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A study on the diversity of Hemiptera and Orthoptera fauna in Tal Chhapar Wildlife Sanctuary, Rajasthan

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Abstract
The present research was conducted at Tal Chhapar Wildlife Sanctuary in Churu, Rajasthan, from January 2022 to November 2023. Tal Chhapar Wildlife Sanctuary is located in the Thar desert region of Rajasthan. The present study reported 19 species of Hemiptera and Orthoptera at the study site, of which 10 species were identified from Hemiptera, while 9 species were identified from Orthoptera. Within the order Hemiptera, the family Pentatomidae recorded the majority of species, and within the Orthoptera, the family Acrididae exhibited the highest diversity. Margalef's Index indicated the highest species richness within Hemiptera for the family Cydnidae at 1.75, while in Orthoptera, the family Pyrgomorphidae exhibited the greatest richness with a value of 1.78. Within Hemiptera, the family Dinidoridae exhibited the highest Pielou's Evenness Index at 0.88, signifying a relatively uniform species distribution. In Orthoptera, Tettigoniidae showed the greatest evenness with a value of 0.90. The Shannon-Wiener Diversity Index reached 1.95 for Dinidoridae in Hemiptera and 1.97 for Tettigoniidae in Orthoptera, highlighting the high species diversity and evenness within both families

Keywords: Hemiptera, orthoptera, diversity, species, insects

Introduction
The largest, most diverse, most successful, and most common taxonomic group on Earth is insects. Insects, being hexapod invertebrates, are classified under the class Insecta, phylum Arthropoda, and kingdom Animalia. (Prakhar *et al.*, 2021) [14]. According to a review by Sankarganesh (2017) [6], in terms of both taxonomic diversity and ecological function, insects are the most diverse group of animals on Earth, making up 75% of all known animal species, which stands out for having an incomparable diversity of forms, colours, shapes, and ecological adaptations. The order Hemiptera is the fifth-largest and most varied insect order. Often referred to as true bugs, the order Hemiptera comprises aphids, cicadas, shield bugs, assassin bugs, planthoppers, water striders, bed bugs, and other insects (Gullan & Cranston, 2014) [8]. Approximately 103,590 species from 152 families and four suborders constitute the order Hemiptera worldwide, and India has 6,058 hemipteran species from 92 families (Chandra *et al.*, 2018; Praveen *et al.*, 2024) [2, 13]. Orthoptera also represent one of the largest and diverse groups of insects. Orthoptera comprises katydids, locusts, crickets, grasshoppers, and their relatives. The name comes from Greek ortho (straight) and ptera (wing), referring to the stiff, parallel forewings. Orthoptera comprises approximately 29,530 species worldwide, and 1,274 species belonging to 442 genera and 23 families, from India (Cigliano *et al.*, 2024; Chand *et al.*, 2024) [1, 4].

Materials and methods
Study area: India's ecosystem is varied, with arid and semiarid areas, nearly every kind of forest, grasslands, lakes, rivers, estuaries, lagoons, islands, and the ocean. Because of its distinct geographic location, varied climate, and high levels of ecological diversity and geodiversity, India has a wealth of biological diversity (Ghosh and Singh, 2000) [7]. The present study was carried out at Tal Chhapar Wildlife Sanctuary, Churu, Rajasthan. This area falls under the biogeographic zone 3A-Thar Desert. The Sanctuary's name comes from

the Tal word, which is commonly used for a plain salty place. With a small number of Acacia nilotica and Prosopis juliflora trees, Tal Chhapar Sanctuary resembles a Tropical Savanna grassland (Jhajhria A. 2021) [9]. The vegetation in this region is classified as desert thorn forest (6B/C1) and northern tropical thorn forest (6B). This region has a dry climate with significant temperature fluctuations that vary with the season (Kaur *et al.*, 2020).

Field survey and collection

The field study was done from January 2022 to November 2023 at the Tal Chhapar wildlife sanctuary, Churu, Rajasthan. Sample collection was done twice a month in the morning and evening sessions. The insect collection was done using two methods, sweep net and hand picking collection, as permitted by the Rajasthan Forest Department. Following the collection, insects were transferred to a killing jar with chloroform-soaked cotton. After the insects had been killed, they were pinned and transferred to a storage box.

Data analysis

Diversity of orders was calculated by various methods. Species richness, evenness were calculated by using Margalef's Index, Pielou's Evenness Index, and the Shannon-Wiener Diversity Index. Past 4.03 software was used to perform data analysis.

Result and observation: In the present study diversity of Hemiptera and Orthoptera was observed at the Tal Chhapar wildlife sanctuary, Churu, Rajasthan. The present study reports that 9 identified species and one unidentified species from 7 families were recorded in Hemiptera, while 9 identified species, belonging to 4 families, were recorded in Orthoptera. Within the order Hemiptera, the family Pentatomidae noted the highest species count with three species, followed by Reduviidae with two species. The families Dinidoridae, Cydnidae, Scutelleridae, Pyrrhocoridae, and Membracidae were each represented by a single species. The Orthoptera order's Acrididae family showed the highest diversity, with four species, followed by Gryllidae and Tettigoniidae, each with two species, and Pyrgomorphidae with one.

Statistical analysis was done for the collected samples of Hemiptera and Orthoptera during the years 2022-23. Within the order Hemiptera, species richness with Margalef's Index was observed to be highest for the family Cydnidae. Species evenness with Pielou's Evenness Index was detected more for the family Dinidoridae. Diversity index with Shannon's Diversity Index was shown more for the families Dinidoridae and Pyrrhocoridae. Within the order Orthoptera, species richness with Margalef's Index was noted more for the family Pyrgomorphidae. Species evenness with Pielou's Evenness Index was observed to be highest for the family Tettigoniidae. Diversity index with Shannon's Diversity Index was recorded more for the family Tettigoniidae.

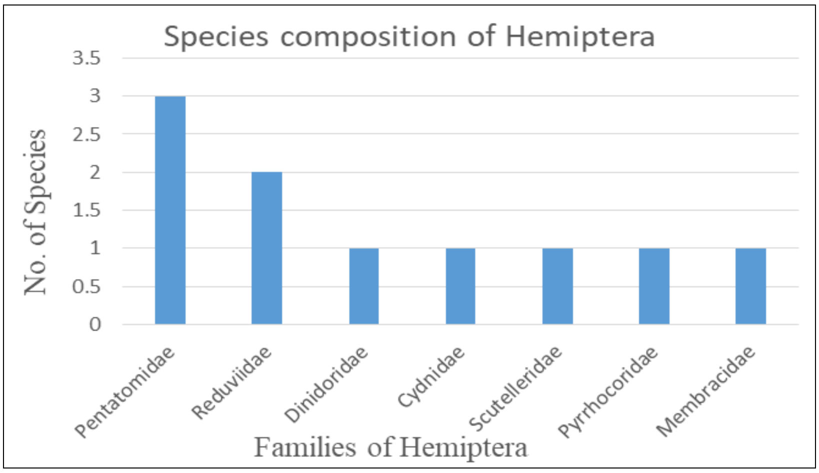

Fig 1: Family wise species composition of Hemiptera

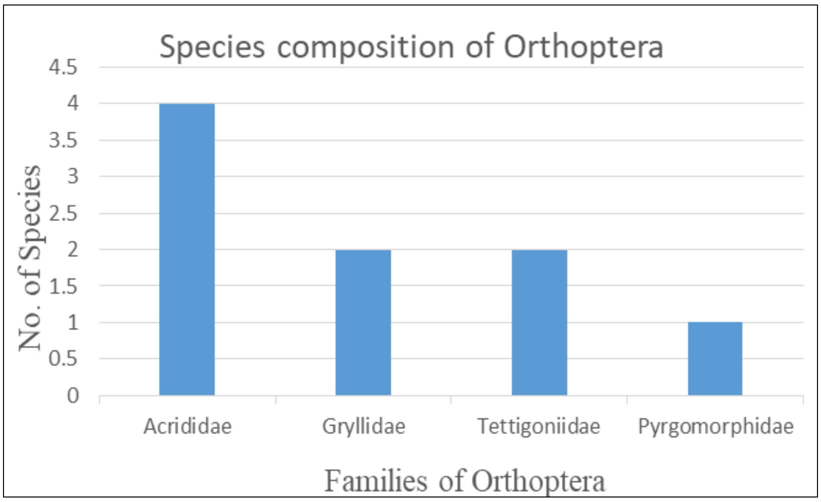

Fig 2: Family wise species composition of Orthoptera

Discussion

A total of 19 species from both orders were noted during the study period from the Tal Chhapar wildlife sanctuary. Within the present study, Order Hemiptera documented 10 species across various families such as Pentatomidae, Reduviidae, Scutelleridae, Dinidoridae, Cydnidae, Pyrrhocoridae, and Membracidae, and Order Orthoptera verified 9 species, primarily from families like Acrididae, Gryllidae, Tettigoniidae, and Pyrgomorphidae. Praveen *et al.*, (2024) [13] conducted a comprehensive documentation of the Hemiptera fauna across all Indian states. Their study recorded a total of 6,058 species from India, including 420 species specifically from the state of Rajasthan, reflecting the regional diversity within the order. The species documented from Rajasthan by Praveen *et al.*, (2024) [13] resembles the results of the present study done at Tal Chhapar Wildlife Sanctuary. Pentatomid Bug Fauna in Semi-Arid Western Rajasthan was observed by Choudhary *et al.* (2024) [3]. There, they documented 15 species belonging to 13 genera and 2 subfamilies. Another study was done by Srivastava (2012) [15] at the pearl millet (bajara) agro ecosystem of Jhunjhunu, where they recorded 12 species of Hemiptera while studying insect fauna. The findings of the present study are resemblance to these studies. Chand *et al.*, (2024) [2] provided a checklist of the Orthoptera fauna of India. In which they recorded 1274 species from 442 genera and 23 families from India, and 102 species from Rajasthan. During an insect fauna study, Srivastava (2012) [15] discovered 8 species of Orthoptera in the Jhunjhunu pearl millet (bajara) agroecosystem. In another study, Pareek *et al.* (2017) [12] observed the fauna of the Acrididae family in five districts of southern Rajasthan: Banswara, Chittorgarh, Dungarpur, Pratapgarh, and Udaipur, recording ten species. Kumar *et al.* (2014) [11] perform a taxonomic analysis of the Acrididae in Rajasthan, India. From various locations, 37 species were documented, divided into 25 genera and 11 subfamilies. The result of these studies supports the present finding at the sanctuary. The Shannon-Weiner Diversity Index was used by Dhakad *et al.* (2014) [5] to determine diversity after observing the families Acrididae, Gryllidae, Pyrgomorphidae, Tetrigidae, and Tettigonidae. Kumar *et al.* (2013) [10] computed the species richness, evenness, and Shannon Diversity index for the Pyrgomorphidae family while surveying Punjab. Their research findings are consistent with those of the current sanctuary study.

Significance

The present research on Hemiptera and Orthoptera fauna helps in the documentation of the invertebrate fauna of the Tal Chhapar Wildlife Sanctuary. Provides comprehensive information on species richness, evenness, and distribution of key insect orders in a semi-arid grassland ecosystem. Additionally, the findings of this study offer a foundation for future ecological and biodiversity research.

Table 1: Species recorded at Tal Chhapar Wildlife Sanctuary

	Family	Species
Order Hemiptera	Pentatomidae	*Halyomorpha halys*
		Bagrada hilaris
		Unidentified sp.
	Dinidoridae	*Coridius ianus*
	Cydnidae	*Pangaeus bilineatus*
	Scutelleridae	*Chrysocoris* sp.
	Reduviidae	*Tiarodes miyamotoi*
		Triatoma sanguisuga
	Pyrrhocoridae	*Probergrothius sanguinolens*
	Membracidae	*Centrotus cornutus*
Order Orthoptera	Gryllidae	*Acheta domesticus*
		Gryllus bimaculatus
	Tettigoniidae	*Sathrophyllia* sp.
		Trigonocorypha sp.
	Acrididae	*Hieroglyphus* sp.
		Heteracris sp.
		Acrida cinerea
		Duroniella kostylevi
	Pyrgomorphidae	*Chrotogonus trachypterus*

Table 2: Data Analysis of Hemiptera

S.No	Family	Margalef's Index (Ma)	Pielou's Evenness Index	Shannon's Diversity Index (H)
1.	Pentatomidae	1.30	0.83	1.89
2.	Dinidoridae	1.60	0.88	1.95
3.	Cydnidae	1.75	0.80	1.86
4.	Scutelleridae	1.73	0.81	1.87
5.	Reduviidae	1.46	0.82	1.88
6.	Pyrrhocoridae	1.67	0.87	1.94
7.	Membracidae	1.68	0.84	1.90

Table 3: Data Analysis of Orthoptera

S. No	Family	Margalef's Index (Ma)	Pielou's Evenness Index	Shannon's Diversity Index (H)
1.	Gryllidae	1.46	0.89	1.96
2.	Tettigoniidae	1.52	0.90	1.97
3.	Acrididae	1.31	0.80	1.86
4.	Pyrgomorphidae	1.78	0.71	1.74

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