of the subabul psyllid *Heteropsylla cubana* Crawford (Veeresh, 1990). *C. coeruleus* was introduced during October 1988 into Bangalore from Thailand (Jalali and Singh, 1989) and the predator has established itself in the subabul fields. Nakahara *et al.* (1987) studied the population dynamics of *C. coeruleus* for a period of two years in Hawaii. They found that there was a cyclical relationship among four main components in the leucaena ecosystem *viz.*, adequate soil moisture (rainfall), periodic flushing of the leucaena, the leucaena psyllid (prey) and *C. coeruleus* (predator). In this investigation, the population of the predator and prey were monitored along with other parameters for a period of thirty weeks.

MATERIALS AND METHODS

A plot of 90 sq.m. planted with subabul trees located behind the Veterinary College UAS, Hebbal, Bangalore was selected for the study on population dynamics of *C. coeruleus* and its prey, *H. cubana*. Subabul trees were spaced at 2 x 1 m and they were of 2.1 m height. In this plot, weekly observations were made on the number of grubs and adults of *C. coeruleus* and its prey *H. cubana* (eggs, nymphs and adults separately). The observations were

* Department of Agricultural Entomology, Tamil Nadu G.D. Naidu Agricultural University, Coimbatore - 641 003

recorded from 23rd March, 1990 to 12th October 1990.

Sixty branches were selected randomly from 30 trees by taking two branches per tree, the trees being the same throughout the study. Observations were made at a height of 1.5 to 1.8 m from the base of the tree. Adults and grubs of *C. coeruleus* and adults of *H. cubana* were visually counted without touching the branch. For etimating the population of eggs and nymphs of *H. cubana*, ratings were followed as developed by Bray and Woodroffe (1988).

Egg numbers were estimated using the following rating system (eggs are laid between the pinnules of the unexpanded leaf).

0 : no eggs visible
1 : few scattered eggs only
2 : less than 20% of pinnules with eggs
3 : between 20% and 75% of pinnules with eggs
4 : Most or all pinnules with eggs
5 : Young leaves and stems covered with eggs

Nymphal population was estimated by using the following rating system because of the presence of large number of nymphs (ratings are expressed in numbers per branch).

0 : none present
1 : less than 5
2 : between 5 and 30
3 : between 30 and approximately 100
4 : Large numbers restricted to leaf only
5 : Large aggregations extending onto stem.

From the observations, the number of adults and grubs of *C. coeruleus* and the adults of *H. cubana* were calculated per five branches dividing the total by 12. Whereas, mean ratings were taken for eggs and nymphs of *H. cubana*. Data on weather parameters *viz.*, maximum and minimum temperatures, rainfall, relative humidity, hours of sunshine and wind speed were collected from the meteorological observatory at the Main Research Station, Hebbal, which was about one kilometre north of the study site (Table 1).

Logarithmic transformation of the data was made for statistical analysis. Simple correlation and regression, multiple correlation and multiple linear regressions were made for the fluctuation of *C. coeruleus* population with prey *H. cubana* and weather factors by the methods given by Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

The initial population of *C. coeruleus* during the third week of March was 4.75 adult beetles per five branches and 2.58 grubs per five branches, when the psyllid population was also high (adult psyllids - 131.5/5 branches; egg rating 2.35 and nymph rating - 2.33) (Table 1). The population of psyllids gradually declined and reached the lowest level during the first week of May (Fig. 1). The predator adults also gradually declined (1.08/5 branches) by second week of May, whereas the grubs disappeared by the last week of April. These observations are in agreement with those of Nakahara *et al.* (1987).

The population of psyllids sharply increased after the third week of May following rain in the previous two weeks and reached the peak by third week of June and then it started fluctuating. Whereas, predator grubs appeared in the second week of June, gradually increased and reached the peak in the last week of August, thereafter it fluctuated slightly.

The adult predators were very low in number during the second week of June. Later on it was almost constant upto the last week of August (Fig.1). By first week of September it again rose up and reached a peak in the third week of September and later it was almost constant.

After second week of September the psyllid population gradually declined, particularly

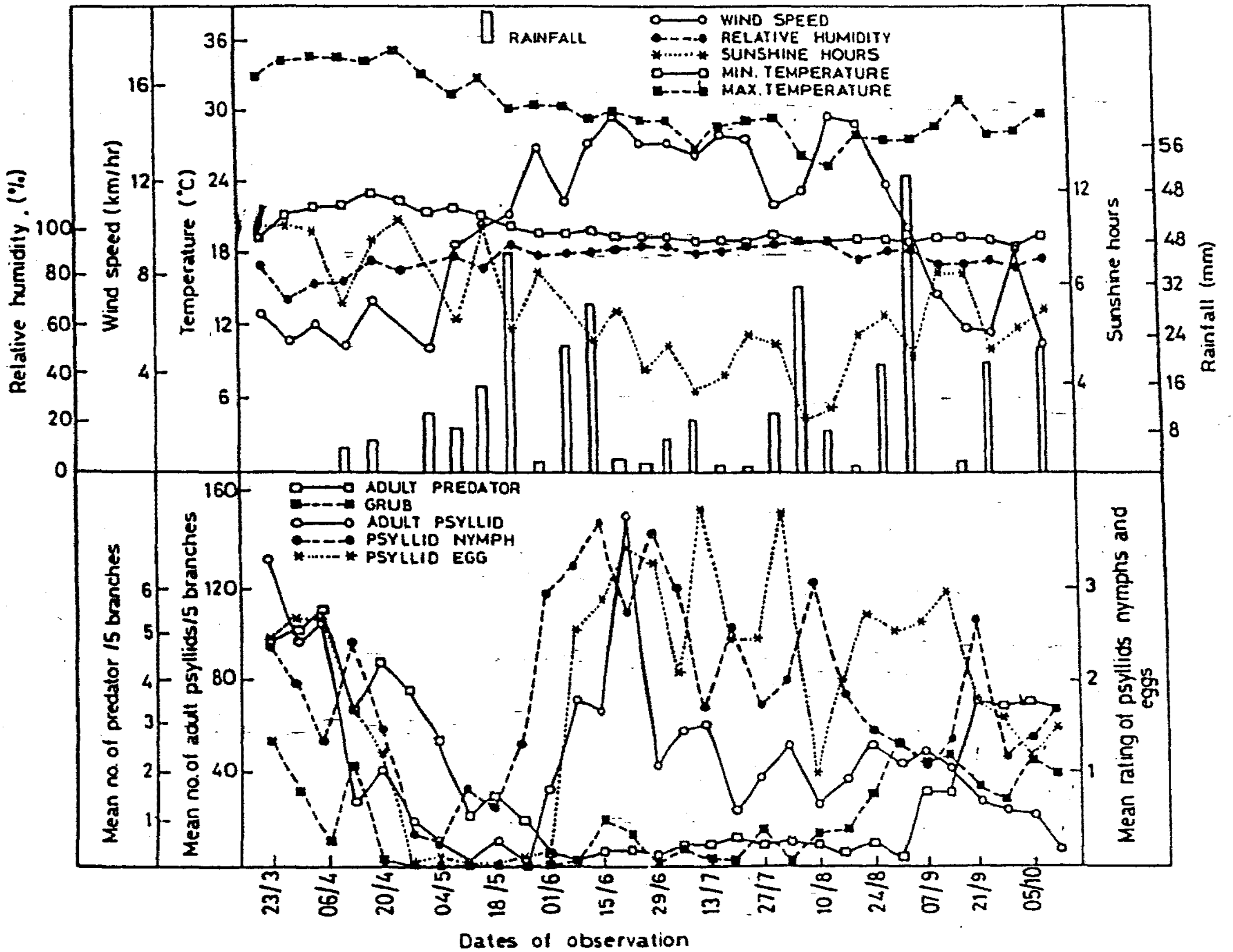

Fig. 1. Population fluctuation of different stages of the predator *Curinus coeruleus* and its prey *Heteropsylla cubana* during March to October 1990

Table 1. Population dynamics of *Curinus coeruleus* and its prey *Heteropsylla cubana* and weather parameters

Date of Observation	Adult Predator per 5 branches	Predator grubs per 5 branches	Adult psyllids per 5 branches	Mean egg rating	Mean nymph rating	Mean Max Temp °C	Mean min Temp °C	Mean relative humidity (%)	Mean wind speed (Kmph)	Mean sun shine hours	Rain in that week (mm)
23-3-90	4.8	2.6	131.5	2.4	2.3	32.9	19.6	86.0	6.5	10.2	0.0
30-3-90	5.0	1.6	95.9	2.6	1.9	34.3	21.5	71.0	5.4	10.3	0.0
6-4-90	5.5	0.5	104.7	2.7	1.3	34.8	22.1	78.0	6.1	10.0	0.0
13-4-90	3.3	2.1	26.4	1.7	2.4	34.6	22.2	79.0	5.2	6.9	3.8
20-4-90	4.3	0.1	41.0	1.2	1.4	34.3	23.2	88.0	7.1	9.7	5.0
27-4-90	3.8	0.0	19.9	0.0	0.4	35.4	22.6	84.0	6.0	10.6	0.0
4-5-90	2.7	0.0	10.4	0.2	0.2	33.3	21.7	86.0	5.1	8.6	9.9
11-5-90	1.1	0.0	0.0	0.0	0.8	31.6	22.1	90.0	9.5	6.3	7.7
18-5-90	1.5	0.0	11.4	0.1	0.6	33.2	21.5	85.0	10.4	10.4	13.5
25-5-90	1.0	0.0	3.8	0.1	1.3	30.3	20.7	95.0	10.6	5.7	36.5
1-6-90	0.3	0.0	33.3	0.2	2.9	30.8	20.2	91.0	13.6	8.3	1.8
8-6-90	0.2	0.1	72.0	2.6	3.2	30.5	20.1	92.0	11.3	7.0	21.0
15-6-90	0.3	1.0	65.6	2.9	3.7	29.6	20.5	93.0	13.8	5.4	28.0
22-6-90	0.3	0.7	149.6	3.5	2.7	30.4	19.9	94.0	15.0	6.7	2.3
29-6-90	0.2	0.0	43.6	3.3	3.6	29.3	19.9	96.0	13.8	4.3	1.8
6-7-90	0.4	0.3	57.7	2.1	3.0	29.5	19.8	96.0	13.9	5.3	6.1
13-7-90	0.4	0.2	60.8	3.8	1.7	27.0	19.3	93.0	13.3	3.4	8.9
20-7-90	0.7	0.1	22.8	2.4	2.5	29.1	19.6	93.0	14.4	4.1	1.5
27-7-90	0.4	0.8	38.8	2.4	1.7	29.7	19.4	96.0	14.1	5.8	0.8
3-8-90	0.5	0.1	50.2	3.7	2.0	30.0	20.1	96.0	11.3	5.4	10.3
10-8-90	0.4	0.7	25.3	1.0	3.0	26.7	19.6	99.0	11.9	2.3	31.5
17-8-90	0.3	0.8	36.6	2.0	1.8	25.9	19.4	96.0	15.2	2.9	7.7
24-8-90	0.4	1.5	51.8	2.7	1.4	28.6	19.8	91.0	14.8	5.8	1.5
31-8-90	0.2	2.6	43.5	2.5	1.3	28.4	19.7	94.0	12.3	6.7	19.0
7-9-90	1.6	2.2	48.7	2.6	1.0	28.4	19.6	96.0	10.1	4.8	50.5
14-9-90	1.5	2.3	41.3	3.0	1.3	29.7	20.0	89.0	7.4	8.5	0.0
21-9-90	3.5	1.7	28.6	1.8	2.6	31.9	20.2	89.0	6.2	8.5	2.8
28-9-90	3.4	1.4	24.3	1.6	1.2	28.8	19.9	92.0	6.0	5.3	19.4
5-10-90	3.5	2.3	22.9	1.2	1.4	29.2	19.2	88.0	9.4	6.2	0.2
12-10-90	3.3	2.0	7.7	1.5	1.7	30.6	20.3	91.7	5.4	7.0	22.0

Table 2 Correlation coefficients of *Curinus coeruleus* with *Heteropsylla cubana* and weather parameters

	Predator Adults	Predator grubs	Psyllid adults	Psyllid eggs	Psyllid nymphs	Maximum Temperature	Minimum Temperature	Relative humidity	Wind speed	Sunshine hours	Rainfall
Predator adults	-	0.3162	-0.0595	-0.2247	-0.4250*	0.6958**	0.5378**	-0.7352**	-0.9093**	0.6273**	-0.2045
Predator grubs		-	0.2942	0.4094*	0.0844	-0.1324	-0.3332	-0.1655	-0.2874	0.0699	0.0692
Psyllid adults			-	0.7506**	0.4755**	-0.0637	-0.3091	-0.1006	0.1625	0.0430	-0.2122
Psyllid eggs				-	0.5422**	-0.3688*	-0.5069**	-0.1450	0.2668	-0.2913	-0.0885
Psyllid nymphs					-	-0.3144	-0.4364*	0.2805	0.4351*	-0.3637	-0.0357

* Significant at 5% ** Significant at 1%

that of adults which became very low (7.76/5 branches) by the second week of October.

The nymphs and eggs which declined by the last week of September increased after the first week of October. The observations were taken upto the second week of October, hence, further trends could not be studied.

Correlation analysis showed that adult predator population had a significant positive relationship with maximum temperature ($r = 0.6958$), minimum temperature ($r = 0.5378$) and hours of sunshine ($r = 0.6273$) but significant negative relationship with relative humidity ($r = -0.7352$), psyllid nymphs ($r = -0.4250$) and wind speed ($r = -0.9093$) (Table 2). Predator grub population had a significant positive relationship with psyllid eggs ($r = 0.4094$). The influence of other factors was not significant.

Adult psyllids had a significant positive relationship with psyllid eggs ($r = 0.7506$) and psyllid nymphs (0.4755). Psyllid eggs had a significant positive relationship with psyllid nymphs ($r = 0.5422$) but negative relationships with maximum temperature ($r = -0.3688$) and minimum temperature ($r = -0.5069$). Psyllid nymphs had a significant positive relationship with wind speed ($r = 0.4351$) and negative relationship with minimum temperature ($r = -0.4364$).

The partial regression coefficient of the adult predator with wind speed was highly significant. However, the partial regression coefficients of other factors were not significant. The multiple regression equation fitted with predator grubs, psyllids (eggs, nymphs and adults) and weather parameters to predict the predator adult population (Y) was :

$$Y = -0.6913+0.1902 X_1+0.0704 X_2 -0.1343 X_3 -0.2286 X_4+2.5780 X_5 - 0.8649 X_6 -0.1718 X_7 - 1.2408 X_8 - 0.4325 X_9 -0.0676 X_{10}$$

with R^2 value of 0.8793.

When weather parameters alone were considerded the equation was

$$Y = 0.7956+0.5765\, X_5 - 0.6959\, X_6 - 0.7261\, X_7 -1.4477\, X_8 - 0.0721\, X_9 - 0.0690\, X_{10}$$

with R^2 value of 0.8622.

Where X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9 and X_{10} denote predator grubs, psyllid adults, psyllid eggs, psyllid nymphs, maximum temperature, minimum temperature, relative humidity, wind speed, hours of sunshine and rainfall, respectively.

Partial regression coefficient showed that wind speed had a strong negative correlation with adult predators. The reason may be that *C. coeruleus* avoided wind by confining to the lower part of the tree or hiding among the branches. This can be supported by the report of Wagiman *et al.* (1990) that the predator had a low dispersal capacity that it could spread upto five km only in a span of three years. Predator grub population had a significant positive relationship with psyllid eggs. This is due to the fact that coccinellids oviposit only under high prey density (Evans and Dixon, 1986).

Weather factors had a significant regulatory effect on psyllid population while the predator did not have any effect on the prey population. But it is premature to conclude anything since the predator was introduced just two years ago and it may take some more time to acclimatize to the new habitat and attain homeostasis with its prey.

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