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## Species composition, abundance, density and diversity of grasshoppers (Insecta: Orthoptera) in a protected forest ecosystem in the Western Himalayas, India

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### Abstract

Present investigations were undertaken to know species composition, abundance, density and diversity of Grasshoppers in the Western Himalayas, India. A total of 1269 individuals of Grasshoppers (Insecta: Orthoptera) belonging to 2 families and 14 species were recorded during the study period. On the basis of total number of species Acrididae was the dominant family with 8 species and constituting 87.55% of the total number of individuals of Grasshoppers followed by Tettigoniidae with 6 species constituting 12.45% of the total number of individuals of Grasshoppers. Similarly, on the basis of total number of individuals of Grasshopper population recorded *Xenocatantops kamyi* Kirby was the most abundant species of grasshopper recorded from the study area followed by *Aulacobothrus leutipus* Walker and *Oedipoda himalayana* Uvarov, respectively. *Letena linearis* (Walk.), *Elimaea* sp. and *Himertula kinnerari* (Uvarov) included less abundant species of Grasshoppers recorded during the study period. Maximum population density of grasshoppers were recorded in rainy season (65.0 hoppers ha<sup>-1</sup>), followed by summer (27.84 hoppers ha<sup>-1</sup>) and winter (12.12 hoppers ha<sup>-1</sup>), respectively. Across the study period Shannon-Wiener diversity Index (H') was recorded as 2.329 for the grasshoppers. Similarly, maximum species diversity was recorded in the rainy season (2.25) followed by summer (1.96) and winter (1.09), respectively.

**Keywords:** Acrididae, Ecology, Family, Grasshoppers, Himalaya, Orthopteran, Species, Tettigoniidae

### 1. Introduction

Orthopterans are common in terrestrial ecosystem and they are comprised medium to large sized, active insects including grasshoppers, locusts and crickets. The number of known species of orthopterans from around the world is about 20,000. Out of that, 1750 species which is about 8.75% are known from India [17]. They are found in different diverse ecosystem from sea level to high altitude of Himalayan hills [4]. Studies related to species composition of orthopterans in the Indian Himalayan regions have been conducted in different climatic conditions by Singh [16], Mani [11], Julka *et al.* [9], Bhowmik and Haldar [3], Kaushal and Joshi [10], Tandon and Shishodia [18], Shishodia [15] and Arya and Dayakrishna [2]. Similarly, Bhowmik [5], Porter *et al.* [12], Tandon and Hazra [17], Joshi *et al.* [8], Ciplak *et al.* [6], Saha and Haldar [13], Ananthaselvi *et al.* [1] and Yadav and Singh [19] have studied abundance, population density and diversity of grasshopper in the different parts of the world. However, not so much attempts have so far been carried out to study the species composition, abundance, density, and diversity of Grasshoppers in the Nanda Devi Biosphere Reserve, Western Himalayas, India. Therefore, keeping in view the abundance, density, species composition and diversity of Grasshoppers was carried out in the present investigation.

### 2. Material and methods

**2.1. Study area:** Nanda Devi Biosphere Reserve (NDBR) is located in the northern part of west Himalaya and spread in three districts of the newly carved state of Uttarakhand namely Chamoli district in Garhwal, Bageshwar and Pithoragarh districts in Kumaon. NDBR is located at 30°03'-31°02'N latitude and 79°12'-80°19' E longitudes with large altitudinal range 1,800 to 7,817amsl with unique topography, climate and soil, supporting diverse ecosystems, habitats, communities, population and species. The high percentage of endemic species in the reserve itself speak about the conservation value of the reserve. The total area of present NDBR is 6,407.03km<sup>2</sup> with a core zone of 712.12km<sup>2</sup>, buffer zone of 5,148.57km<sup>2</sup> and a transition zone of 546.34km<sup>2</sup>. The buffer zone encircles the core zone and is open for multiple

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uses. In this zone, inhabitants are allowed to use the resources to meet daily needs and, Similarly tourism (trekking, etc.) is also allowed. A total of 45 villages inhabit in this zone. The inhabitants belong to the Indo-Mongoloid (Bhotia) and Indo-Aryan groups. The reserve occupies a special place in the Biosphere Reserve system of high altitude Himalayan region of India. Its territory comprises a unique combination of natural areas in the mixed temperate forest, sub alpine forest,

alpine meadows, several highest peaks and glaciers. Climatically, the area is unique and has three seasons i.e. winter (November to March), summer (April to mid-June) and rainy from middle of June to mid-October. Figure 1 gives location of different study sites within Western part of NDBR. All the sites in the study area are located in the high elevations ranging from 2000m to 4000m.

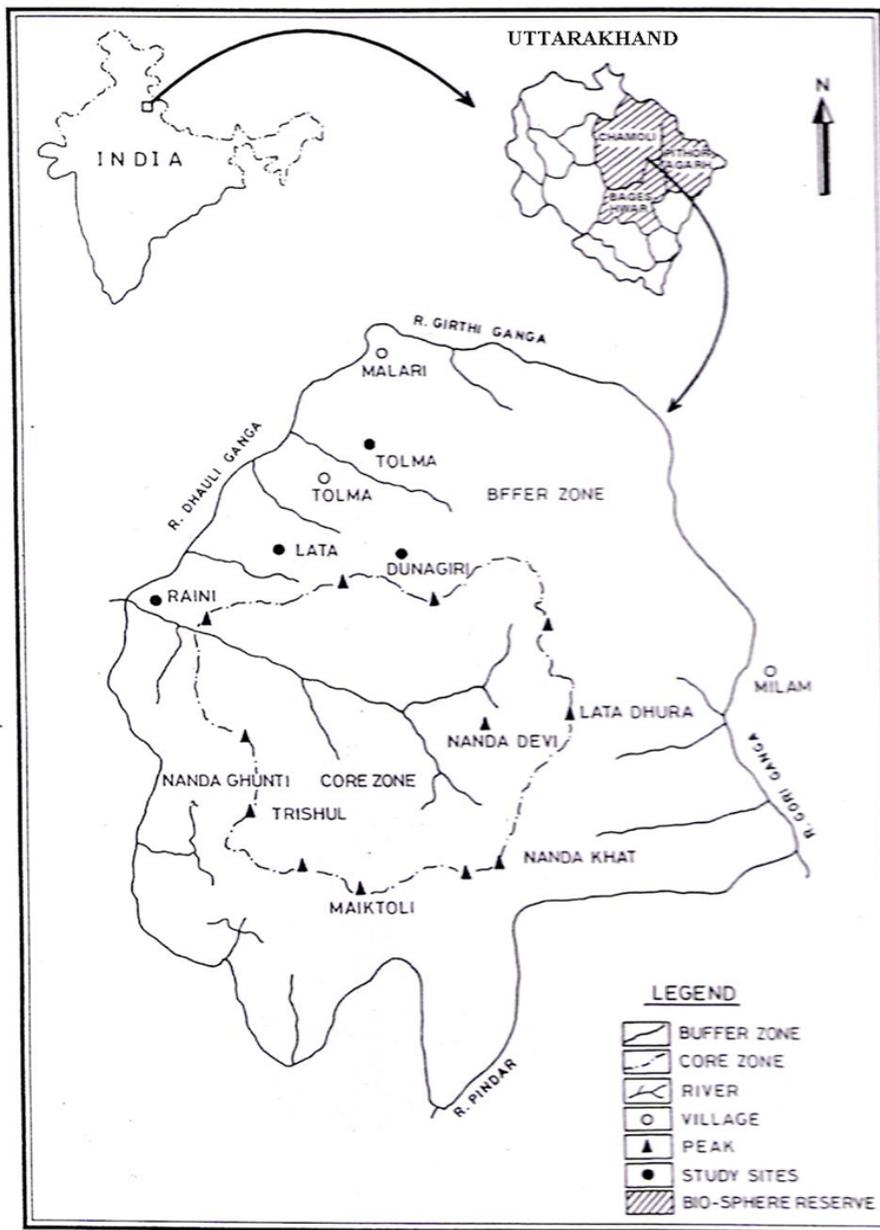


Fig. 1. Map of Nanda Devi Biosphere Reserve Showing the Location of the study sites

**2.2. Grasshopper sampling:** The insects were collected by “Sweep Sampling Method”, as per Gadagkar *et al.*<sup>[7]</sup>. The net sweeps were carried to collect the insects. The net used in systematic sweeping were made of thick cotton cloth with a diameter of 30 cm at mouth and a beg length of 60 cm. Sampling was done at random and at an interval of 15 days. The collected Orthopteran insects were transferred into jars containing Ethyl Acetate (CH<sub>2</sub>COOC<sub>2</sub>H<sub>5</sub>) soaked cotton. These jars were brought to the laboratory and the insects were

stretched and pinned. The entomological pin number 1 to 20 were used according to the size of the specimen. These were oven dried at 60 °C for 72 hours to preserve them and then set in to wooden boxes and labelled according to their systematic position.

**2.3. Population density:** Population density of Grasshoppers was calculated by dividing the total number of grasshoppers collected on each sampling date from each site with four.

Since, the area of each site selected for collection was 4 ha. Density from each site has been recorded as hoppers per hectare.

**2.4. Species and seasonal diversity:** Survey of diversity is essential for understanding the distribution of the forms. The insect community was considered diverse in two different ways, in terms of different species and different seasons, respectively. The diversity was calculated by using “Shannon Wiener Index <sup>[14]</sup>”.

### 3. Results and Discussions

**3.1. Species composition:** A total of 1269 individuals of Grasshoppers (Insecta: Orthoptera) belonging to 14 species under two families were recorded during the study period. On the basis of number of species, Acrididae was the most dominant family with 8 species followed by Tettigonidae with 6 species. The number of individuals of different species and their percentage contribution to total Grasshoppers has been

presented in Table 1. A total of 1111 individuals of family Acrididae were collected during the study period, which constituted 87.54% of the total Orthopterans. *Xenocatantops karnyi* Kirby was the most dominant species of this family in terms of number of individuals and constituted 17.82% of the total individuals, very closely followed by *Aulacobothrus luteips* Walk. (17.02%), *Oedipoda himalayana* Uvarov (15.93%), *Oedipoda* sp. (14.3%), *Chorthippus* sp. (13.95%), *Paraconophyma scabra* Walker (12.33%), *Spathosternum pr. prasiniferum* Walker (4.86%) and *Gastrimargus transversus* Thun. (3.78%). Family Tettigonidae was represented by 158 individuals and constituted 12.45% of the total Orthopterans. *Mecapoda* sp. was the most dominant species of this family and constituted 25.94% of the total individuals followed by *Conocephalus maculatus* Le Guillow (20.25%), *Phaneroptera gracilis* Burmeister (17.08%), *Himertula kinneari* Uvarov (14.56%), *Elimaia* sp. (13.29%) and *Latana linearis* Walker (8.87%).

**Table 1:** Species composition and relative number of individuals of grasshoppers and their percent contribution recorded during study period.

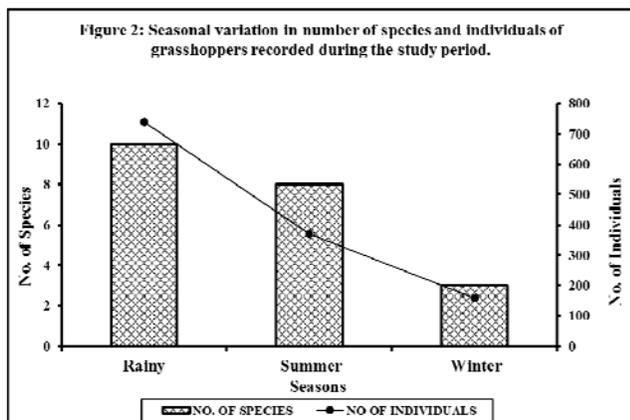
S. No.	Species composition (Order: Orthoptera)	Number of individuals	Percent (%)
<b>Family: Acrididae</b>			
1.	<i>Oedipoda himalayana</i> Uvarov	177	15.93
2.	<i>Xenocatantops karnyi</i> Kirby	198	17.82
3.	<i>Aulacobothrus luteips</i> Walk.	189	17.02
4.	<i>Paraconophyma scabra</i> Walk.	137	12.33
5.	<i>Spathosternum pr. prasiniferum</i> Walk.	54	4.86
6.	<i>Gastrimargus transversus</i> Thun.	42	3.78
7.	<i>Oedipoda</i> sp.	159	14.31
8.	<i>Chorthippus</i> sp.	155	13.95
<b>Family: Tettigonidae</b>			
9.	<i>Phaneroptera gracilis</i> Burmeister	27	17.08
10.	<i>Conocephalus maculatus</i> Le Guillow	32	20.26
11.	<i>Himertula kinneari</i> Uvarov	23	14.56
12.	<i>Letana linearis</i> Walker	14	8.87
13.	<i>Elimaia</i> sp.	21	13.29
14.	<i>Mecapoda</i> sp.	41	25.94
	Total	1269	100.00

Indian Himalayas harbour different species composition with varying number of Orthopteran insects. In comparison, Singh <sup>[16]</sup> reported 5 species belonging to 3 families of Orthoptera from North-West Himalaya, India. Mani <sup>[11]</sup> reported few species of Orthoptera from above the timber line in the Himalayas which belong to species *Bryodema* and *Gomphomastrax*, endemic to the middle Asiatic mountains, *Conophyma* a genus of apterous grasshoppers also endemic in middle Asia and abundant on Pamir and North-West Himalayas and *Dicranophyma* a genus endemic to the Himalaya. In the present study, a wingless (apterous) species *Paraconophyma scabra* Walker (Orthoptera: Acrididae) has been reported from North-West part of Nanda Devi Biosphere Reserve. Bhowmik and Haldar <sup>[3]</sup> recorded the 28 species of grasshopper in Himachal Pradesh. Kaushal and Joshi <sup>[10]</sup> have reported 13 species belonging to 3 families of Orthoptera from grassland ecosystem at Naukuchiatal, Nainital. Acrididae was the most dominant family with 9 species followed by Tettigonidae and Gryllidae (2 species each). Tandon and Shishodia <sup>[18]</sup> reported 97 species of Orthoptera from Western Himalaya, India. Acrididae was the most dominant family with

49 species followed by Gryllidae (32 species), Tetrigidae (2 species), Tettigonidae and Eneopteridae (2 species each), Trigonidiidae, Scleopteridae, Mogoplistidae and Gryllotalpidae (1 species each). Shishodia <sup>[15]</sup> has reported 14 species belonging to 3 families of order Orthoptera from Nanda Devi Biosphere Reserve, India. Acrididae was the most dominant family with 11 species followed by Tettigonidae (2 species) and Tetrigidae (1 species). In a more recent study, Arya and Dayakrishna <sup>[2]</sup> reported 18 species under 3 families of Orthopteran from a high altitude forest ecosystem in the Kumaun Himalayas, India. Family Acrididae was dominant with 13 species followed by Tettigonidae with 4 species and Gryllidae with 1 species.

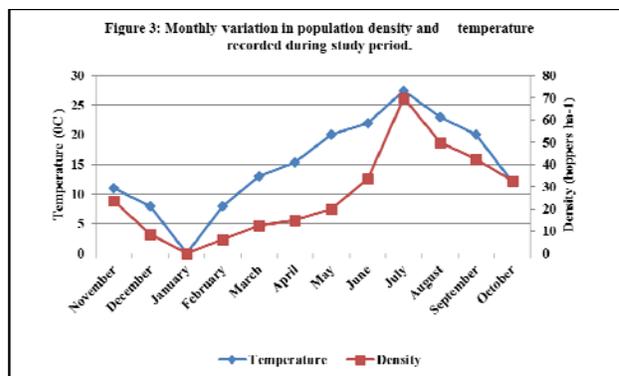
**3.2. Abundance:** *Xenocatantops karnyi* Kirby was the most abundant species constituted 15.6% of the total Orthopterans collected, and 60% individuals of this species was recorded during rainy season. *Aulacobothrus leutipus* Walker was the second abundant species and constituted 14.89% towards the total number of individuals collected. The maximum numbers of individuals of this species were recorded during rainy

season followed by summer and winter. *Oedipoda himalayana* Uvarov constituted 13.94% towards the total numbers of individuals collected and was the third most abundant species. Again the maximum numbers of individuals of this species were recorded during the rainy season followed by summer and winter. The less abundant species were *Letena linearis* (Walk.), *Elimaea* sp. and *Himertula kinneari* Uvarov. Figure 2 shows seasonal variation in number of species and individuals of Grasshoppers recorded during the study period. During the entire study period, maximum number of species of Orthopterans were recorded during the rainy season (10 species) followed by summer season (8 species) and winter season (3 species), respectively. Similarly, maximum number of individuals of Orthopterans were recorded again during the rainy season (740 individuals) followed by summer season (370 individuals) and winter season (159 individuals), respectively



**3.3. Population density:** Population density of grasshoppers was recorded maximum in the month of July (70.0 hoppers ha<sup>-1</sup>) whereas, it was minimum (6.25 hoppers ha<sup>-1</sup>) in the month of February, whereas no insects could be collected during the month of December in the present investigation. Figure 3 shows monthly variation in population density of grasshoppers (adults and nymphs) and temperature recorded during the study period. The population density was low during December to February (winter season) but increased during rainy season with increase in temperature, humidity and number of food plants. The nymphs had a higher density values during the rainy season, it may be because of the hatching of eggs laid during the summer month of the study period and also due to the favourable moisture and conditions. In comparisons, Porter *et al.* [12] have reported the nymph and adult average population density (2.30 hoppers/ m<sup>2</sup>) of grasshoppers in native grassland from California. Similarly,

Arya and Dayakrishna [2] have studied community dynamics of grasshoppers in a high altitude forest ecosystem in the Nainital and reported population density of grasshoppers was recorded maximum in the month of July (22.25 insects ha<sup>-1</sup>) whereas, it was minimum (2.25 insects ha<sup>-1</sup>) in the month of December, whereas no insects were recorded during the month of January and February.



**3.4. Species diversity, richness and evenness of grasshoppers:** Table 2 shows the species richness, diversity and evenness calculated for grasshoppers during the study period. Across the study period Shannon-Wiener diversity Index (H') was recorded as 2.329 for the grasshoppers. Similarly, maximum species diversity was recorded in the rainy season (2.25) followed by summer (1.96) and winter (1.09), respectively. During the present study, maximum species richness of grasshoppers were recorded in rainy season (10 species), followed by summer (8 species) and winter (3 species), respectively. Similarly, maximum number of individuals of grasshoppers were recorded during the rainy season (780) followed by summer (334) and winter (155), respectively. Higher value of evenness (0.992) indicated that the grasshoppers community was evenly distributed in the winter season. In comparison, Porter *et al.* [12] have recorded the species diversity of grasshoppers as 0.104 in native grassland from California and highest species richness was observed in the month of August. Saha and Haldar [13] reported species diversity of Orthopteran insects as 1.0331 in dry deciduous forests of West Bengal in India. In a more recent study, Arya and Dayakrishna [2] have studied community diversity of Orthopteran in the Nainital Lake catchment area and reported species diversity of Orthopterans across the study was 3.907. Maximum species diversity was recorded during the rainy season (0.155) and followed by summer (0.149) and winter (0.141)

**Table 2:** Species richness, abundance, diversity and evenness recorded for grasshoppers across different seasons and across the study period

S. No.	Seasons	Species richness	Abundance	Shannon-Wiener diversity Index (H')	Evenness (H/S)
1.	Summer	8	334	1.96	0.885
2.	Rainy	10	780	2.25	0.959
3.	Winter	3	155	1.09	0.992
4.	Across the study	14	1269	2.329	0.733

**4. Conclusions**

Presence of a very good number of grasshoppers species in the NDBR with high density and a higher value abundance of grasshoppers than what has been reported by some earlier workers in different ecosystems of the world indicate that the

availability of sufficient food plants, adaptability of grasshoppers to the ecological factors prevailing in the study area. The maximum grasshopper's activities in the present study area were observed during the rainy season. Minimum values of recorded parameters in the present study were

obtained in the winter season when minimum number of host plants, temperature was low and productivity was very low.

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