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Seasonal Variations in Ovariole Numbers/Ovary in *Coccinella septempunctata* L. (Coleoptera: Coccinellidae)

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The ovariole number increased during winter and decreased during summer and monsoons. The range of 41–50 ovarioles/ovary was the most common (46.92%). The range of 51–60 ovarioles constituted 24.62% of the total population. The ranges of 31–40 and 41–50 ovarioles/ovary occur predominantly during the period of inadequate food. Suboptimal quantity of food is considered to be the causative factor for this reduction. The ranges of 51–60 and 61–70 ovarioles occurred most frequently during the period of adequate aphid food.

Key Words: *Coccinella septempunctata*, **Ovarioles, Potential fecundity**

Introduction

The number of ovarioles in an insect is closely related to the growth of the population of the species concerned (Virkki 1978). The ovariole number has been observed to be constant for each insect species (Davey 1965). Robertson (1957) and Bhat and Pushkar (1977) suggested that variation in ovariole numbers is genetic in origin. But several intrinsic and extrinsic factors may alter this genetically determined trait (Virkki 1978). Review by Robertson (1961) showed that intraspecific variations in ovariole numbers occur in *Coccinella septempunctata* L., which has been discussed in detail in an earlier paper (Rhamhalinghan 1985). An attempt has been made to investigate in detail the relation between ovariole number and aphid density in the wild, to unfold the reproductive strategies of these aphidophagous insects.

Materials and Methods

The pupae of *C. septempunctata* were collected from various regions of Nilgiri district, particularly in and around rural areas, at an altitude of about 2000m to 2200m above MSL, twice a month, throughout the period of study. The adults, 24 hr after emergence, were dissected and the ovarioles counted, as detailed elsewhere (Rhamhalinghan 1985). The aphid population/plant was determined either by direct counting or weighing, following the methods of Atwal and Sethi (1963), at monthly intervals, from 15 plants selected at random.

Results and Discussion

Rhamhalinghan (1985) focussed on the effects of inadequate and adequate food on the ovariole numbers/ovary in *C. septempunctata*. Perusal of the data from January 1983 to May 1986 shows that there was seasonal variation in ovariole numbers/ovary. More or less uniform trend existed during the three-year study period. While the ovariole number was comparably lower from April to October, throughout the study period, the same increased during winter. The observations further show that there was a close relationship between ovariole number and aphid density in the wild (tables 1, 2).

The agricultural practice in parts of Nilgiris, particularly in the rural area, is the main factor that influences the ovariole numbers in this predator. The major events in different seasons are presented in table 1. The beginning of summer was characterized by scanty aphid food for the Coccinellids. Further, the larvae from the eggs laid by the summer generations had to depend on quantitatively meagre and qualitatively poor aphids, found on scattered and

Table 1 *Seasonal events in relation to agricultural practice in rural areas of Nilgiri district*

Months	Season	Important events	Field condition	Aphid population/plant	
March	Summer	End of harvesting season	-Dry-End of the season	Scanty	(474.93 ± 54.73)
April	Summer	Sowing *Eleusine* sp. and *Panicum* sp. Radish and Mustard	Preparation of land for sowing	Scanty	(262.93 ± 54.41)
May	Summer	Sowing beans, peas, wheat and mustard	Sprouting crops	Scanty	(151.40 ± 32.14)
June	Southwest monsoon	Removal of weeds from fields	Growing crops	Scanty	(129.13 ± 15.13)
July	"	"	"	"	(203.33 ± 57.99)
August	"	—	"	"	(230.73 ± 45.85)
Late August	Spring	Sowing mustard Harvestg. beans and peas	Well flourished crops	Begins to increase	(669.86 ± 58.16)
September	"	Sowing beans and peas	"	"	(777.46 ± 32.78)
October	North east monsoon	Sowing fenugreek Harvesting wheat	2nd sowing season begins Growing crops	Decreased	(171.86 ± 15.85)
November	"	Sowing fenugreek	Flourishing crops	Begins to increase	(1329.93 ± 101.15)
Late November	Winter	Sowing wheat	"	Increased	(3536.53 ± 186.10)
December	"		"	"	(8725.73 ± 234.11)
January	"	—	"	"	(15968.26 ± 1204.50)
February	"	Harvesting wheat	"	"	(10686.66 ± 502.11)

unseasonal mustard and radish plants that could provide only fewer nutrients to the aphids. In this condition, the larvae had to rely on plant sap and pollens and cannibalism was not also uncommon. The aphid population was not sufficient to provide adequate nutrients for the developmental activities, which finally lead to the reduction in the body size (Rhamhalinghan 1985).

Unable to withstand the rain and the high velocity wind of southwest monsoon and the torrential rain of northeast monsoon, the larvae fell to the ground. Crawling on the wet ground was distressing and they took more time to reach the plants to feed on the aphids, which got soaked in water, thereby becoming unfit to be ingested. Further, 80 to 90% of the aphid population was washed out by torrential rain leaving only a small population as food for the coccinellid larvae. As a result of this unfavourable feeding condition, the larvae were able to ingest only a minimum quantity of food so as to produce smaller imagins, that harbour fewer ovarioles.

But the situation was different during 1983. The failure of southwest monsoon created a much favourable condition and due to the significantly low rainfall, the population of aphids increased enormously. In this advantageous trophic level, the lady beetles showed increased number of ovarioles. Suitable environmental conditions brought about increase in aphid density during winter, which enabled the coccinellid larvae to exploit maximally this favourable trend so as to produce larger active adults.

Since the larvae of *C. septempunctata* do not possess well developed sense organs to detect their prey (Banks 1957, Marks 1977), their searching movements are at random. Though Marks (1977) observes the involvement of chemical markers for the recognition of previously searched area, there exists variation among the larvae. They waste time and energy in revisiting the already searched area (Banks 1957). Further, when the aphid density/plant decreases, they have to cover a large area without encountering the prey. For an adult beetle, covering a large area for food is not an embarrassing problem. But for a crawling larva, with limited ability for movement, it is toilsome. Considerable reserve might be utilised for this, leaving a little for the developmental activities. Hence smaller adults are produced.

Subnormal feeding of the larvae reportedly leads to the reduction in ovariole numbers of the adults (Engelmann 1970, Nayar 1977, Virkki 1978, Rhamhalinghan 1985). This may presumably be due to the lack of adequate energy and reserve for the conversion and developmental activities, respectively. The larvae that hatch during summer and monsoon

Table 2 *Seasonal variations in ovariole numbers/ovary in* Coccinella septempunctata

Months	1983				1984				1985				1986			
	Specimens observed	Range	Mean	SD	Specimens observed	Range	Mean	SD	Specimens observed	Range	Mean	SD	Specimens observed	Range	Mean	SD
January	154	30–79	60.67	8.11	86	39–92	65.46	11.48	117	41–83	61.98	5.26	79	44–86	60.21	4.60
February	166	32–85	58.89	10.43					144	37–91	60.92	5.67	84	48–92	59.36	4.52
March	131	31–72	57.01	8.46	117	34–81	57.94	6.07	104	36–84	53.41	3.86	82	41–79	52.45	6.78
April	100	29–61	44.20	8.08	121	28–79	45.07	5.42	78	30–74	43.22	5.77	80	32–67	41.89	5.17
May	69	29–63	41.94	3.94	64	28–72	43.00	6.96	60	31–71	42.16	6.15	65	31–58	41.06	2.96
June	105	31–85	52.47	6.96	98	34–62	41.23	3.13	68	33–74	42.32	5.97	—	—	—	—
July	122	34–69	49.56	6.46	114	37–62	41.87	2.94	62	29–60	42.72	3.92	—	—	—	—
August	112	33–69	50.20	6.17	107	37–68	41.54	4.48	119	31–59	42.01	4.35	—	—	—	—
September	128	34–71	43.81	6.38	131	35–68	42.01	2.47	128	31–54	41.21	4.31	—	—	—	—
October	146	36–69	41.58	3.37	128	37–65	41.23	2.95	141	34–48	41.08	2.82	—	—	—	—
November	86	30–88	63.53	9.34	144	41–79	47.92	4.57	132	32–68	57.29	8.20	—	—	—	—
December					139	38–81	58.06	5.50	122	37–79	60.75	5.08	—	—	—	—

either will not get adequate aphids in the wild or may not be in a condition to ingest more aphids due to the physical stress created by torrential rain and high velocity wind. Contrary to this, the winter generation larvae happen to come across heavily populated aphid colonies in the same plant where they hatch and ingest as much as possible, producing larger and healthy beetles with increased number of ovarioles/ovary.

The trophic level in the wild, thus constitutes the primary factor that influences the number of ovarioles/ovary in this aphidophagous lady beetle. All other biotic and abiotic factors constitute the secondary factors that influence indirectly the ovariole number, either by limiting the aphid population in the environment or by decreasing the intake by the larvae.

The range of 41–50 ovarioles was the most common, followed by 51–60 and 31–40 ovarioles (table 3). Rhamhalinghan (1985) showed that the adults from well-fed larvae had 65.5 ovarioles/ovary. On the contrary, the adults from the minimum-fed larvae had 43 ovarioles/ovary. Further, the frequency of the range of 41–50 ovarioles/ovary in the minimum-fed group in the laboratory experiment, predominated other ranges. The bulk of the population (46.92%) from the wild also showed this range (table 3), which appears to be in agreement with the values given by Bagal and Trehan (1945), Hariri (1966), Iperti (1966) and Wang et al. (1977).

Laboratory experiments show that 93.33% of the individuals have a range of 61–70 ovarioles in the well-fed individuals, which is the optimal range in this group. But in the minimum-fed individuals, 58.67% have the optimal range of 41–50 ovarioles (Rhamhalinghan 1985) (table 3). Present observation, shows that 46.92% of the individuals had a range of 41–50 ovarioles. However, it is not improper to expect a higher range of ovarioles from the wild, since their condition must be better than that of the minimum-fed group in the laboratory and so the range of 51–60 ovarioles/ovary falls between the optimal ranges of the minimum- and maximum-fed groups. This range of 51–60 constitutes 24.62% of the total population in the present observation (table 3).

The ranges of 21–30 and 71–100 ovarioles/ovary may be regarded as subnormal and abnormal ranges, respectively, and these together constitute only 2.83% of the total population. The range of 31–40 ovarioles is also subnormal but can be clubbed with the next higher range of 41–50, since these two ranges occur predominantly during the period of inadequate food supply (April to October) (tables 1 and 2). The ranges of 51–60 and 61–70 ovarioles/ovary occur most frequently during winter, which is characterized by abundant aphid food in the field (tables 1, 2).

The ability to increase the ovariole number is thus dependent on the availability of adequate aphid food for the larvae. Nevertheless, at the minimal feeding level the reproductive ability is not much crippled but lies at minimal potential fecundity level of 41–50 ovarioles. It is interesting to note that most of the minimum-fed group in the laboratory (58.67%) and from the wild (46.92%) are able to maintain the range of 41–50 ovarioles/ovary. This may presumably be due to certain innate physiological quality that maintains this minimal potential fecundity even during adverse conditions, in the bulk of the population. This aspect needs further investigation.

The maximal potential fecundity range is 61–70. This constitutes 14.73% of the population (table 3). In that case 51–60 ovarioles must be the optimal potential fecundity range, which may fluctuate on either side, i.e. 41–50 or 61–70 range, undoubtedly caused by the trophic level of the environment. Comparision of the data for well fed group, underfed group and the specimens from wild would prove this observation clearly (table 3).

The breakups for the winter period alone of each year from 1983 to 1986 showed similar patterns as observed (for melanics and typicals) in an earlier report (Rhamhalinghan 1985).

The increase in the number of ovarioles and body size during favourable period empowers the beetles to explore and maximally utilize the seasonal patterns of the environment. On the contrary, to tide over the stress created by inadequate food in the habitat, the beetles adopt equally important reproductive strategies.

Table 3 *The overall frequencies of ovarioles/ovary in* Coccinella septempunctata *under different conditions*

No. of ovarioles/ ovary (Range)	Collected from the wild during 1983–85		Laboratory experiments*			
			Well-fed group		Under-fed group	
	No. of speci-mens	%	No. of speci-mens	%	No. of speci-mens	%
26–30	8	0.21	—	—	2	2.67
31–40	419	10.90	—	—	18	24.00
41–50	1803	46.92	—	—	44	58.67
51–60	946	24.62	1	1.33	10	13.33
61–70	566	14.73	70	93.33	1	1.33
71–80	72	1.87	2	2.67	—	—
81–90	24	0.62	2	2.67	—	—
91–100	5	0.13	—	—	—	—
TOTAL	3843		75		75	

*Rhamhalinghan (1985)

The seriousness of the situation is reflected first on their body size. Smaller individuals with fewer ovarioles are produced. Virkki (1978) observes that reduction of ovariole number may be physiologically compensated for by an increased production of eggs through the remaining ovarioles. This is true with seven spotted lady beetles. The egg output/ovariole in beetles with reduced number of ovarioles is greater than that of the beetles with increased number of ovarioles (Rhamhalinghan, unpublished observations).

Though the aphid population is scanty during March, the larvae that hatch during the latter half of February have the opportunity to get adequate aphids and when they emerge during the first half of March show increased number of ovarioles (table 2). Similarly, as the larvae that hatch during the second week of November happen to get sufficient quantity of aphid food, the resulting imagins show increased number of ovarioles.

These observations might apply to other insects as well, which undergo the same environmental stress. Shifts in these traits may appear as the habitat pattern changes. Therefore the ovariole number may presumably be a labile trait under the influence of biotic or abiotic conditions rather than a fixed pattern, at least in some species, if not in all insects.

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References

Atwal A S and Sethi S L 1963 Predation by *Coccinella septempunctata* on the cabbage aphid, *Lipaphis erysimi*, in India; *J. Anim. Ecol.* **32** 481–488

Bagal S R and Trehan K N 1945 Life history and bionomics of two predaceous and one mycophagous species of Coccinellidae; *J. Bombay Nat. Hist. Soc.* **45** 566–575

Banks C J 1957 The behaviour of individual coccinellid larvae on plants; *Br. J. Anim. Behav.* **5** 12–24

Bhat P P and Pushkar N 1977 Estimation of genetic variation and heritability of ovariole number in *Tribolium castaneum; Tribolium inform. Bull.* **20** 90–94

Davey K G 1965 *Reproduction in Insects*, Univ. Rev. Biol. (Sanfrancisco: W H Freeman and Co.)

Engelmann P 1970 *The Physiology of Insect Reproduction* pp 113–125 (Oxford: Pergamon)

Hariri G 1966 Studies of the physiology of hibernating Coccinellidae: Changes in the metabolic reserves and gonads; *Proc. R. ent. Soc. Lond.* **A41** 133–144

Iperti G 1966 Some components of efficiency in aphidophagous coccinellids; in *Ecology of Aphidophagous Insects* ed. I Hodek (The Hague: Dr. W. Junk Publishers) 253 pp

Marks R J 1977 Laboratory studies of plant searching behaviour of *Coccinella septempunctata* larvae; *Bull. ent. Res.* **67** 235–241

Nayar K K 1977 *Invertebrate Reproduction* pp 84–85 (New Delhi: Oxford & IBH Publ. Co.)

Rhamhalinghan M 1985 Intraspecific variations in ovariole numbers/ovary in *Coccinella septempunctata* L.; *Indian Zool.* **9** 91–97

Robertson F W 1957 Studies in quantitative inheritance.X. Genetic variation of ovary size in *Drosophila; J. Genet.* **55** 410–427

—— 1961 Ovariole numbers in Coleoptera; *Can. J. Zool.* **39** 245–263

Virkki N 1978 Ovariole numbers in two Puerto Rican oedionychina; *Agric. Univ. Puerto Rico.* **1** 50–56

Wang T S, Zong H C, Hu C Y and Quo F 1977 Observations on the Reproduction of *Coccinella septempunctata; Acta Entomol. Sin.* **20** 397–404