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SPATIAL DISTRIBUTION OF THREE SPECIES OF COCCINELLID PREDATORS ON OAK PLANT

T.K. SINGH, M.A. SATTAR SHAH* AND DEVIKARANI KH.
DEPARTMENT OF LIFE SCIENCES
MANIPUR UNIVERSITY, CANCHIPUR -795 003, INDIA.
DEPARTMENT OF ZOOLOGY, Y.K. COLLEGE, WANGJING-795 148, INDIA*.
(e-mail : tksingh06@yahoo.co.in)

The spatial distribution of three coccinellid predators-*Harmonia dimidiata* Fabricius, *Harmonia eucharis* (Mulsant) and *Cheilomenes sexmaculata* Fabricius on oak plant was studied at experimental field of Regional Tasar Research Station (RTRS), Mantripukhri, Manipur during two consecutive cropping seasons (2009-10 & 2010-11). The various statistical parameters-variance to mean ratio, mean crowding, Llyod's index of patchiness, index of clumping, mean colony size, dispersion parameter- k, co-efficient of variance, Iwao's regression and Taylor's Power Law were used to study the distribution pattern of predators on oak plant. The predators were observed to follow contagious distribution on oak plant.

Key words : Spatial distribution, *Harmonia dimidiata. Harmonia eucharis, Cheilomenes sexmaculata.*

INTRODUCTION

The knowledge of spatial distribution pattern is essential in understanding the interactions between pests and predators and is a prerequisite for development of sampling plans for estimating and monitoring the pest and its natural enemy abundance (Onzo *et. al.*, 2005). The spatial distribution of an insect can be employed in investigating population dispersion behaviour, establishing a precise sampling scheme and sequential sampling (Margolis *et al.*, 1984), binomial sampling (Binns & Bostanian, 1990), studying of population dynamics (Jarosik *et al.*, 2003) and in detecting pest levels that justify control measures (Arnaldo & Torres, 2005).

The oak tree which form the major food plant of Tasar silkworm are susceptible to several pests of which the oak aphids constitute a major one. Biological control utilizing predators particularly ladybeetle has received wide attention and is a viable component of Integrated Pest Management. Population of predators increases rapidly under favourable environmental conditions and hence an understanding of the population build up of pest and study of spatial distribution of both prey and predators is a must for effective pest management. However, a detailed study of spatial distribution of three coccinellid predators feeding on oak aphids viz., *H. dimidiata, H. eucharis* and *C. sexmaculata* have not been made so far. Hence, the present work was conducted to study spatial distribution of the three coccinellid predators.

MATERIALS AND METHODS

Spatial distribution of three coccinellid predators *viz. H. dimidiata* Fabricius, *H. eucharis* Mulsant and *C. sexmaculata* Fabricius was conducted at the experimental field of Regional Tasar Research Station, Mantripukhri, Manipur for two consecutive cropping seasons (2009-2010 & 2010-11). The spatial distribution of the predators was studied by using the following distribution parameters.

Variance to mean ratio : The mean (X) and variance (S^2) were calculated for each set of observation to work out the variance to mean ratio.

Mean crowding : The mean crowding (X*) was calculated by using the formula (Llyod, 1967) : $X^* = X + (S^2/X - 1)$

Llyod's index of patchiness : Llyod's index of patchiness which is the ratio of mean crowding to mean density was calculated.

Index of clumping : The index of clumping (IDM) was calculated by using David & Moore's (1954) formula : $IDM = S^2/X - 1$

Dispersion parameter : It was calculated by using the formula of Elliot (1979) as $K = X^2/S^2\text{-}X$

Co-efficient of variance : The co-efficient of variance (CV) was calculated by using the formula : $CV = VS^2/X$

Further mean colony size, Taylor's Power Law (1961) which gives a relation between variance and mean and Iwao's regression equation (1968) between mean crowding and mean density were also calculated.

RESULTS AND DISCUSSION

The values of various statistical parameters used to study the spatial distribution of three coccinellids predators-*H. dimidiata, H. eucharis* and *C. sexmaculata* on oak plant are given in Table I to VI. The values of variance during the entire study period were observed to be greater than their respective mean values excepting during 2 or 3 sampling months indicating contagious distribution of the predators. Hence, the values of variance to mean ratio were greater than unity which proved that the population of the predators was aggregated and followed contagious distribution. Likewise, the values of mean crowding and mean colony size were greater than their respective means indicating the contagious distribution of the predators. It was however observed to be random during 2 or 3 sampling months when the density of the predators was extremely low in the field. Lloyd's patchiness index being greater than unity in almost all the sampling months also confirmed the contagious distribution of the predators. The result is in conformity with that of Kianpour *et al.* (2010). Magro *et al.* (1999) also recorded the aggregated distribution of five coccinellids predators on citrus.

The values of index of clumping were all positive, indicating the contagious distribution of the predators. The values of k being less than 8 in all sampling months further strengthening the contagious distribution of the predators on oak (Southwood, 1978). The values of co-efficient of variance were larger than zero in almost all cases indicating the contagious distribution of the predators.

The values of index of basic contagion (α) being greater than zero in Iwao's regression analysis indicated that the basic component of distribution was a group of predators and not a single predator. And the values of co-efficient of density contagiousness were greater than unity indicating contagious distribution.

Table 1 : Statistical parameters for testing the distribution pattern of *H. dimidiata* on *Q. serrata* during 2009-10.

Sampling	Mean population density ($\overline{X}$)	Variance	Variance to mean ratio ($S^2/\overline{X}$)	Dispersion parameter (K)	Co-efficient of variance (CV)	Index of clumping (IDM)	Mean crowding Index (X*)	Lloyd's patchiness Index ($X^*/\overline{X}$)	Mean colony (C*)
April	0.80	1.07	1.34	2.37	1.29	0.34	1.14	1.43	2.14
May	2.70	4.01	1.49	5.56	0.74	0.49	3.19	1.18	4.19
June	2.20	2.84	1.29	7.56	0.77	0.29	2.49	1.13	3.49
July	1.10	2.10	1.91	1.21	1.32	0.91	2.01	1.83	3.01
August	1.60	2.27	1.42	3.82	0.94	0.42	2.02	1.26	3.02
September	2.60	4.49	1.73	3.58	0.81	0.73	3.33	1.28	4.33
October	0.40	0.49	1.23	1.78	1.75	0.23	0.63	1.58	1.63
November	1.20	2.18	1.82	1.47	1.23	0.82	2.02	1.68	3.02
December	2.50	4.50	1.80	3.13	0.85	0.80	3.30	1.32	4.30
January	1.60	2.04	1.28	5.82	0.89	0.28	1.88	1.18	2.88
February	0.30	0.46	1.53	0.56	2.26	0.53	0.83	2.77	1.83
March	0.10	0.10	1.00	0.01	3.16	0.00	0.10	1.00	1.10

Table II : Statistical parameters for testing the distribution pattern of *H. dimidiata* on *Q. serrata* during 2010-11.

Sampling	Mean population density ($\overline{X}$)	Variance	Variance to mean ratio ($S^2/\overline{X}$)	Dispersion parameter (K)	Co-efficient of variance (CV)	Index of clumping (IDM)	Mean crowding Index (X*)	Lloyd's patchiness Index ($X^*/\overline{X}$)	Mean colony (C*)
April	0.80	1.07	1.34	2.37	1.29	0.34	1.14	1.43	2.14
May	2.80	4.84	1.73	3.84	0.78	0.73	3.53	1.26	4.53
June	2.10	7.88	3.75	0.76	1.34	2.75	4.85	2.30	5.85
July	1.20	2.18	1.82	1.47	1.23	0.87	2.02	1.68	3.02
August	1.50	2.72	1.81	1.84	1.10	0.81	2.31	1.54	3.31
September	2.50	4.50	1.80	3.13	0.85	0.80	3.30	1.32	4.30
October	0.50	0.50	1.0	0.25	1.41	0.00	0.50	1.00	1.50
November	1.10	2.10	1.91	1.21	1.32	0.91	2.01	1.83	3.01
December	2.50	4.50	1.80	3.13	0.85	0.80	3.30	1.32	4.30
January	1.70	2.68	1.58	2.94	0.96	0.58	2.28	1.34	3.28
February	0.20	0.40	2.00	0.20	3.16	1.00	1.20	6.00	2.20
March	0.10	0.10	1.00	0.01	3.16	0.00	0.10	1.00	1.10

Table III : Statistical parameters for testing the distribution pattern of *H. eucharis* on *Q. serrata* during 2009-10.

Sampling	Mean population density ($\overline{X}$)	Variance	Variance to mean ratio ($S^2/\overline{X}$)	Dispersion parameter (K)	Co-efficient of variance (CV)	Index of clumping (IDM)	Mean crowding Index (X*)	Lloyd's patchiness Index ($X^*/\overline{X}$)	Mean colony (C*)
April	0.10	0.10	1.0	0.01	3.16	0.00	0.10	1.00	1.10
May	1.20	2.18	1.82	1.47	1.23	0.82	2.02	1.68	3.02
June	0.80	1.73	2.16	0.69	1.64	1.16	1.96	2.45	2.96
July	0.20	0.40	2.00	0.20	3.16	1.00	1.20	6.00	2.20
August	0.20	0.40	2.00	0.20	3.16	1.00	1.20	6.00	2.20
September	0.40	0.49	1.23	1.78	1.75	0.23	0.63	1.58	1.63
October	0.60	1.16	1.93	0.64	1.80	0.93	1.53	2.55	2.53
November	0.60	0.93	1.55	1.09	1.61	0.55	1.15	1.92	2.15
December	1.20	2.18	1.82	1.47	1.23	0.82	2.02	1.68	3.02
January	1.00	2.22	2.22	0.82	1.49	1.22	2.22	2.22	3.22
February	0.80	1.29	1.61	1.31	1.42	0.61	1.41	1.76	2.41
March	0.30	0.46	1.53	0.56	2.26	0.53	0.83	2.77	1.83

Table IV : Statistical parameters for testing the distribution pattern of *H. eucharis* on *Q. serrata* during 2010-11.

Sampling	Mean population density ($\overline{X}$)	Variance	Variance to mean ratio ($S^2/\overline{X}$)	Dispersion parameter (K)	Co-efficient of variance (CV)	Index of clumping (IDM)	Mean crowding Index (X*)	Lloyd's patchiness Index ($X^*/\overline{X}$)	Mean colony (C*)
April	0.10	0.10	1.0	0.01	3.16	0.00	0.10	1.00	1.10
May	1.40	2.71	1.94	1.50	1.18	0.94	2.34	1.67	3.34
June	0.90	2.32	2.58	0.57	1.69	1.58	2.48	2.76	3.48
July	0.30	0.46	1.53	0.56	2.26	0.53	0.83	2.77	1.83
August	0.20	0.40	2.00	0.20	3.16	1.00	1.20	6.00	2.20
September	0.30	0.46	1.53	0.56	2.26	0.53	0.83	2.77	1.83
October	0.60	1.16	1.93	0.64	1.80	0.93	1.53	2.55	2.53
November	0.50	0.50	1.00	0.25	1.41	0.00	0.50	1.00	1.50
December	1.90	2.54	1.34	5.64	0.84	0.34	2.24	1.18	3.24
January	1.10	2.10	1.91	1.21	1.32	0.91	2.01	1.83	3.01
February	0.70	1.34	1.91	0.77	1.65	0.91	1.61	2.30	2.61
March	0.10	0.10	1.00	0.77	3.16	0.00	0.10	1.00	1.10

Table V : Statistical parameters for testing the distribution pattern of *C. sexmaculata* on *Q. serrata* during 2009-10.

Sampling	Mean population density ($\bar{X}$)	Variance	Variance to mean ratio ($S^2/\bar{X}$)	Dispersion parameter (K)	Co-efficient of variance (CV)	Index of clumping (IDM)	Mean crowding Index (X*)	Lloyd's patchiness Index ($X^*/\bar{X}$)	Mean colony (C*)
April	1.40	2.71	1.94	1.50	1.18	0.94	2.34	1.67	3.34
May	1.90	2.54	1.34	5.64	0.84	0.34	2.24	1.18	3.24
June	0.90	2.32	2.58	0.57	1.69	1.58	2.48	2.76	3.48
July	0.20	0.40	2.00	0.20	3.16	1.00	1.20	6.00	2.20
August	0.10	0.10	1.00	0.01	3.16	0.00	0.10	1.00	1.10
September	0.40	0.49	1.23	1.78	1.75	0.23	0.63	1.58	1.63
October	0.20	0.40	2.00	0.20	3.16	1.00	1.20	6.00	2.20
November	0.60	1.16	1.93	0.64	1.80	0.93	1.53	2.55	2.53
December	1.50	2.72	1.81	1.84	1.10	0.81	2.31	1.54	3.31
January	1.30	2.23	1.72	1.82	1.15	0.72	2.02	1.55	3.02
February	0.80	1.29	1.61	1.31	1.42	0.61	1.41	1.76	2.41
March	0.20	0.40	2.00	0.20	3.16	1.00	1.20	6.00	2.20

TableVI : Statistical parameters for testing the distribution pattern of *C. sexmaculata* on *Q. serrata* during 2010-11.

Sampling	Mean population density ($\bar{X}$)	Variance	Variance to mean ratio ($S^2/\bar{X}$)	Dispersion parameter (K)	Co-efficient of variance (CV)	Index of clumping (IDM)	Mean crowding Index (X*)	Lloyd's patchiness Index ($X^*/\bar{X}$)	Mean colony (C*)
April	1.30	2.23	1.72	1.82	1.15	0.72	2.02	1.55	3.02
May	1.80	2.18	1.21	1.82	0.82	0.21	2.01	1.12	3.01
June	1.00	2.22	2.22	0.82	1.49	1.22	2.22	2.22	3.22
July	0.30	0.46	1.53	0.56	2.26	0.53	0.83	2.77	1.83
August	0.10	0.10	1.00	0.01	3.16	0.00	0.10	1.00	1.10
September	0.40	0.49	1.23	1.78	1.75	0.23	0.63	1.58	1.63
October	0.20	0.40	2.00	0.20	3.16	1.00	1.20	6.00	2.20
November	0.50	0.50	1.00	0.25	1.41	0.00	0.50	1.00	1.50
December	1.60	2.27	1.42	3.82	0.94	0.42	2.02	1.26	3.02
January	1.20	2.18	1.82	1.47	1.23	0.82	2.02	1.68	3.02
February	0.70	1.34	1.91	0.77	1.65	0.91	1.61	2.30	2.61
March	0.10	0.10	1.00	0.01	3.16	0.00	0.10	1.00	1.10

Table VII : Iwao's and Taylor's regression of the three coccinellid predators on *Q. serrata*

S. No.	Method	Different predator's parameters on *Q. serrata*	Duration	Regression equation	Correlation co-eff. (r)
1.	Iwao's regression	Mean crowding (X*) on mean density (X) of *H. dimidiata*	2009-10	X* = 0.3088 + 1.1251x	0.970
2.	Iwao's regression	Mean crowding (X*) on mean density (X) of *H. dimidiata*	2010-11	X* = 0.348 + 1.315x	0.886
3.	Iwao's regression	Mean crowding (X*) on mean density (X) of *H. eucharis*	2009-10	X* = 0.49 + 1.41x	0.850
4.	Iwao's regression	Mean crowding (X*) on mean density (X) of *H. eucharis*	2010-11	X* = 0.460 + 1.266x	0.834
5.	Iwao's regression	Mean crowding (X*) on mean density (X) of *C. sexmaculata*	2009-10	X* = 0.7564 + 1.0085x	0.820
6.	Iwao's regression	Mean crowding (X*) on mean density (X) of *C. sexmaculata*	2010-11	X* = 0.382 + 1.161x	0.858
7.	Taylor's power regression	Log variance (S^2) on log mean density (X) of *H. dimidiata*	2009-10	S^2 = 0.1613 +1.1139x	0.990
8.	Taylor's power regression	Log variance (S^2)) on log mean density (X) of *H. dimidiata*	2010-11	S^2 = 0.23 + 1.172x	0.973
9.	Taylor's power regression	Log variance (S^2)) on log mean density (X) of *H. eucharis*	2009-10	S^2 = 0.2793 + 1.1539x	0.977
10.	Taylor's power regression	Log variance (S^2)) on log mean density (X) of *H. eucharis*	2010-11	S^2 = 0.253 + 1.173x	0.973
11.	Taylor's power regression	Log variance (S^2)) on log mean density (X) of *C. sexmaculata*	2009-10	S^2 = 0.2467 + 1.0515x	0.971
12.	Taylor's power regression	Log variance (S^2)) on log mean density (X) of *C. sexmaculata*	2010-11	S^2 = 0.195 + 1.121x	0.951

The values of aggregation index (b) in Taylor's Power Law analysis were greater than one indicating contagious distribution of the predators. Kovanci *et al.* (2007) examined the spatial distribution pattern of all predatory arthropod groups using Taylor's Power Law and observed that most arthropod predators except carabids exhibited aggregated dispersion patterns in strawberry fields. Taylor's power law and Iwao's regression analysis method were also employed by Kianpour *et al.*, (2010) while studying the bionomics of *Aphis gossypii* and its predators *Coccinella septempunctata* and *Hippodamia variegata* on egg plant and observed the contagious distribution pattern.

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