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Diversity and abundance of Weevils (Coleoptera: Curculionidae) in Jhunjhunu district of Rajasthan, India

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Abstract
The diversity and abundance of Curculionidae in Jhunjhunu district of Rajasthan, India was studied from January 2021 to December 2022. Using four different collection methods sweep nets, hand picking, pitfall trap and light traps, A total of 19 species belonging to 14 genera under 8 subfamilies of the family Curculionidae were recorded. The most abundant subfamily Entiminae was comprised of the highest number of species (6 species), followed by Hyperinae, Lixinae and Cyclominae (3 species each) and Alcidinae, Dryophthorinae, Curculioninae and Apioninae (1 species each). As compared to the number of individuals, again Entiminae was the most abundant subfamily (28.38% of the total individuals), followed by Cyclominae (22.28%), Lixinae (19.54%), Hyperinae (15.91%), Apioninae (7.42%), Dryophthorinae (5.74%), Alcidinae (0.61%), and Curculioninae (0.08%). The present study indicates a great diversity of weevils in the area and provides preliminary data for future works.

Keywords: Diversity, abundance, Weevils, Curculionidae, Jhunjhunu

Introduction

Review of literature authenticates that the family Curculionidae is a big family of the Order Coleoptera. Schonherr (1837), Gyllenhal (1843) [7], Boheman (1851) [3] and Fahraeus (1871) [4] are Swedish workers who made the foundation of the family Curculionidae. There are many workers from the world who have contributed to the family Curculionidae. The prominent workers refer to Laccordaire (1863) [14], LeConte (1874) [15], Marshall (1916) [18], Heller (1941) [8] etc. Marshall (1913 a, b) [16, 17] described six new species of Indian Curculionidae, *viz*., *Myllocerus carinirostris*, *Cyrtepistomus* sp., C. *pannosus* sp., *M. catechu* sp., *Himatium asperum* sp., *Alcides porrectirostris* sp., and *Amblyrrhinus suberecticollis* sp. on diverse economically important plants. A very large number of weevils belonging to 34 genera of the family Curculionidae as major pests of the forest ecosystem were recorded by Stebbing (1914). Anderson (1992) [1] gave an annotated checklist of weevils (Coleoptera: Curculionoidea) from southern Florida. Ramamurthy and Ghai (1988) revised the genus *Myllocerus*, studied 73 species (15 new species), revised the key for 89 species, provided a checklist of 336 species, and raised five varieties to subspecific status. Pajni (1990) published a book "Fauna of India (Coleoptera: Curculionidae)" in which 201 species of Curculionidae of subfamily Eremninae and Tribe Cyphicerini were reported from India and the adjoining lands of Burma and Bangladesh, and out of which 120 species were new.

Morron (2000) [22] studied Mexican weevils belonging to 6 families *viz*., Nemonychidae, Belidae, Anthribidae, Brentidae, Attelabidae, Dryophthoridae and 27 subfamilies. Mukhopadhyay and Biswas (2000) [23] described 22 species of weevil belonging to 18 genera associated with 4 subfamilies under Curculionidae family from Meghalaya. Mukhopadhyay and Halder (2003) [23] reported 28 species of weevil belonging to 19 genera associated with 5 subfamilies under Curculionidae from Sikkim. Korotyaev and Hong (2004) [12] enlisted 58 species of weevils from Korea. Setliff (2007) gave a checklist of weevils which included 2,955 species and 553 genera occurring in the Papuan region. Tara *et al*., (2010) recorded diversity of 9 weevil species *viz*., *Cylas formicarius*, *Myllocerus discolor*, *Alcidodes signatus*, *Alcidodes collaris*, *Xanthochelus faunus*, *Apion* sp., *Lixus truncatulus*, *Odoiporous longicollis*, *Phytoscaphus* sp. from Samba district of Jammu and Kashmir State. Gultekin (2010) [6] examined forty-six species of the genera *Broconius* Desbrochers and *Lixus* Fabricius.

Ramesha and Ramamurthy (2011) redescribed the genus *Barimononychus* for its essential generic characters along with one species *viz*., *B. kazirangensis* based on additional genitalia structure and morphometry. Similarly, Ramesha and Ramamurthy (2011) studied genus *Baris* Germar (Coleoptera: Curculionidae) in which 12 species were reported from India with 4 new species. Ghahari *et al*., (2011) [5] gave diversity of a total of 33 species of 9 genera *viz*., *Curculio*, *Larinus*, *Hypera*, *Ceutorhynchus*, *Tychius*, *Otiorhynchus*, *Lixus*, *Coniatus* and *Donus* associated with four subfamilies *viz*., Lixinae, Curculioninae, Entiminae, and Phytonominae under the Curculionidae family from Iran. Mahendiran and Ramamurthy (2012) [24] revised 2 species of the genus *Dermatoxenus* Marshall (Curculinidae: Entiminae) from India. Updated generic and species descriptions, annotated checklist and a modified key to the species were also provided. Jadhav and Sharma (2012) [13] reported 32 species from 15 genera spread over 3 subfamilies of weevil (Curculionidae) from Maharashtra. Ayri *et al*., (2012) [2] described the second species of *Synorchestes* Voss, *S. indicus* sp., from India. A key to the two species was also provided. Sathe and Khairmode (2013) studied diversity and occurrence of weevils (Coleoptera: Curculionidae) from Kolhapur district in which 22 species were reported feeding on various crops. Khairmode and Sathe (2014) [9] studied seasonal abundance of two species of weevil *viz. M. discolar* and *M. viridanus* in mulberry

garden from Kolhapur region of Maharashtra. Both species of weevil were found throughout the year on mulberry plants but they were most abundant in the months from July to October. Khairmode *et al*., (2019) [10] revealed the diversity, seasonal abundance, and distribution of 37 species associated with 22 genera from Kolhapur district, Maharashtra, India.

Mailafiya *et al*., (2018) [25] studied species abundance of weevils belonging to two amaranth hosts in Maiduguri, north eastern Nigeria. Kotchofa *et al*., (2019) [11] studied diversity and distribution of sweet potato weevils in southern Benin. Ranjini and Ghosh (2019) reported *Myllocerus viridanus* as a phytophagous pest on 21 plant species from Kerala, India. Mohagan *et al*., (2020) [26] recorded diversity of 22 species of weevil in Marahan, Marilog Forest Reserve, Southern Mindanao, Philippines.

Material 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.

Weevils were collected using sweep nets, hand picking, pitfall trap and light traps. After collection, the Weevils 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 weevils were identified to the species level using a Stereo Zoom Binocular Microscope (Magnus MSZ-Bi), following taxonomic keys by Morris (1997 [19], 2002 [] & 2012) [21]. The weevils were also photographed for future reference.

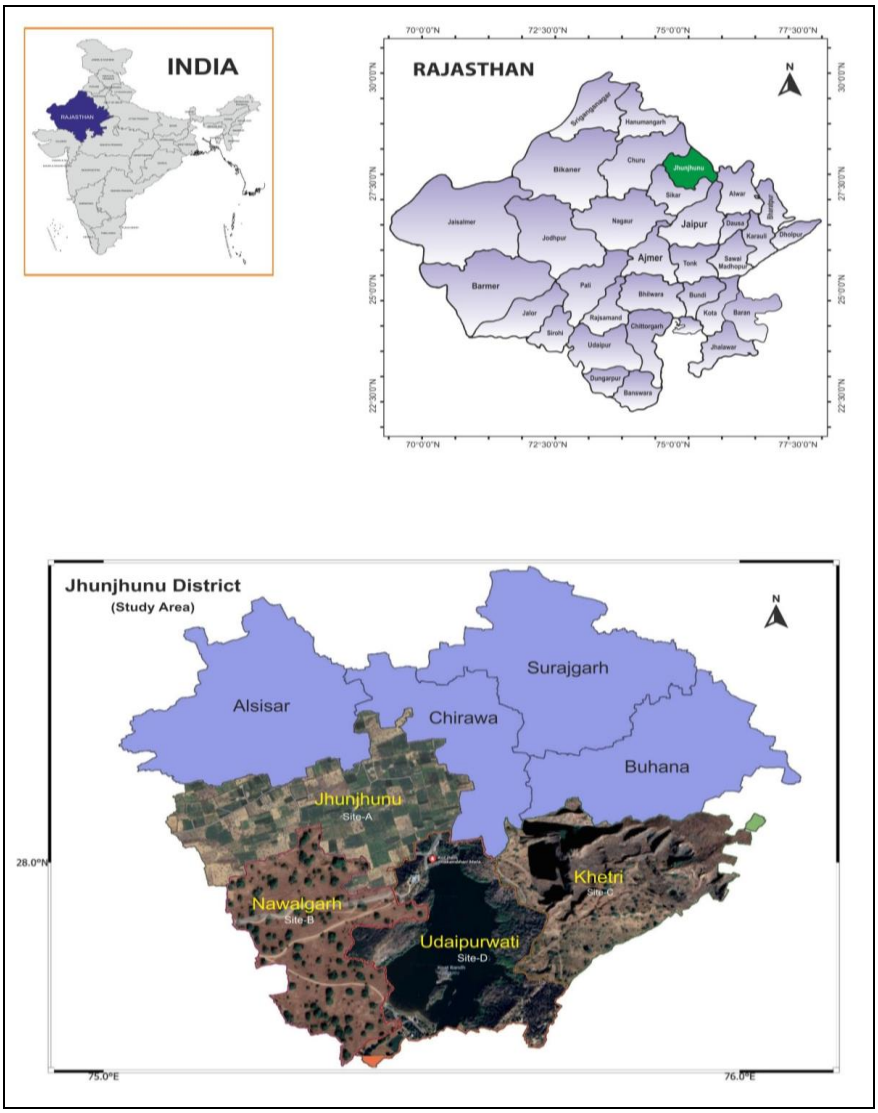

Photo Plate 1: Location of Jhunjhunu district with sampling sites

Result

A total of 19 species belonging to 14 genera under 8 subfamilies of the family Curculionidae were recorded from January 2021 to December 2022 from four study sites selected in the Jhunjhunu district **(**Photo Plat 2). As evident from species richness and abundance of different subfamilies (Table 1), subfamily Entiminae was comprised of the highest number of species (6 species), followed by Hyperinae, Lixinae and Cyclominae (3 species each) and Alcidinae, Dryophthorinae, Curculioninae and Apioninae (1 species each) (Fig 1). As compared to the number of individuals, again Entiminae was the most abundant subfamily (28.38% of the total individuals), followed by Cyclominae (22.28%), Lixinae (19.54%), Hyperinae (15.91%), Apioninae (7.42%), Dryophthorinae (5.74%), Alcidinae (0.61%), and Curculioninae (0.08%) (Fig 1).

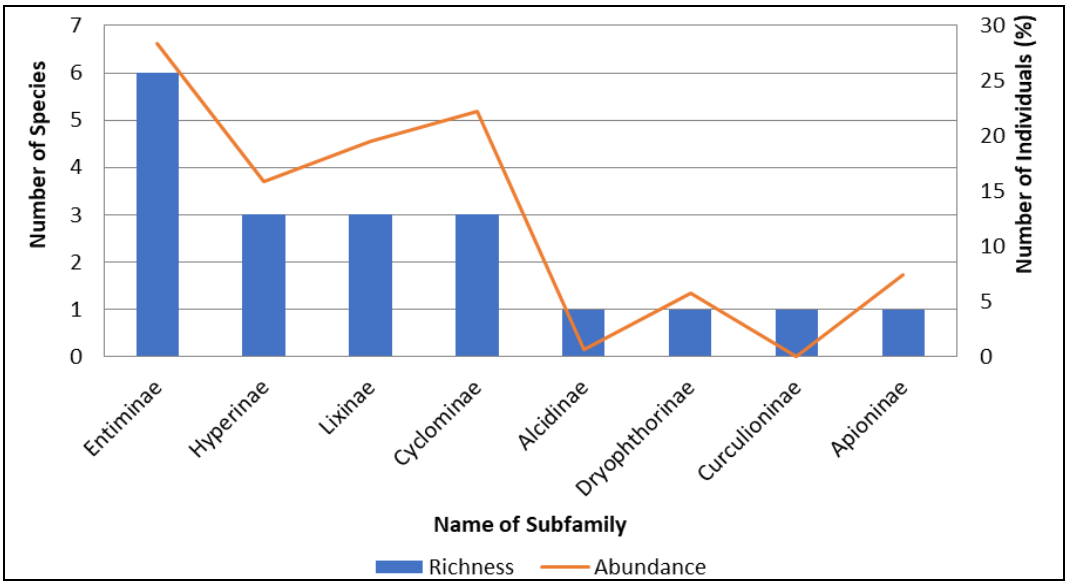

Fig 1: Species richness and abundance of Curculionidae family in the study area from January 2021 to December 2022.

During the first year of study, maximum number of species belonged to the subfamily Entiminae constituting 6 species, followed by Hyperinae, Lixinae and Cyclominae (3 species each), Alcidinae, Dryophthorinae and Curculioninae (1 species each) (Table 1&2). On the other hand, again maximum number of individuals belonged to the subfamily Entiminae which constituted 30.05% of the total individuals, followed by Cyclominae (25.78%), Lixinae (20.59%), Hyperinae (16.51%), Dryophthorinae (6.30%), Alcidinae (0.55%) and Curculioninae (0.18%).

During the second year of study, maximum number of species belonged to the subfamily Entiminae constituting 6 species, followed by Hyperinae, Lixinae and Cyclominae (3 species each), Alcidinae, Dryophthorinae and Apioninae (1 species each) (Table 1&2). On the other hand, again maximum number of individuals belonged to the subfamily Entiminae which constituted 26.85% of the total individuals, followed by Cyclominae (19.08%), Lixinae (18.58%), Hyperinae (15.37%), Apioninae (14.18%), Dryophthorinae (5.23%), Alcidinae (0.67%).

Table 1: Weevils recorded from different study sites selected in the Jhunjhunu district from January 2021 to December 2022.

S.No.	Family	Subfamilies	Species
1	Curculionidae	Entiminae	*Myllocerus marmoratus*
2			*Myllocerus viridanus*
3			*Myllocerus* sp.
4			*Artipus floridanus*
5			*Naupactus leucoloma*
6			*Polydrusus* sp.
7		Hyperinae	*Hypera postica*
8			*Hypera zoilus*
9			*Hypera* sp.
10		Lixinae	*Lixus (Phillixus) subtilis*
11			*Atactogaster zebra*
12			*Cleonis pigra*
13		Cyclominae	*Listroderes* sp.
14			*Listroderes costirostris*
15			*Ethemaia* sp.
16		Alcidinae	*Alcidodes karelinii*
17		Apioninae	*Apion* sp.
18		Dryophthorinae	*Scyphophorus acupunctatus*
19		Curculioninae	*Pseudopoophagus* sp.

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

Curculionidae	2021		2022		2021-22	
	Richness	Abundance	Richness	Abundance	Richness	Abundance
Entiminae	6	162	6	159	6	321
Hyperinae	3	89	3	91	3	180
Lixinae	3	111	3	110	3	221
Cyclominae	3	139	3	113	3	252
Alcidinae	1	3	1	4	1	7
Dryophthorinae	1	34	1	31	1	65
Curculioninae	1	1	0	0	1	1
Apioninae	0	0	1	84	1	84
Total	18	539	18	592	19	1131

Myllocerus marmoratus | *Myllocerus* sp. | *Myllocerus viridanus* | *Artipus floridanus*

Naupactus leucoloma | *Polydrusus* sp. | *Hypera postica* | *Hypera zoilus*

Hypera sp. | *Lixus (Phillixus) subtilis* | *Atactogaster zebra* | *Cleonis pigra*

Listroderes sp. | *Listroderes costirostris* | *Ethemaia* sp. | *Alcidodes karelinii*

Apion sp.	*Scyphophorus acupunctatus*	*Pseudopoophagus* sp.

Photo Plate 2: Family- Curculionidae

Discussion

Review of literature authenticates that the family Curculionidae is a big family of the order Coleoptera. Schonherr (1837), Gyllenhal (1843) [7] and Fahraeus (1871) [4], Swedish workers, made foundation to the family Curculionidae. Likewise, there are many workers from the world who have also contributed to the family Curculionidae. The prominent workers refer to Laccordaire (1863) [14], LeConte (1874) [15], Marshall (1916) [18], Heller (1941) [8] etc. Marshall (1913 a, b) [16, 17] described six new species of Indian Curculionidae, *viz*., *Myllocerus carinirostris* sp. nov., *Cyrtepistomus* gen. nov., C. *pannosus* sp. nov., *M. catechu* sp. nov., *Himatium asperum* sp. nov., *Alcides porrectirostris* sp. nov., and *Amblyrrhinus suberecticollis* sp. nov. on diverse economically important plants. Pajni (1990) published a book "Fauna of India (Coleoptera: Curculionidae)" in which 201 species of Curculionidae of subfamily Eremninae and Tribe Cyphicerini from India and the adjoining lands of Burma and Bangladesh, were documented out of which 120 species were new.

As compared to previous studies on weevil diversity from various regions of India, 19 species of weevils related to 14 genera under 8 subfamilies *viz*., Entiminae, Hyperinae, Lixinae, Cyclominae, Alcidinae, Apioninae, Dryophthorinae and Curculioninae were reported from the Jhunjhunu district during the present study. Similarly, Mukhopadhyay and Biswas (2000) [23] described 22 species of weevil belonging to 18 genera associated with 4 subfamilies under Curculionidae family from Meghalaya, India. Likewise, Mukhopadhyay and Halder (2003) reported 28 species of weevil belonging to 19 genera associated with 5 subfamilies of Curculionidae family from Sikkim. Similarly, Sathe and Khairmode (2013) studied diversity and occurrence of weevils from Kolhapur district, Maharashtra in which 22 species were reported feeding on various crops. However, Tara *et al*., (2010) recorded diversity of 9 weevil species *viz*., *Cylas formicarius*, *Myllocerus discolor*, *Alcidodes signatus*, *Alcidodes collaris*, *Xanthochelus faunus*, *Apion* sp., *Lixus truncatulus*, *Odoiporous longicollis*, *Phytoscaphus* sp. from Samba district of Jammu and Kashmir. Similarly, Ramesha and Ramamurthy (2011) studied genus *Baris* Germar, in which 12 species were reported from India with 4 new species.

The results of present study on weevils are not in accordance with the study by Korotyaev and Hong (2004) [12] who enlisted 58 species of weevils from Korea. Similarly, Ghahari *et al*., (2011) [5] documented diversity of a total of 33 species of 9 genera *viz*., *Curculio*, *Larinus*, *Hypera*, *Ceutorhynchus*, *Tychius*, *Otiorhynchus*, *Lixus*, *Coniatus* and *Donus* associated with four subfamilies *viz*., Lixinae, Curculioninae, Entiminae, and Phytonominae under the Curculionidae family from Iran. Likewise, Jadhav and Sharma (2012) [13] reported 32 species from 15 genera spreaded over 3 subfamilies of weevil (Curculionidae) from Maharashtra. Alike, Khairmode *et al*., (2019) revealed the diversity, seasonal abundance, and distribution of 37 species associated with 22 genera from Kolhapur district, Maharashtra, India. Similar to the results, Mohagan *et al*., (2020) [26] recorded the diversity of 22 species of weevil in Marahan, Marilog Forest Reserve, Southern Mindanao, Philippines.

Conclusion

Weevils played a complex role in agriculture, acting both as destructive pests and as valuable allies in ecological management. On one hand, many weevil species caused significant harm by damaging crops and stored grains, leading to reduced yields and economic losses for farmers. On the other hand, certain weevils were effectively utilized as biological control agents to manage invasive plant species, offering an environmentally friendly alternative to chemical herbicides. Understanding the specific behaviour and impact of each weevil species was essential for developing effective agricultural strategies that minimized harm while maximized potential benefits.

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