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Leaf beetles diversity of Navsari Agricultural University campus in relation to their morphological characteristics

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Abstract

The present experiment was conducted to study the diversity in Navsari Agricultural University campus in relation to their diversity and morphological characteristics (Morphometrics of total body length and width, fore leg length, mid leg length, hind leg length and length of antennae), at Department of Agricultural Entomology, N. M. College of Agriculture, Navsari Agricultural University, Navsari (Gujarat) India, during March 2018 to December 2018. A total of 14 species of leaf beetles under 11 genera and 6 subfamilies were recorded from different habitats of NAU, Navsari campus. Among the 14 species the total body length, body width, fore leg length, mid leg length, hind leg length and length of antennae of the most abundant species *i.e. Phyllotreta cruciferae* were 1.94 ± 0.04 mm, 0.96 ± 0.02 mm, 0.83 ± 0.04 mm, 0.99 ± 0.04 mm, 1.14 ± 0.06 mm and 1.98 ± 0.23 mm, respectively.

Keywords: Leaf beetles, diversity, morphometrics

Introduction

Insects are very important part of human life. They are considered as pests of many crops and had a great economic importance. Among various insect pests, the order Coleoptera (beetles and weevils) are considered as very important group. Among the Coleoptera the insects of the family Chrysomelidae are commonly known as leaf beetles, which includes over 35,000 species and more than 2,000 genera distributed worldwide except in the arctic regions and is one of the largest and most commonly encountered among all the beetle families (Jolivet *et al.*, 2009; Thormann *et al.*, 2016) ^[1, 2]. Leaf beetles are the most abundant and harmful coleopteran pests of vegetables and show diverse adaptations to wide range of environmental conditions and habitats. They are also highly specialized insects feeding on a wide range of plant groups and are important both ecologically and economically due to their worldwide distribution and distinct host range. In south Gujarat there was no any research work has been carried out so far, to know the present status of the leaf beetle diversity in different crop fields. Therefore, the present study was proposed.

Objectives

To study the diversity and morphological characteristics of leaf beetles (Chrysomelidae) in Navsari Agricultural University campus, Navsari, Gujarat, India.

Materials and Methods

Study on diversity and morphology of leaf beetles in NAU campus was carried out by the Department of Agricultural Entomology, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat, India during March 2018 to December 2018. Collection of the leaf beetle specimens were done by handpicking and were killed and preserved in 70% alcohol. Each specimen was examined under zoom, stereoscopic trinocular microscope having 10X eyepiece and 0.7X to 4.5X object lens. Photographs of species and their behavioral patterns were captured with the help of digital camera (Nikon D5200). Live leaf beetle specimens from the field were photographed to document the colour patterns and specific behavioral postures. The unidentified specimens of leaf beetle were identified by Dr. K. D. Prathapan, Professor, Department of Entomology, College of Agriculture, Kerala Agricultural University, Vellayani, Trivandrum, Kerala for identification of the specimens. Simultaneously, collections of leaf beetles were also done for measurement of their body length, body width,

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fore leg length, mid leg length, hind leg length and the length of the antennae with the help of dissecting stereo-trinocular microscope having SCAPE software.

Statistical analysis: The experimental data was analysed statistically by using minimum, maximum values and average \pm standard deviation (SD) of the length of different body parts.

Results and Discussion

A total of 771 specimens leaf beetle was collected which belongs to 14 species under 11 genera and 6 subfamilies from different habitats of NAU, Navsari campus (Table 1 and 2). The value of Shannon-Wiener index of diversity for leaf beetles at NAU, Navsari campus was 1.79. Whereas, the species evenness was 0.68 (Table 3). The morphological characteristics (Morphometrics of total body length and width, fore leg length, mid leg length, hind leg length and length of antennae) of the observed species are given below (Table 4). The diversity index was computed using Shannon-Wiener Species Diversity Index formula^[3].

Shannon-Wiener diversity index

$$\text{Species Diversity Index } (H') = - \sum_{i=1}^k p_i \ln p_i$$

$$= 1.79$$

Species evenness

$$\text{Species evenness } (J') = \frac{H'}{H'_{max}}$$

$$= 1.79/2.64$$

$$= 0.68$$

$$H'_{max} = - \sum_{i=1}^n \ln N$$

$$= 2.64$$

Morphometrics

1. *Aulacophora foveicollis* (Lucas, 1849)

Description: This beetle is commonly known as Red pumpkin beetle. The body is elongate measuring about 5-7 mm in length with reddish orange touch. The colour of the elytra varies from pale orange-yellow to bright orange-red to medium brown and the abdomen is black with soft white hairs. The head is hypognathous and the antennae is filiform in shape.

Measurements: The total body length: 5.61 \pm 0.89 mm, body width: 2.00 \pm 0.30 mm, fore leg length: 2.72 \pm 0.06 mm, mid leg length: 3.78 \pm 0.03 mm, hind leg length: 4.47 \pm 0.10 mm and antennal length: 3.22 \pm 0.58 mm.

2. *Aulacophora lewisii* (Baly, 1886)

Description: This beetle is similar to Red pumpkin beetle. The body is yellowish brown and with black shining elytron. The head, pronotum, legs and antennae pale are brown in colour. The head is hypognathous and the antennae are filiform in shape.

Measurements: Total body length: 3.92 \pm 0.16 mm, body width: 2.05 \pm 0.23mm, fore leg length: 2.71 \pm 0.05 mm, mid leg length: 3.62 \pm 0.19 mm, hind leg length: 4.44 \pm 0.08 mm and antennal length: 2.55 \pm 0.18 mm.

3. *Cassida circumdata* (Herbst, 1799)

Description: This is a small tortoise beetle about 3-4 mm in size, greenish yellow in colour with green crescent mark in middle. The body is broad oval shaped resembling the body of a tortoise. The antennae are filiform and pale brownish in colour.

Measurements: Total body length: 3.78 \pm 0.21 mm, body width: 2.70 \pm 0.07 mm, fore leg length: 1.89 \pm 0.05 mm, mid leg length: 1.57 \pm 0.04 mm, hind leg length: 1.60 \pm 0.05 mm and antennal length: 1.47 \pm 0.06 mm.

4. *Chaeridiona picea* (Baly, 1869)

Description: The beetle is small (2-4 mm), the body is wedge-shaped; coarsely punctate, punctures may coalesce, punctures in regular rows on elytra; pronotum with tooth in each anterior angle. The color of the body is black in colour. The head is projecting forward and the antennae are robust and filiform in shape. The legs are moderately long and relatively slender.

Measurements: Total body length: 3.04 \pm 0.08 mm, body width: 1.37 \pm 0.07 mm, fore leg length: 1.78 \pm 0.04 mm, mid leg length: 1.63 \pm 0.04 mm, hind leg length: 1.79 \pm 0.03 mm and antennal length: 1.30 \pm 0.06 mm.

5. *Chiridopsis bipunctata* (Linnaeus, 1767)

Description: This beetle is a small (4-5 mm) tortoise beetle which is pale green in colour with six black spots on the elytra. The body shape resembles that of a tortoise, hence it is known as tortoise beetle. The elytra are green in color and with punctures.

Measurements: Total body length: 4.36 \pm 0.09 mm, body width: 3.62 \pm 0.09 mm, fore leg length: 3.02 \pm 0.14mm, mid leg length: 2.23 \pm 0.06 mm, hind leg length: 2.98 \pm 0.10 mm and antennal length: 1.51 \pm 0.21 mm.

6. *Colasposoma* sp.1

Description: *Colasposoma* sp. adults are broad, strongly convex body shape, with prominent elytral humeri. The elytra are shining metallic blue in colour. The head is hypognathous and the antennae are filiform in shape.

Measurements: Total body length: 5.01 \pm 0.00 mm, body width: 3.14 \pm 0.00 mm, fore leg length: 2.89 \pm 0.00 mm, mid leg length: 3.30 \pm 0.00 mm, hind leg length: 3.78 \pm 0.00 mm and antennal length was 2.79 \pm 0.00 mm.

7. *Colasposoma* sp.2

Description: This beetle is similar with *Colasposoma* sp.1 in body shape as well as size. The only difference is in the colour pattern of the elytra. The elytra are shining metallic green in colour with reddish brown patches on the elytra. The head is hypognathous and the antennae are filiform in shape.

Measurements: Total body length: 4.81 \pm 0.08 mm, body width: 2.93 \pm 0.16 mm, fore leg length: 2.87 \pm 0.07 mm, mid leg length: 3.27 \pm 0.03 mm, hind leg length: 3.85 \pm 0.06 mm and antennal length: 2.66 \pm 0.23 mm.

8. *Dicladispa armigera* (Oliver, 1808)

Description: The hispa, *D. armigera* is a defoliator during the vegetative stage of the rice plant. The adult is a small bluish-

black beetle fringed with numerous long hard spines over the body. The head is projecting forward and the antennae are filiform in shape.

Measurements: Total body length: 3.67±0.17 mm, body width: 1.57±0.16 mm, fore leg length: 1.75±0.08 mm, mid leg length: 1.61±0.04 mm, hind leg length: 1.80±0.04 mm and antennal length: 1.54±0.13 mm.

9. *Hermaeophaga ruficollis* (Lucas, 1849)

Description: The beetle is small (2.0-2.5 mm in length), broadly oval in shape. The colour is entirely yellow to light brown with dark brown sutural. The head is hypognathous and oval. The elytra are, convex, with well-developed humeral calli. The antennae are filiform in shape.

Measurements: Total body length: 2.41±0.11 mm, body width: 1.21±0.04 mm, fore leg length: 1.14±0.03 mm, mid leg length: 1.33±0.04 mm, hind leg length: 1.53±0.03 mm and antennal length: 1.13±0.08 mm.

10. *Lema* sp.1

Description: The body is elongate. The dorsal surface is reddish brown in colour. The head is hypognathous and the antennae are slender and filiform in shape.

Measurements: Total body length: 4.20±0.07 mm, body width: 1.65±0.14 mm, fore leg length: 1.84±0.08 mm, mid leg length: 2.76±0.10 mm, hind leg length: 3.58±0.12 mm and antennal length: 2.15±0.24 mm.

11. *Lema* sp.2

Description: The body is elongate. The dorsal surface is reddish brown in colour except the elytra is with black patches at the tip. The head is hypognathous and the antennae are slender and filiform in shape.

Measurements: Total body length: 4.82±1.30 mm, body width: 2.09±0.74 mm, fore leg length: 2.57±0.43 mm, mid leg length: 3.37±0.28 mm, hind leg length: 3.78±0.55 mm and antennal length: 2.07±0.53 mm.

12. *Oulema melanopus* (Linnaeus, 1758)

Description: This beetle is known as Cereal leaf beetle. The

adult beetle is elongate with a brightly colored orange-red thorax, yellow legs and metallic blue head and elytra. The head is hypognathous and the antennae are filiform

Measurements: Total body length: 4.67±0.14 mm, body width: 1.92±0.16 mm, fore leg length: 2.66±0.19 mm, mid leg length: 3.39±0.11 mm, hind leg length: 3.80±0.14 mm and antennal length: 2.39±0.22 mm.

13. *Phyllotreta cruciferae* (Goeze, 1777)

Description: This beetle is generally known as crucifer flea beetle. The adult is a small, oval-shaped, blackish beetle with a bright blue sheen on the elytra, measuring about 2-3 mm in length. Flea beetles have enlarged hind femora on their hind legs, which they use to jump quickly when disturbed.

Measurements: Total body length: 1.94±0.04 mm, body width: 0.96±0.02 mm, fore leg length: 0.83±0.04 mm, mid leg length: 0.99±0.04 mm, hind leg length: 1.14±0.06 mm and antennal length: 1.98±0.23 mm.

14. *Podagrica* sp.

Description: Adult beetles of *Podagrica* sp. are 2.0 to 3.5 mm in size. Head and neck shield are coloured red. The elytra are dark blue to blue green and rarely are detected metal coloured. The head is hypognathous and the antennae are filiform in size.

Measurements: Total body length: 2.59±0.10 mm, body width: 1.64±0.04 mm, fore leg length: 1.76±0.08 mm, mid leg length: 2.11±0.08 mm, hind leg length: 2.27±0.05 mm and antennal length: 1.31±0.03 mm.

Table 1: Species distribution of leaf beetles of different subfamilies in the NAU, Navsari campus

Sr. No	Subfamily	Genera	No. of species
1.	Alticinae	3	3
2.	Cassidinae	2	2
3.	Criocerinae	2	3
4.	Eumolpinae	1	2
5.	Galerucinae	1	2
6.	Hispiinae	2	2
Total		11	14

Table 2: Different leaf beetle species recorded from NAU, Navsari campus

Sr. No	Scientific name	Common name
I. Subfamily: Alticinae		
1.	<i>Hermaeophaga ruficollis</i> (Lucas, 1849)	Flea beetle
2.	<i>Phyllotreta cruciferae</i> (Goeze, 1777)	Flea beetle
3.	<i>Podagrica</i> sp.	Flea beetle
II. Subfamily: Cassidinae		
4.	<i>Cassida circumdata</i> (Herbst, 1799)	Tortoise beetle
5.	<i>Chiridopsis bipunctata</i> (Linnaeus, 1767)	Tortoise beetle
III. Subfamily: Criocerinae		
6.	<i>Lema</i> sp.1	Leaf beetle
7.	<i>Lema</i> sp.2	Leaf beetle
8.	<i>Oulema melanopus</i> (Linnaeus, 1758)	Cereal leaf beetle
IV. Subfamily: Eumolpinae		
9.	<i>Colasposoma</i> sp.1	Leaf beetle
10.	<i>Colasposoma</i> sp.2	Leaf beetle
V. Subfamily: Galerucinae		
11.	<i>Aulacophora foveicollis</i> (Lucas, 1849)	Red pumpkin beetle
12.	<i>Aulacophora lewisii</i> (Bali, 1886)	Pumpkin beetle
VI. Subfamily: Hispiinae		
13.	<i>Chaeridiona picea</i> (Baly, 1869)	Leaf beetle
14.	<i>Di cladispa armigera</i> (Oliver, 1808)	Hispa

Table 3: Biodiversity indices of leaf beetles in NAU, Navsari campus

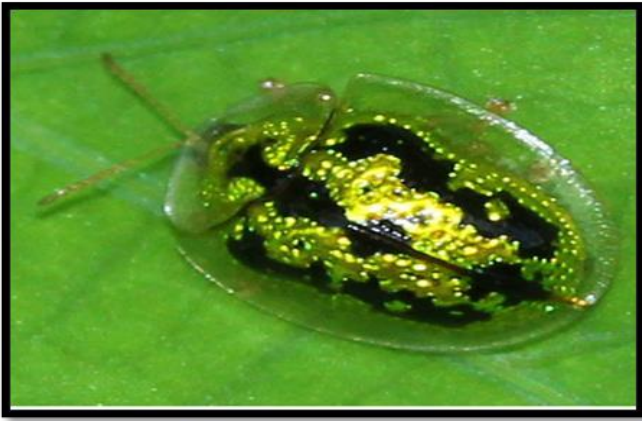
Sr. no.	Species of leaf beetle	No. of samples	p_i	$\ln(p_i)$	$p_i \ln(p_i)$
1.	<i>Aulacophora foveicollis</i> (Lucas, 1849)	53	0.069	-2.67740	-0.18405
2.	<i>Aulacophora lewisii</i> (Baly, 1886)	44	0.057	-2.86350	-0.16342
3.	<i>Cassida circumdata</i> (Herbst, 1799)	16	0.021	-3.88751	-0.08042
4.	<i>Chaeridiona picea</i> (Baly, 1869)	13	0.017	-4.08274	-0.06884
5.	<i>Chirdopsis bipunctata</i> (Linnaeus, 1767)	18	0.244	-3.75732	-0.08772
6.	<i>Colasposoma</i> sp.1	1	0.001	-6.64769	-0.00862
7.	<i>Colasposoma</i> sp.2	6	0.008	-4.85593	-0.03779
8.	<i>Dicladispa armigera</i> (Oliver, 1808)	3	0.004	-5.54908	-0.02159
9.	<i>Hermaeophaga ruficollis</i> (Lucas, 1849)	137	0.178	-1.72771	-0.30700
10.	<i>Lema</i> sp.1	9	0.012	-4.45046	-0.05195
11.	<i>Lema</i> sp.2	5	0.006	-5.03825	-0.03267
12.	<i>Oulema melanopus</i> (Linnaeus, 1758)	48	0.062	-2.77649	-0.17286
13.	<i>Phyllotreta cruciferae</i> (Goeze, 1777)	356	0.462	-0.77276	-0.35681
14.	<i>Podagrica</i> sp.	62	0.080	-2.52055	-0.20269
Total		N= 771	1	-51.59496	-1.79400

n= Number of specimens of individual species
N= Total number of specimens of all species
 p_i = Proportion of i^{th} species in the total sample

Table 4: Measurements of different body parts of leaf beetles

Sr. No.	Species of leaf beetles	Body length (mm)	Body width (mm)	Length of legs (mm)			Length of antennae (mm)
				Fore leg	Mid leg	Hind leg	
				Av.±SD	Av.±SD	Av.±SD	
1.	<i>A. foveicollis</i>	5.61±0.89	2.00±0.30	2.72±0.06	2.72±0.06	4.47±0.10	3.22±0.58
2.	<i>A. lewisii</i>	3.92±0.16	2.05±0.23	2.71±0.05	3.62±0.19	4.44±0.08	2.55±0.18
3.	<i>C. circumdata</i>	3.78±0.21	2.70±0.07	1.89±0.05	1.57±0.04	1.60±0.05	1.47±0.06
4.	<i>C. picea</i>	3.04±0.08	1.37±0.07	1.78±0.04	1.63±0.04	1.79±0.03	1.30±0.06
5.	<i>C. bipunctata</i>	4.36±0.09	3.62±0.09	3.02±0.14	2.23±0.06	2.98±0.10	1.51±0.21
6.	<i>Colasposoma</i> sp.1	5.01±0.00	3.14±0.00	2.89±0.00	3.30±0.00	3.78±0.00	2.79±0.00
7.	<i>Colasposoma</i> sp.2	4.81±0.08	2.93±0.16	2.87±0.07	3.27±0.03	3.85±0.06	2.66±0.23
8.	<i>D. armigera</i>	3.67±0.17	1.57±0.16	1.75±0.08	1.61±0.04	1.80±0.04	1.54±0.13
9.	<i>H. ruficollis</i>	2.41±0.11	1.21±0.04	1.14±0.03	1.33±0.04	1.53±0.03	1.13±0.08
10.	<i>Lema</i> sp.1	4.20±0.07	1.65±0.14	1.84±0.08	2.76±0.10	3.58±0.12	2.15±0.24
11.	<i>Lema</i> sp.2	4.82±1.30	2.09±0.74	2.57±0.43	3.37±0.28	3.78±0.55	2.07±0.53
12.	<i>O. melanopus</i>	4.67±0.14	1.92±0.16	2.66±0.19	3.39±0.11	3.80±0.14	2.39±0.22
13.	<i>P. cruciferae</i>	1.94±0.04	0.96±0.02	0.83±0.04	0.99±0.04	1.14±0.06	1.98±0.23
14.	<i>Podagrica</i> sp.	2.59±0.10	1.64±0.04	1.76±0.08	2.11±0.08	2.27±0.05	1.31±0.03

1. *Aulacophora foveicollis* (Baly, 1886)2. *Aulacophora lewisii* (Baly, 1886)



3. *Cassida circumdata* (Herbst, 1799)



7. *Colasposoma* sp.2



4. *Chaeridiona picea* (Baly, 1869)



8. *Dicladispa armigera* (Oliver, 1808)



5. *Chiridopsis bipunctata* (Linnaeus, 1767)



9. *Hermaphysa ruficollis* (Lucas, 1849)



6. *Colasposoma* sp.1



10. *Lema* sp.1

11. *Lema* sp.212. *Oulema melanopus* (Linnaeus, 1758)13. *Phyllotreta cruciferae* (Goeze, 1777)14. *Podagrica* sp.

Although the chrysomelid leaf beetles are of economic importance they are not adequately studied in India. A total of 771 specimens of leaf beetle were collected which belongs to 14 species under 11 genera and 6 subfamilies from NAU, Navsari Campus. Thus, it indicates that there is high diversity of leaf beetles in the study area. Basu *et al.* (1981) ^[4], Basu (1985) ^[5], Ghate *et al.* (2003) ^[6], Kalaichelvan and Verma (2005) ^[7], Chaudhary and Saravanan (2010) ^[8], Singh *et al.* (2010) ^[9], Agarwala and Bhattacharjee (2012) ^[10], Aland *et al.* (2012) ^[11], Pawara *et al.* (2012) ^[12], Arya and Joshi (2014) ^[13], Arya *et al.* (2016) ^[14], Gajendra and Prasad (2016) ^[15], Koya *et al.* (2016) ^[16] and Thakkar and Parikh (2016) ^[17] also recorded chrysomelid leaf beetles from different parts of India which is more or less in accordance with the present findings. The difference with the present values may be due to the small area selected for the study or difference in locality or the geographical area, diverse kind of habitat, vegetation, food availability and agricultural practices.

Conclusion

From the above results, it can be concluded that Navsari Agricultural University, Navsari campus harbors a diverse variety of leaf beetles which accounts to 14 species of chrysomelid leaf beetles. The reason being the availability of food, favorable climatic condition, floral diversity that can support a wide variety of faunal diversity.

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