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Diversity and abundance of leaf beetles (Coleoptera: Chrysomelidae) in Jhunjhunu district of Rajasthan, India

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Abstract
Leaf beetles are the most diverse, successful, and dominant family within the order Coleoptera, found in nearly every habitat around the world. Their success is attributed to a wide range of characteristics, including varied body sizes, habits, fecundity, different modes of respiration, and diverse food sources. These features have enabled them to become a vital component of ecosystems. This study focused on collecting and identifying various species of leaf beetles to assess their diversity and abundance across different habitats in Jhunjhunu district. Insects were gathered from diverse environments, such as public parks, gardens, fruit and vegetable markets, and agricultural fields. A total of 25 species belonging to 21 genera under 8 subfamilies of the family Chrysomelidae were recorded from January 2021 to December 2022 from four study sites selected in the Jhunjhunu district. The subfamily Bruchinae had the highest number of species (7), followed by Galerucinae (5), Criocerinae (4), and Cryptocephalinae, Orsodacninae, Cassidinae, and Chrysomelinae (2 species each), with Alticinae having 1 species. The varied habitats in Jhunjhunu district offer an ideal climate for leaf beetles. This study aims to document the diversity of leaf beetles, providing valuable preliminary information for their conservation and potential use in integrated weed control.

Keywords: Diversity, Abundance, Leaf beetles, Chrysomelidae, Jhunjhunu

Introduction

Coleopteran playing a fundamental ecological role in all type of ecosystems, accounts for 38% of entire insects and about 387,100 species of the Coleopteran are known to exist in the world (Zhang, 2013) [26]. The family Chrysomelidae is known as one of the largest family of coleopteran insects which include more than 37,000 reported species and they are extensive in all Zoogeographical regions (Biondi and D' Alessandro, 2012 [8]; Jolivet and Verma, 2002 [15]; Schmitt, 1996) [24]. Still many species of Chrysomelidae family living in forest canopies are awaiting for discovery. Chrysomelidae family includes many established and potential agricultural pest because of their phytophagous feeding habit. Agarwala and Bhattacharjee (2012) [3] reported eight species of tortoise beetle belonging to 5 genera under Cassidinae subfamily of Chrysomelidae family from Tripura state. Biswas *et al*., (2015) [5] described a total of 13 species of chrysomelid beetles from Bhibhuti Bhusan Wildlife Sanctuary, West Bengal, India. Debbarma and Patel (2020) [10] recorded diversity of 14 leaf beetle species associated with 11 genera under 6 subfamilies *viz*., Alticinae and Criocerinae (3 species each), Cassidinae, Eumolpinae, Galerucinae and Hispinae (2 species each) from different habitats of NAU, Navsari campus, Gujarat. Dilipsundar *et al*., (2022) [11] revealed assemblages and functional guilds of 17 species of Galerucinae beetle under 11 genera in agro-ecosystem of Tamil Nadu. A total of 91 chrysomelid species were reported from Baja California peninsula. Ghahari and Hawkeswood (2011) [14] collected a total of 25 species of leaf beetles from 14 genera and 5 subfamilies *viz*., Alticinae, Clytrinae, Chrysomelinae, Cryptocephalinae, Galerucinae from western Iran. Samin *et al*., (2019) recorded 8 species of Chrysomelinae subfamily belonging to four genera *viz*., *Chrysolina* (5 spp.), *Neophaedon* (1 sp.), *Timarcha* (1 sp.), *Plagiodera* (1 sp.) and 12 species of Cryptocephalinae subfamily belonging to four genera *viz*., *Coptocephala* (2 spp.), *Labidostomis* (2 spp.), *Smaragdina* (2 spp.) and *Cryptocephalus* (6 spp.) of Chrysomelidae family from Iran. Azhari *et al*., (2019) [1] have studied fauna of chrysomelid beetles consisting of 25 species and 60 morphospecies within nine subfamilies *viz*., Galerucinae, Chrysomelinae, Eumolpinae, Hispinae, Alticinae, Crytocephalinae, Donaciinae, Cassidinae and Criocerinae along an elevational gradient at Mount Fraser, Pahang, Malaysia. Bibi *et al*., (2020) [7] recorded 51 species of leaf beetles associated with four subfamilies *viz*., Chrysomelinae, Alticinae, Galerucinae and Clytrinae of Chrysomelidae family from different areas of district Haripur, Khyber Pakhtunkhwa of Pakisthan. Nguyen (2022) [19] collected 52 species of leaf beetles related to 31 genera under 5 subfamilies *viz*., Cassidinae (3 species), Criocerinae (1 species), Cryptocephalinae (3 species), Eumolpinae (17 species) and Galerucinae (20 species) on the islands of Vietnam. Ekiz (2022) [12] prepared a checklist of 122 species of seed beetle fauna associated with 14 genera of Turkey.

Materials and Methods

Jhunjhunu district (Photo Plate- 1), located between latitudes 27°38' to 28°31' North and longitudes 75°02' to 76°06' East, covers a geographical area of 5,926 sq. km. The region experiences extreme temperatures, reaching up to 48°C in the summer and dropping below 0°C in the winter. The district's altitude ranges from 312 to 368 meters above sea level. Rainfall in the area varies between 350 and 500 mm, predominantly occurring during the monsoon season from July to September.

For the present study, four sampling sites were selected: agricultural lands (Site-A), plains dominated by grasses and herbs (Site-B), rocky areas (Site-C), and water body banks (Site-D). The geographic coordinates for these sites are as follows: Site-A is located at 28°19'N, 75°31'E; Site-B at 27°89'N, 75°01'E; Site-C at 28°02'N, 75°63'E; and Site-D at

27°65'N, 75°41'E. Field surveys were conducted from January 2021 to December 2022 at the chosen sites, with sampling carried out once a month during both morning and evening hours throughout the study period.

Leaf beetles were collected using sweep nets, hand picking, and light traps. After collection, the beetles were transported to the laboratory at the Department of Zoology, SRRM Govt. College, Jhunjhunu. The specimens were then pinned, stretched, and dried before being preserved in insect boxes with Paradichlorobenzene. The collected beetles were identified to the species level using a Stereo Zoom Binocular Microscope (Magnus MSZ-Bi), following taxonomic keys by White (1983) [25]; Evans (2008) [13]; McHugh and Riley (2016); Seeno and Wilcox (1982) [24]. The beetles were also photographed for future reference.

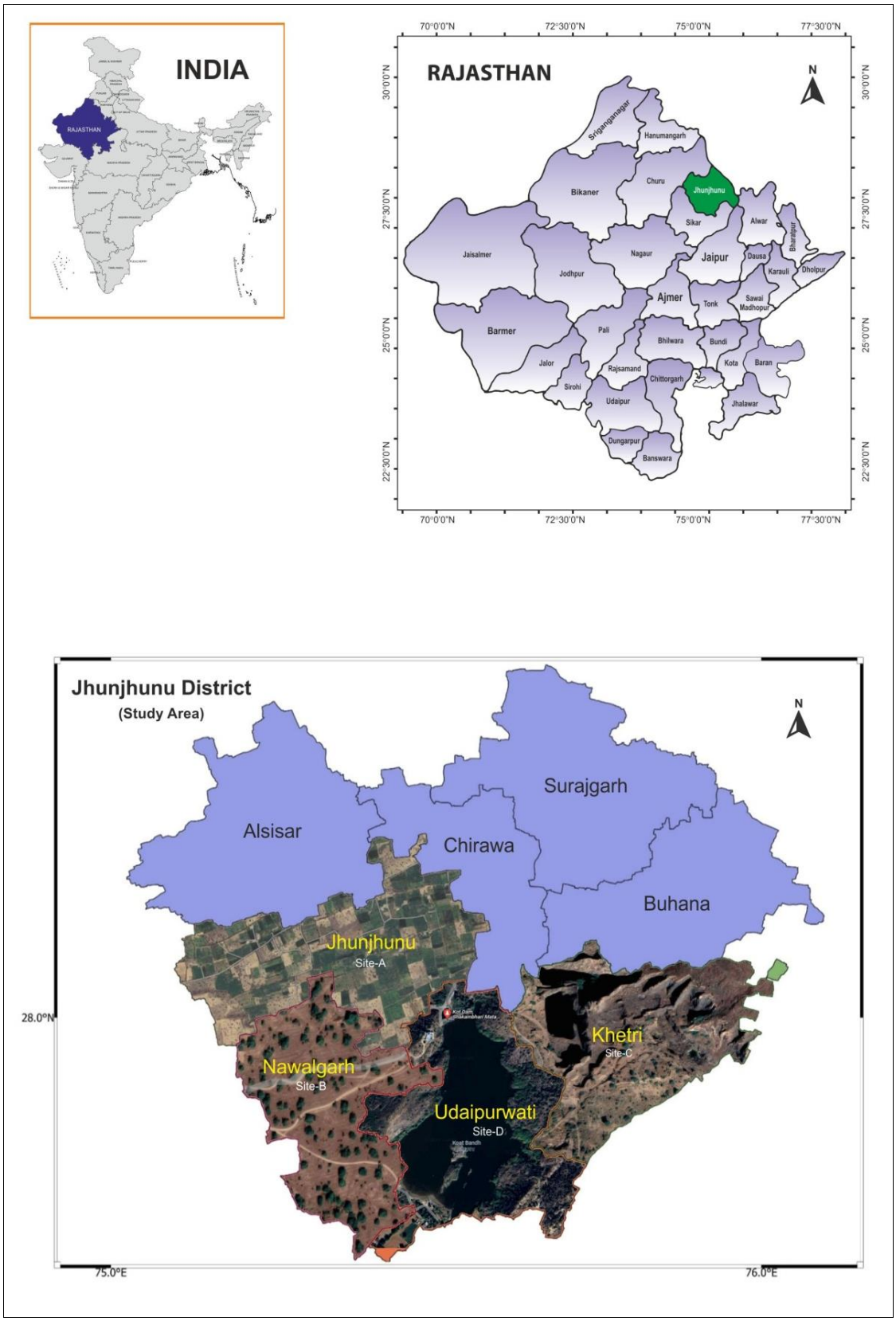

Photo Plate 1: Location of Jhunjhunu district with sampling sites

Result

A total of 25 species belonging to 21 genera under 8 subfamilies of the family Chrysomelidae were recorded from January 2021 to December 2022 from four study sites selected in the Jhunjhunu district (Photo Plate-2). As evident from species richness and abundance of different subfamilies (Table 1&2), subfamily Bruchinae was comprised of the highest number of species (7 species), followed by Galerucinae (5 species), Criocerinae (4 species), Cryptocephalinae, Orsodacninae, Cassidinae, and Chrysomelinae (2 species each) and Alticinae (1 species) (Fig 1). As compared to the number of individuals, Galerucinae was the most abundant subfamily (36.10% of the total individuals), followed Bruchinae (24.07%), Criocerinae (20.15%), Orsodacninae (9.40%), Cassidinae (3.86%), Chrysomelinae (2.90%), Cryptocephalinae (1.77%) and Alticinae (1.71%) (Fig 1).

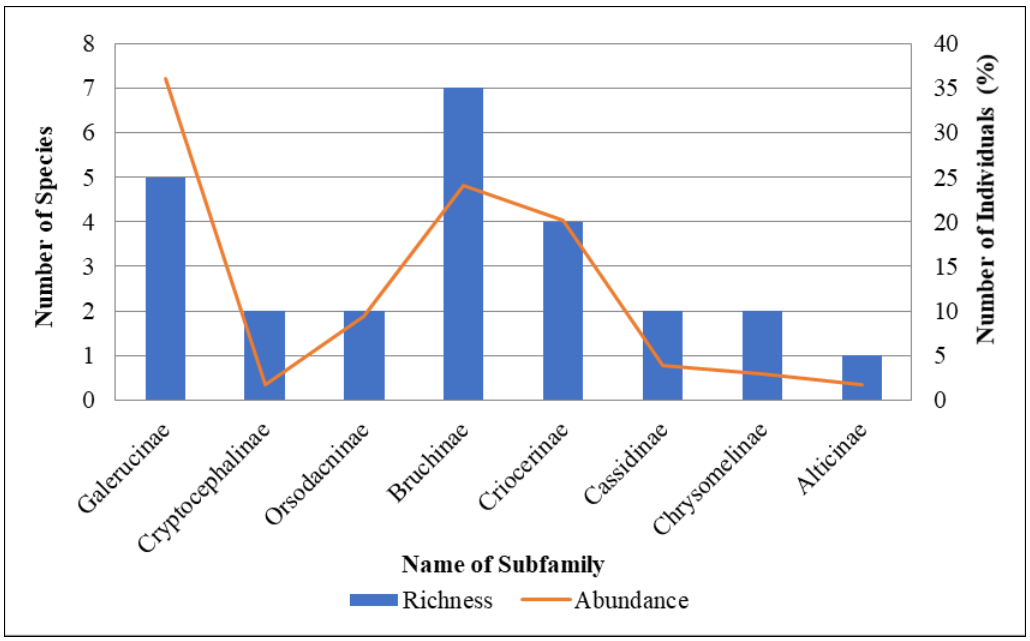

Fig 1: Species richness and abundance of Chrysomelidae family in the study area from January 2021 to December 2022.

During the first year of study, maximum number of species belonged to the subfamily Bruchinae constituting 6 species, followed by Galerucinae (5 species), Criocerinae (4 species), Cryptocephalinae, Orsodacninae and Cassidinae (2 species each), Chrysomelinae and Alticinae (1 species each) (Table 1&2). On the other hand, maximum number of individuals belonged to the subfamily Galerucinae which constituted 39.47% of the total individuals, followed by Bruchinae (22.13%), Criocerinae (19.19%), Orsodacninae (8.61%), Cassidinae (4.79%), Chrysomelinae (2.61%), Alticinae (1.85%), and Cryptocephalinae (1.30%).

During the Second year of study, maximum number of species belonged to the subfamily Bruchinae constituting 7 species, followed by Galerucinae (5 species), Criocerinae (4 species), Orsodacninae, Cassidinae and Chrysomelinae (2 species each), Cryptocephalinae and Alticinae (1 species each) (Table 1&2). On the other hand, maximum number of individuals belonged to the subfamily Galerucinae which constituted 32.83% of the total individuals, followed by Bruchinae (25.95%), Criocerinae (21.08%), Orsodacninae (10.16%), Chrysomelinae (3.17%), Cassidinae (2.96%), Cryptocephalinae (2.22%), and Alticinae (1.58%).

Table 1: Species of different subfamilies under the family Chrysomelidae recorded from the study area from January 2021 to December 2022.

S.No.	Family	Subfamilies	Species
1	Chrysomelidae	Galerucinae	*Medythia nigrobilineata*
2			*Oides palleata*
3			*Longitarsus belgaumensis*
4			*Psylliodes punctulata*
5			*Aulacophora* sp.
6		Cryptocephalinae	*Clytra laeviuscula*
7			*Cryptocephalus* sp.
8		Orsodacninae	*Orsodacne cerasi*
9			*Orsodacne atra*
10		Bruchinae	*Amblycerus robiniae*
11			*Bruchus loti*
12			*Acanthoscelides obtectus*
13			*Caryedon serratus*
14			*Algarobius prosopis*
15			*Callosobruchus maculatus*
16			*Callosobruchus chinensis*
17		Criocerinae	*Lema diversipes*

18			*Lema postrema*
19			*Neolema ovalis*
20			*Neolema* sp.
21		Cassidinae	*Charidotella sexpunctata*
22			*Hispa atra*
23		Chrysomelinae	*Leptinotarsa decemlineata*
24			*Zygogramma bicolorate*
25		Alticinae	*Aphthona* sp.

Table 2: Species richness and abundance of different subfamilies under the family Chrysomelidae recorded from the study area from January 2021 to December 2022.

Chrysomelidae	2021		2022		2021-22	
	Richness	Abundance	Richness	Abundance	Richness	Abundance
Galerucinae	5	362	5	310	5	672
Cryptocephalinae	2	12	1	21	2	33
Orsodacninae	2	79	2	96	2	175
Bruchinae	6	203	7	245	7	448
Criocerinae	4	176	4	199	4	375
Cassidinae	2	44	2	28	2	72
Chrysomelinae	1	24	2	30	2	54
Alticinae	1	17	1	15	1	32
Total	23	917	24	944	25	1861

Medythia nigrobilineata

Oides palleata

Longitarsus belgaumensis

Psylliodes punctulate

Aulacophora sp.

Clytra laeviuscula

Cryptocephalus sp.

Orsodacne cerasi

Orsodacne atra

Amblycerus robiniae

Bruchus loti

Acanthoscelides obtectus

Photo Plate 2: Family- Chrysomelidae

Discussion

Chrysomelidae is a large and diverse family of beetles known as leaf beetles. These beetles are widely distributed across various habitats and are recognized for their economic importance, ecological roles, and stunning diversity in colour and form. The family Chrysomelidae is known as one of the biggest family of coleopteran insects which include more than 40,000 to 43,000 reported species and they are extensive in all Zoogeographical regions (Biondi and D' Alessandro, 2012 [8]; Konstantinov *et al*., 2011 [17]; Bouchard *et al*., 2011 [9]; Konstantinov, 2018) [16]. Chrysomelid beetles are phytophagous, where the majority

of species consume leaves, some are known to feed on flowers, fruits, stems, and even roots. This feeding behaviour has significant implications for agriculture and horticulture, as certain leaf beetle species are considered as crop pests and cause considerable damage to crops and ornamental plants.

As compared to previous studies on leaf beetle diversity from various regions of India, the present study recorded 25 species of the leaf beetles related to 21 genera under 8 subfamilies *viz*., Galerucinae, Cryptocephalinae, Orsodacninae, Bruchinae, Criocerinae, Cassidinae, Chrysomelinae and Alticinae from Jhunjhunu district. Similarly, Dilipsundar *et al*., (2022) [11] studied diversity and species abundance of 17 leaf beetle species related to 11 genera under Galerucinae subfamily in different agroecosystems of Tamil Nadu. However, Biswas *et al*., (2015) [5] described a total of 13 species of chrysomelid beetles from Bhibhuti Bhusan Wildlife Sanctuary, West Bengal, India. Similarly, Debbarma and Patel (2020) [10] recorded diversity of 14 leaf beetle species associated with 11 genera under 6 subfamilies *viz*., Alticinae and Criocerinae (3 species each), Cassidinae, Eumolpinae, Galerucinae and Hispinae (2 species each) from different habitats of NAU, Navsari campus, Gujarat.

The results of the present study on leaf beetles are also in accordance with several studies across the globe. For example, Beenen and Roques (2010) identified a total of 25 species of Chrysomelidae family, where 14 species were of seed beetles (bruchids) and 11 species were of leaf beetles belonging to subfamilies Alticinae and Chrysomelinae, respectively from Europe. Similarly, Ghahari and Hawkeswood (2011) [14] collected 25 species of leaf beetles of 14 genera related to 5 subfamilies *viz*., Alticinae, Clytrinae, Chrysomelinae, Cryptocephalinae, Galerucinae from western Iran. Likewise, Azhari *et al*., (2019) [1] also studied fauna of chrysomelid beetles consisting of 25 species and 60 morphospecies within nine subfamilies *viz*., Galerucinae, Chrysomelinae, Eumolpinae, Hispinae, Alticinae, Crytocephalinae, Donaciinae, Cassidinae and Criocerinae along an elevational gradient at Mount Fraser, Pahang, Malaysia.

The present results are quite comparable with the study by Bhatia *et al*., (2007) [6] who described 7 species of Tortoise beetles from Jammu that were closely associated with *Ipmoea carnea* plant, and pose great threat to growth and reproduction of *I. carnea*. Likewise, Agarwala and Bhattacharjee (2012) [3] reported 8 species of tortoise beetle belonging to 5 genera under Cassidinae subfamily of Chrysomelidae family from Tripura state.

The results of the present study are comparable with the study by Bibi *et al*., (2020) [7] who recorded 51 species of leaf beetles associated with four subfamilies *viz*., Chrysomelinae, Alticinae, Galerucinae and Clytrinae of Chrysomelidae family from different areas of district Haripur, Khyber Pakhtunkhwa of Pakisthan. Similarly, Nguyen (2022) [19] collected 52 leaf beetle species related to 31 genera under 5 subfamilies *viz*., Cassidinae (3 species), Criocerinae (1 species), Cryptocephalinae (3 species), Eumolpinae (17 species) and Galerucinae (20 species) from the islands of Vietnam. Similarly, Dilipsundar *et al*., (2022) [11] revealed assemblages and functional guilds of 17 species of Galerucinae beetle under 11 genera in agro-ecosystem of Tamil Nadu.

The results of the present study on leaf beetles are at par with the study by Nadein *et al*., (2012) [20] who carried out a study on distribution of Chrysomelidae from Pakistan and Afaghanistan and recorded 19 and 9 species, respectively. Similarly, Andrews and Gilbert (2005) [2] reported a total of 91 chrysomelid species from Baja California peninsula for the first time and 29 species are tabulated as endemic. However, Samin *et al*., (2019) recorded 8 species of Chrysomelinae subfamily belonging to four genera *viz*., *Chrysolina* (5 spp.), *Neophaedon* (1 sp.), *Timarcha* (1 sp.), *Plagiodera* (1 sp.) and 12 species of Cryptocephalinae subfamily belonging to four genera *viz*., *Coptocephala* (2 spp.), *Labidostomis* (2 spp.), *Smaragdina* (2 spp.) and *Cryptocephalus* (6 spp.) of Chrysomelidae family from Iran. However, in contradiction with the present study Kalaichelvan and Verma (2005) [18] reported a checklist of 95 species associated with 10 subfamilies *viz*., Alticinae (23 species), Cassidinae (18 species), Galerucinae (15 species), Criocerinae (10 species), Cryptocephalinae (8 species), Clytrinae and Eumolpinae (6 species each), Chrysomelinae and Hispinae (4 species each) and Chlamisinae (1 species) of Chrysomelidae family from Bhilai-Durg, Chhattisgarh. Similarly, Ekiz (2022) [12] prepared a checklist of 122 species of seed beetle fauna associated with 14 genera of Turkey.

Conclusion:

Preliminary study authenticates good diversity and distribution of leaf beetles in the Jhunjhunu district and concludes that agriculture fields are dominated by leaf beetles. Many leaf beetles are considered significant pests in agriculture due to their feeding habits. These beetles typically feed on plant foliage, and in some cases, their feeding can result in severe damage to crops. However, not all leaf beetles are harmful to crops. Some species can contribute to pest control in agricultural systems by feeding on weeds or other pest insects. Therefore, leaf beetles are a double-edged sword in agriculture. While many species cause harm to crops by feeding on foliage, others can play an important role in controlling weeds and contributing to biological control programs. Sustainable management practices, such as IPM, aim to minimize their negative impact while leveraging their potential benefits in integrated agricultural systems. Altogether, proper conservation strategies will be helpful to conserve natural microhabitats of leaf beetles because these microhabitats and ecological zones play a significant role in conservation of diversity and species richness of leaf beetles.

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