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ELYTRAL POLYMORPHISM IN SEVEN SPOTTED LADYBIRD BEETLE *COCCINELLA SEPTEMPUNCTATA* L.

Mohammad Thamseer M K*, S S Yadav, Rahul Saini and Krishna Rolania

Department of Entomology, Chaudhary Charan Singh
Haryana Agricultural University, Hisar 125004, Haryana, India
*Email: thamseeransar@gmail.com (corresponding author)

ABSTRACT

The existence of polymorphs in the seven spotted ladybird beetle *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) when analysed revealed five morphs collected in different seasons. These were predating on sucking pests infesting cotton and wheat. The morphological characters including male genitalia were studied in these. The abundance of various morphs revealed morph 1 with maximum abundance (73.3%), and the frequency of the melanic forms increased with the decrease in temperature.

Key words: *Coccinella septempunctata*, elytra, colour, polymorphs, Haryana, pronotal pattern, spots and patterns on elytra, temperature, abundance, wheat, cotton, aphids, whitefly

Polymorphism is the occurrence of phenotypic variation within a species (Gullan 2014). The ground colour, patterns and spots on wings are among the characters that vary. Polymorphic trait may be present in both the sexes or may exhibit sexual dimorphism (Bonduriansky, 2017). The phenomenon of polymorphism has been attributed to various causes including structural (Kurachi et al., 2002), physiological and molecular basis (Nijhout, 1982;Van Gossum, 2008). Coccinellidae is a large family with around 6000 species globally (Vandenberg, 2002) and 520 species are in India (Poorani, 2004). The polymorphism in coccinellids is widely studied and numerous morphs are known among ladybird beetles (Blehman, 2007; Karthika, 2017; Kawakami et al., 2013; Singh et al., 2016; Zare et al., 2012). Such morphs lead to misidentifications- for instance, the two variants of *Coccinella septempunctata* L. namely *C. septempunctata* var. *divaricata* and *C. septempunctata* var. *confusa* were considered as separate species (Olivier, 1808; Wiedemann, 1823) while others regarded them as mere genetic variants (Mader, 1936; Varma, 1954; Rao, 1962).

Hence, the knowledge of polymorphism is imperative to identify the species accurately. The elytral polymorphism is maintained in the natural population through non-random mating with the male elytral colour being one of the key factor in mate selection by female (Osawa and Nishida, 1992).Thus the study of polymorphism both at the morphological and genetic level is warranted (Hodek et al., 2012). Polymorphism in ladybird beetles has been well studied and provide evidence of natural variation and micro evolutionary processes occurring in nature (Honek et al. 2012; Gautier et al., 2018). The knowledge on the polymorphs of the coccinellids is scanty in India, and in *C. septempunctata*, one of the most common predators found in both agricultural and horticultural habitats, it is poorly studied (Hodek and Honek, 2013). The present study documents the presence and frequency of different morphs of *C. septempunctata* in Haryana.

MATERIALS AND METHODS

The study was carried out with samples collected from different locations of Haryana comprising all the three agroclimatic zones of the state namely arid, semi-arid and subhumid zones spanning over (27^{o} 37'- 30^{o}35'N, 74^{o}28'- 77^{o}36'E). The ladybird beetles were collected by both hand collection and using aerial nets during winter between March and November, 2020. These were collected from wheat fields on aphids namely *Sitobion avenae* and *Rhopalosiphum maidis* (Hemiptera: Aphididae) while in summer and kharif, were collected on the whitefly *Bemisia tabaci* (Hemiptera: Aleyrodidae) in cotton. The collected specimens were killed using ethyl alcohol in killing bottles and stored in vails containing 70% ethyl alcohol. The beetles were observed under stereozoom microscope (Zeiss Stemi 508) and the differences in characters such as pronotal pattern, spots and patterns on elytra were used to designate the morphs. The species identity was confirmed through morphological and male genitalia characters using the available key (Gordon, 1985)

RESULTS AND DISCUSSION

Among the 605 specimens collected across Haryana, five morphs of *C. septempunctata* were designated based on the variation in the elytral patterns (Fig. 1). The seasonal variation of polymorph frequency is depicted in Table 1. The characters of morphs are as follows:

Morph-1: Elytra with seven distinct spots (Fig 1a). The ground colour is highly variable and may be yellow, orange, red, brownish red or pinkish orange. There is no distinct sutural line. A large eye drop with a neck shaped maculae is present on the scutellum with white triangular spots on the base of both the elytron lying adjacent to it. Both the elytra contain three circular spots each with two spots present at around the end of anterior one third of the elytron and the third spot present at the beginning of the posterior one third of the wing. This morph was found in highest abundance (73.3%) across the collection sites and accounted for 100% of the specimen collected in summer and kharif.

Morph-2: Elytra with two pairs of fused spots and a free scutellar spot. The spot on the scutellum is same as present in morph 1 (Fig. 1b). Each elytron with three fused oblique spots. Two lateral spots on each elytron forming a dumb bell shape with the posterior spot being bigger and connected by a narrow bridge. Other spots present on either side of the sutural line midway through the elytron is nearly as big as the posterior spot and is joined broadly to the smaller maculae situated adjacently. This morph corresponds to *C. septempunctata* var. *confusa* as described by Wiedmann (Weidmann, 1823).

Morph-3: Elytra with separately fused scutellar and fused lateral spots. The scutellar spot is fused with the anterior spots on each elytron forming a triangular pattern (Fig. 1c). Both the lateral spots on each elytron are very narrowly joined by a thin black line. The posterior maculae reach the caudal end of the elytra and on dorsal view, the distal one third of the elytron appears black. The ground colour of elytra may be yellow, orange or red.

Morph-4: Elytra with distinct scutellar and anterior circular spots and fused lateral spots with vague black strips in elytra joining them. The scutellar spot is eye drop with a neck shaped while the anterior spots adjacent to the sutural line are circular in shape and free (Fig 1 d). The lateral spots are relatively closely spaced and joined together by a broad bridge. A faint black pattern runs in the elytron which passes through all the spots. No distinct sutural line and the ground colour is red.

Morph-5: All the spots coalesce to form a continuous anchor shaped pattern on the elytra. The spots present on both elytron fuse horizontally and vertically along the margin of the sutural line (Fig. 1e). The posterior pattern ends parallel to the elytra without touching the caudal margin. The coalesced spots leave a yellowish nearly triangular area in between them. This was the least abundant morph with only twelve specimen (3.2%).

The results of the present study agree with Kalaisekar et al. (2012) who identified three morphs on the basis of elytral base colour rather than the patterns

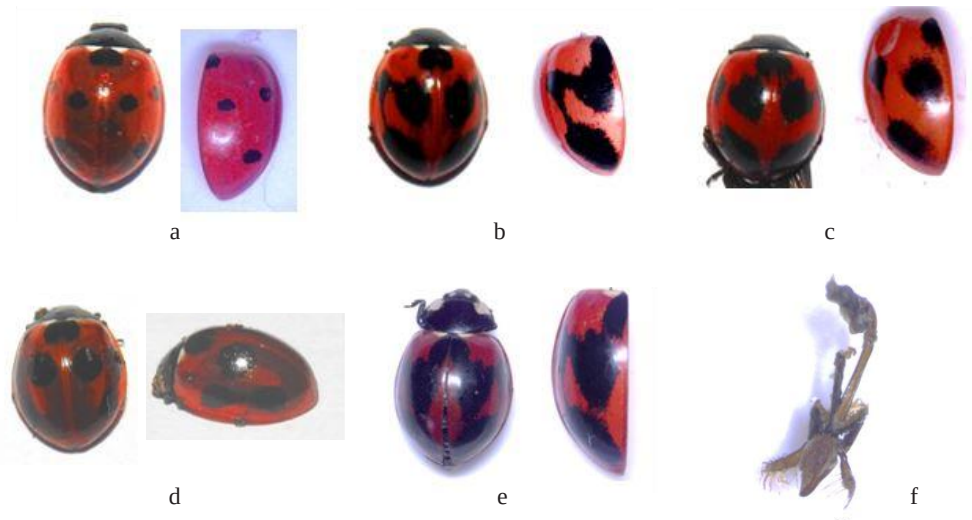

Fig. 1. *C. septempunctata*; a-e: Polymorphs- elytral patterns; f. Male genitalia (tegmen and sipho)

Table 1. Frequency of polymorphs of *C. septempunctata* across seasons

Morph	Seasons			
	Winter		Summer	
	No. of specimens	%	No. of specimens	%
1	272	73.3	234	100
2	46	12.4	0	0
3	23	6.2	0	0
4	18	4.8	0	0
5	12	3.2	0	0
Total	371	100	234	100

but is significantly <16 morphs of *C. septempunctata* which were described by Rao et al. (1962).

The present results corroborate with the argument that temperature is a predominant factor in morph frequency (Honek et al., 2012) as only the morph 1 was present in the field during summer (Table 1) and with the onset of the winter, more melanic forms began to appear. But, this correlation with temperature is contradicted by some studies which ascertain that the polymorph development is a mere genetic function (Lamana and Miller, 1995). Polymorphism in ladybird beetles is also linked to mate preference along with the body size (Muggleton, 1979; Majerus et al., 1982; Brakefield, 1984c; O'Donald et al., 1984). The melanic forms which absorb more sunlight during the winter season reported higher mating success compared to the non-melanic forms which explain the variation in morph frequency during different seasons (Ueno et al., 1998). An extensive study across a wider area and different ecosystems, both natural and manipulated may lead to the identification of more morphs and a conclusive result can be drawn on the true basis of polymorphism. There is a need to understand the trends in the pattern evolution and their exact function in the species.

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