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Seasonal species richness and abundance of leaf beetles (*Coleoptera: Chrysomelidae*) in Jhunjhunu district of Rajasthan, India

Dr. Rajmohan Meena
Department of Zoology, Govt. College Jayal, Nagaur, Rajasthan, India

Abstract

This study investigates the seasonal variations in species richness and abundance of the *Chrysomelidae* family in the Jhunjhunu district over two consecutive years (January 2021–December 2022). The data revealed a pronounced seasonal pattern, with the rainy season exhibiting the highest species richness and abundance, comprising 25 species and accounting for 84.30% of the total abundance. In contrast, the summer and winter seasons showed markedly lower values, with 9 species and 13.11% abundance in summer, and 7 species and 2.57% in winter. This trend was consistent across both years of the study, highlighting the rainy season as the peak period for Chrysomelidae activity. Diversity indices further corroborated these findings. The rainy season recorded the highest Shannon's diversity index (HX = 2.798), Margalef's richness (Mx = 3.262), and Pielou's evenness (Jx = 0.869), indicating a more diverse and evenly distributed community. Conversely, the winter season exhibited lower diversity and higher dominance, suggesting a less stable community structure during this period.

Keywords: Species richness, abundance, Jhunjhunu, leaf beetles

Introduction

The *Chrysomelidae* family, commonly known as leaf beetles, encompasses a diverse group of phytophagous insects that play significant roles in various ecosystems. In India, the seasonal dynamics of *Chrysomelidae* species are influenced by climatic factors, host plant availability, and ecological interactions. Understanding these patterns is crucial for ecological studies and pest management strategies (Biondi and D'Alessandro, 2012; [1] Furth, 2006; Jolivet *et al*., 2009; Kumar and Verma, 2017; Singh and Singh, 2014) [2, 3, 4, 5]. A study in a tropical forest fragment in northeastern Mexico found that leaf beetle abundance and species richness were significantly greater during the rainy season, which supported 60 species compared to fewer in the dry season. Despite lower species counts, the dry season showed higher diversity and lower dominance, indicating more even distribution. These patterns suggest that seasonal changes and microclimatic factors such as temperature, heat index, evapotranspiration, and wind speed play key roles in shaping leaf beetle communities (Lucio-Garcia *et al*., 2022) [6]. Research in Sierra de San Carlos, Mexico, showed that leaf beetle abundance, species richness, and diversity peaked during the rainy season, likely due to increased plant density and quality providing more resources. In contrast, the dry season's reduced host plant availability and harsher environmental conditions led to lower beetle activity. The study emphasizes the impact of seasonal shifts in vegetation and climate on leaf beetle populations (Sánchez-Reyes *et al*., 2016) [7]. In a fragmented low thorn forest in northeastern Mexico, seasonal effects on leaf beetle communities varied with successional stage. Younger successional areas (4 and 17 years old) showed higher beetle abundance during the rainy season, likely due to increased herbaceous and shrub growth. In contrast, conserved areas with perennial vegetation supported stable beetle populations year-round. The study highlights the importance of plant community composition and successional stage in shaping seasonal beetle dynamics (Treviño-Carreón& Valiente-Banuet; 2017) [8]. A study in Kovada Lake and Kızıldağ National Parks in Turkey found that leaf beetle species exhibited distinct seasonal activity patterns, with peaks in spring and early summer. The highest diversity was recorded in early June, with species composition clustering into three seasonal periods: early April, late April to early July, and late July to late October. These patterns were attributed to the availability and quality of host plants, which varied seasonally, affecting beetle activity and community structure (Şen & Gök; 2016) [9]. The exotic leaf beetle *Ophraella communa*, introduced to Japan from North America, exhibited two peaks in population abundance during the year. The study observed that beetle activity was influenced by the availability of host plants, with differences in abundance between plants growing in different microhabitats, such as hillsides and riverbanks. These findings suggest that local environmental conditions and host plant characteristics play significant roles in determining the seasonal activity of leaf beetles (Miyatake & Ohno; 2010) [10]. In the Siruvani Forest of the Nilgiri Biosphere Reserve, southern India, a study observed that insect abundance including leaf beetles was highest during the southwest monsoon across various habitats such as moist-deciduous, riverine, and teak plantation forests. The moist-deciduous habitat supported the highest insect abundance, while the teak plantation had the lowest. Seasonal fluctuations in insect abundance were consistent across these habitats, with the monsoon period being particularly significant for beetle populations (Arun and Vijayan, 2004) [11]. In the Kashmir Valley, a study on flea beetles in brassicaceous vegetable crops revealed that the emergence of beetles from overwintering generations occurred from the second fortnight of March to the end of May. New generations began emerging in early June, with peak trap catches recorded during the second fortnight of July. This indicates a clear seasonal pattern in the abundance of flea beetles, which are important pests of cruciferous crops (Rather *et al.*, 2017) [17]. In Ballavpur Wildlife Sanctuary, a dry deciduous forest in West Bengal, the seasonal diversity of common phototropic coleopterans, including leaf beetles, was studied. The highest capture rates were observed during the monsoon season, with the lowest during the post-monsoon period. This suggests that monsoon rains play a crucial role in the seasonal abundance of leaf beetles in this region (Saha *et al.*, 2009) [13].

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) [20]; Evans (2008) [17]; McHugh and Riley (2016) [18]; Seeno and Wilcox (1982) [19]. The beetles were also photographed for future reference.

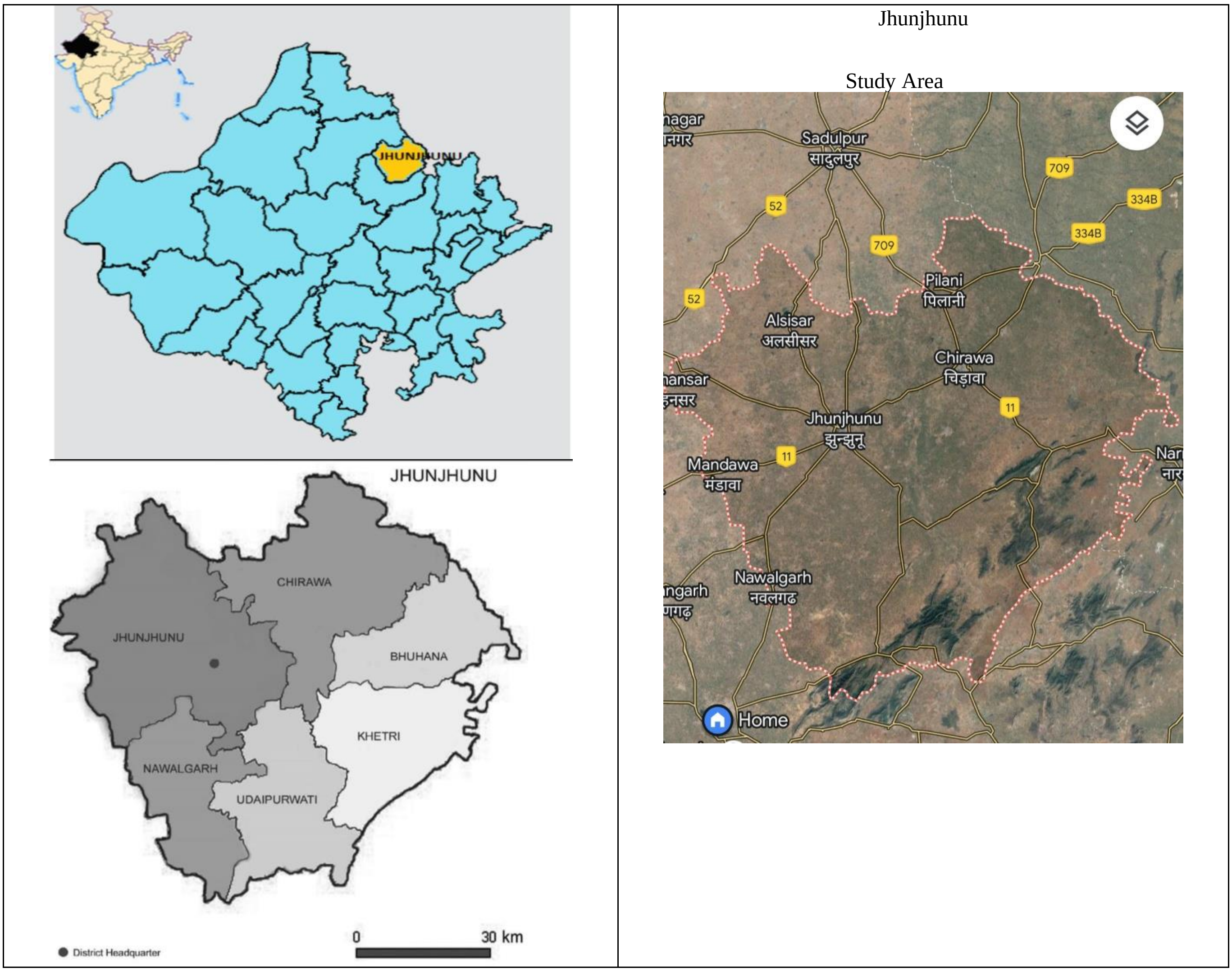

Photo Plate 1: Location of Jhunjhunu district with sampling sites

Result

Figure 1 presents species richness and abundance of Chrysomelidae family across seasons in the study area. The species richness and abundance were high during rainy season (25 species with 84.30% of the total abundance), followed by summer (9 species with 13.11% of the total abundance) and winter (7 species with 2.57% of the total abundance) (Table 1&2).

During first year of the study, maximum number of species and individuals was recorded during rainy season (22 species with 82.76% of the total abundance), followed by summer (9 species with 14.50% of the total abundance) and winter (4 species with 2.72% of the total abundance) (Table

2). Similarly, during second year of the study, maximum number of species and individuals was recorded during rainy season (24 species with 85.80% of the total abundance), followed by summer (8 species with 11.75% of the total abundance) and winter (6 species with 2.43% of the total abundance) (Table 2).

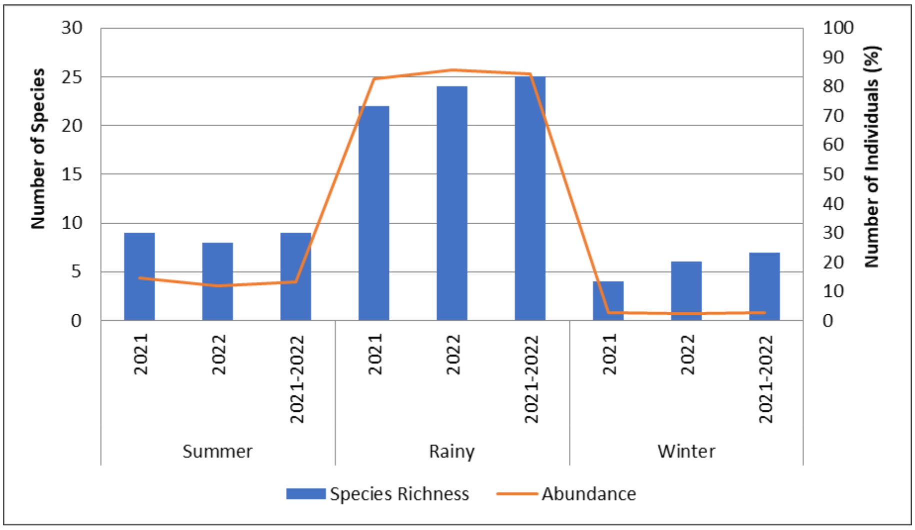

Fig 1: Species richness and abundance of Chrysomelidae family across seasons in the study area from January 2021 to December 2022.

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

The seasonal variations in various diversity measures calculated for Chrysomelidae family assemblages in the study area have been provided in **Table 3**. During two consecutive years of sampling period (from January 2021 to December 2022), rainy season exhibited the maximum species diversity (H^X = 2.798), richness (M^x = 3.262), evenness (J^x = 0.869) and Simpson index (D^x = 0.080) followed by summer (H^X = 1.690), richness (M^x = 1.455), evenness (J^x = 0.769) and Simpson index (D^x = 0.243) and winter (H^X = 1.364), richness (M^x = 1.550), evenness (J^x = 0.700) and Simpson index (D^x = 0.393).

Table 3: Values of diversity indices for Chrysomelidae family recorded across seasons from the study area from January 2021 to December 2022.

Diversity Measures	2021			2022			2021-22		
	S	R	W	S	R	W	S	R	W
Shannon's diversity	1.74	2.65	1.35	1.48	2.87	1.62	1.690	2.798	1.364
Simpson index	0.22	0.09	0.26	0.28	0.07	0.23	0.243	0.080	0.393
Margalef's richness	1.63	3.16	1.54	1.48	3.43	1.59	1.455	3.262	1.550
Pielou's evenness	0.79	0.85	0.97	0.71	0.90	0.90	0.769	0.869	0.700

Discussion

The seasonal diversity of the *Chrysomelidae* family in India reflects complex interactions between climatic factors, host plant dynamics, and ecological processes. Continued research in this area is essential for developing integrated pest management strategies and conserving biodiversity in agricultural and natural ecosystems (Biondi and D'Alessandro, 2012; Furth, 2006; Jolivet *et al*., 2009; Kumar and Verma, 2017; Singh and Singh, 2014). [1, 2, 3, 4, 5]
The data revealed a pronounced seasonal pattern, with the rainy season exhibiting the highest species richness and abundance, comprising 25 species and accounting for 84.30% of the total abundance. In contrast, the summer and winter seasons showed markedly lower values, with 9 species and 13.11% abundance in summer, and 7 species and 2.57% in winter.
In the present study, it was reported that leaf beetle diversity and abundance were higher in the rainy season, possibly due to increased plant growth and the availability of food resources. Likewise, Meena *et al*., (2017) [14] found that rainfall significantly influenced the seasonal diversity of leaf beetles in the Aravalli Range of India and suggested that rainfall resulted in greater availability of vegetation, providing a greater supply of food resources for leaf beetles. Similarly, Ranjan and Singh (2015) [15] found that rainfall significantly affected the composition of leaf beetle communities in the Shivalik Hills of India. The study revealed that species richness and evenness were higher during the rainy season and that certain leaf beetle species were more abundant during specific rainfall periods. The present results are in consonance with the study conducted in the Western Ghats of India, Gandhi and Ghate (2011) [16] observed that the abundance and diversity of leaf beetles were positively correlated with rainfall, with higher abundance during the wetter months.

Conclusion

This study highlighted the significant seasonal variation in the diversity and abundance of leaf beetles in Jhunjhunu district of Rajasthan, India, emphasizing the complex interactions between climatic factors, host plant dynamics, and ecological processes. The rainy season is crucial for leaf beetle populations, providing optimal conditions for growth and reproduction due to increased plant availability. In contrast, the dry season posed challenges, potentially leading to reduced beetle activity and diversity. These patterns were influenced by factors such as temperature, humidity, and host plant quality, which varied seasonally and affected beetle physiology and behaviour. Understanding these seasonal dynamics is essential for developing effective integrated pest management strategies and conserving biodiversity in agricultural and natural ecosystems. Further research is necessary to explore the underlying mechanisms driving these seasonal patterns and to assess the long-term implications of climate variability on leaf beetle communities.

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