***Minireview Article***

“Diversity and Distribution of Orthopteran Insects in Bihar”

**Abstract**

Orthoptera are a vital component of terrestrial ecosystems, contributing significantly to nutrient cycling and serving as prey and survivals for various predators. Understanding the species richness and diversity of orthoptera fauna is crucial for developing conservation strategies and maintaining ecological balance in the Bihar region. Previous studies have documented the orthoptera fauna in various parts of India, highlighting the diversity and ecological roles of these insects. However, there is a paucity of detailed research focusing specifically on the orthoptera species richness and diversity in different habitats of the Bihar region.

This study investigating the orthoptera fauna in the different districts of Bihar i.e. Muzaffarpur, West Champaran, Gopalganj, Vaishali & Kaimur that provide insights into habitat preferences and the impact of environmental factors on species distribution. After consulting various books and research papers related to orthoptera order it is found that a total of 104 species of orthoptera are reported from the state of Bihar, India. Globally about 29434 species and about 1274 species from India of orthoptera are known to science.

The study highlights the rich orthopteran biodiversity in Bihar and underscores the importance of continued research in this region. This review aims to provide a comprehensive overview of the existing data, identify potential knowledge gaps, and serve as a foundation for future ecological and taxonomic studies on Orthoptera in Bihar.

**Keywords:** Bihar, Diversity, Ecological Balance, Orthoptera, Taxonomic Studies, Terrestrial Ecosystems

**Introduction**

Orthoptera, derived from the two Greek word “Ortho” meaning straight and “ptera” meaning wing. Synonyms of Orthoptera is Saltatoio or Salatatoptera. It includes Crickets, Grasshoppers and Locusts (Punzo, 2000; Chang et al., 2021; Das et al., 2021; Kasalo et al., 2024). It is widely distributed in all ecological system with significant biological component of grassland as a crucial link in the food chain (Punzo, 2000; Akhilandeshwari et al., 2024). The Orthoptera order ranks among the largest in the Insecta class, encompassing around 24,000 species. This order is categorized into 29 to 39 families, depending on various academic perspectives (Shishodia, 1999; Shishodia et.al. 2010). Of these, 19 to 27 families are part of the suborder Caelifera, while 10 to 12 families belong to the suborder Ensifera (Eades & Otte 2009, Ingrisch & Rentz, 2009). In India, there are 1,033 species or subspecies recorded, spread across 400 genera and 21 families (Shishodia et.al. 2010). As per the checklist provided by Zoological Survey of India, number of species increases upto 29434 globally including 5263 genera and 83 families. In India, 1274 number of species recorded belonging to 442 genera and 23 families in two suborders (SR & Guptha, 2021). Out of 1274 number of species recorded from India, Bihar represent 137 number of species (Shishodia et.al. 2010).

General Characteristics of order Orthoptera include incomplete metamorphosis, cylindrical body, 2 pairs of wings, 3 pairs of legs, modified hind pair of legs for jumping, chewing and biting types mouth parts, The prothorax is large (Chang et al., 2021; Sperber et al., 2021). The forewings, when fully developed, are long and somewhat thick, featuring a submarginal costal vein and often serving as stridulatory organs. In contrast, the hindwings are membranous with a large anal area. Females usually have a well-developed ovipositor. The compound eyes are large, and the antennae can vary from short to very long, depending on the species.

On the basis of Antennae, Orthoptera is divided into two major suborders.

1. Caelifera b) Ensifera.

**Suborder Caelifera**

Caelifera, a suborder of the Orthoptera order, includes the "short-horned" grasshoppers, which are distinguished in living species by their hind legs designed for jumping (Schirmel et al., 2010). These grasshoppers have antennae with fewer than 30 segments and do not possess auditory organs on the prothorax (Aziz et al., 2024). Caelifera falls under the superfamily Acridoidea, with species typically being of moderate size, ranging from under 10 mm to 65 mm. The antennae are usually thread-like, though sometimes sword-shaped. The tarsi consist of three segments, and the hind femora are elongated, slender, and thickened at the base to aid in jumping. The forewings are tough tegmina, while the hind wings resemble a fan. The male's external genitalia are intricate, symmetrical, and hidden. Worldwide, there are about 8,000 known species in this group, with 518 species across 214 genera and 11 families recorded in India (Shishodia et.al. 2010).

**Suborder Ensifera**

Ensifera comprises “long-horned” orthoptera include crickets, katydids, grigs, weta and Cooloola monster characterized by hind femora usually somewhat enlarged antennae thread like, with more than 30 segments, ovipositor long, sword like (sometime needle like) internally has 6 valves tarsi with 3-4 segments (Schirmel et al., 2010). Tympanum on the front tibia in most groups (or absent). There are about 4765 species under 860 genera throughout the world (Yuan et al., 2021). Out of these only 515 species under 184 genera and 10 families (Shishodia et.al.2010)are reported from India. Generally, these insects are phytophagous and few species have been reported to damage agricultural crops.

**Habitat**

Orthoptera species are found in almost every land-based environment, from the crevices in coastal rocks, deserts, grasslands, and savannas, to caves, underground tunnels, and the canopy of rainforests, as well as the summits of mountain ranges in alpine regions (Shishodia, 1999; Shishodia et.al. 2010; Bidau, 2014; Das et al., 2021). The greatest variety of Orthoptera is seen in both dry and wet tropical forests. Numerous katydid, cricket, and grasshopper species have been recorded in forest ecosystems (Punzo, 2000). Nonetheless, many species remain unidentified, even as large areas of their habitats are being rapidly destroyed (Hartwick, 1991).

**Behavior**

In Orthoptera, the main method of sound production is stridulation, which involves rubbing one modified part of the body against another. Katydids (Tettigoniidae) and crickets (Grylloidea) create sound by moving a specialized vein, called the stridulatory vein, on one forewing (tegmen) against a hardened edge on the other forewing, known as the scraper (Bidau, 2014; Chang et al., 2021). This stridulatory vein features a file-like row of teeth, with numbers ranging from a few to several hundred. In most katydids, the stridulatory area is found at the base of the forewings, while in crickets, nearly the entire surface of the forewings is adapted for this purpose. Typically, katydids have the stridulatory file on the left forewing and the scraper on the right, whereas in crickets, this setup is reversed (Ingrisch & Rentz, 2009; Schirmel et al., 2010; Bidau, 2014; Hartwick, 1991). A membranous section at the base of the forewing, called the mirror, helps amplify the sound. Grasshoppers use a similar stridulation technique, but instead of rubbing their forewings together, they produce sound by rubbing the inner surface of the hind femur against a vein of the forewing (Ingrisch & Rentz, 2009; Schirmel et al., 2010). The sound frequencies produced by orthopterans during stridulation vary, ranging from a few kHz in most crickets and grasshoppers to over 100 kHz in some katydids. Besides stridulation, some grasshoppers also engage in crepitation, creating a crackling noise during flight by rapidly flexing their hind wings (Eades & Otte 2009; Ingrisch & Rentz, 2009; Schirmel et al., 2010). This behavior is especially common among band-winged grasshoppers (Oedipodinae) and is important for courtship and territorial displays (Shishodia, 1999; Shishodia et.al. 2010; Hartwick, 1991).

**Reproduction**

In most female organisms, the reproductive system is composed of two ovaries, which are tubular structures where eggs develop. As these eggs mature, they move backward into a single oviduct. The oviduct leads to a vagina, which opens to the outside and may end in either a simple or specialized ovipositor, made up of paired structures called ovipositor valves. Next to the oviduct or vagina is a sac known as the spermatheca, which functions as a storage area for male sperm. Fertilization takes place as the eggs move through the oviduct, aided by the stored sperm (Hartwick, 1991; Bidau, 2014; Chang et al., 2021). In typical males, there are two testes that generate a large amount of slender, motile sperm. These sperm are stored in expanded sections of the tubes that extend backward from the testes. Secretions from accessory glands not only provide a medium for sperm transport but also help in forming a thin-walled sac, or reservoir, containing sperm and fluid. This structure, known as the spermatophore, is commonly found among orthopterans (Eades & Otte 2009; Ingrisch & Rentz, 2009; Hartwick, 1991; Bidau, 2014; Chang et al., 2021).

**Life Cycle**

Grasshoppers experience incomplete metamorphosis, which involves three separate stages from birth to maturity. The first stage, the egg, starts after fertilization when the female grasshopper lays eggs either underground or in leaf debris. She then secretes a sticky substance to encase the eggs in an egg pod, which can hold between 10 and 300 eggs. These eggs remain inactive beneath the sand or within leaf litter throughout the fall and winter. After about ten months, during the warmer spring or summer months, the eggs hatch, releasing nymphs (Hartwick, 1991; Bidau, 2014; Chang et al., 2021). The next stage is the nymph phase, where the nymphs emerge and actively search for plant leaves to eat. Although nymphs look similar to adult grasshoppers, they do not have reproductive organs or wings. The nymphs undergo molting, shedding their exoskeleton to allow for growth, five to six times before becoming adults. This nymphal stage lasts around six weeks until they fully develop into adult grasshoppers (Hartwick, 1991; Bidau, 2014; Chang et al., 2021). In the adult phase, grasshoppers develop wings about 25 to 30 days after the nymph stage and reach sexual maturity within 15 days. Unlike nymphs, adult grasshoppers have improved mobility, allowing them to escape predators and hunt more effectively. Although they can live up to 12 months, only about 50% of adult grasshoppers survive, mainly due to predation by birds, snakes, and lizards (Hartwick, 1991; Bidau, 2014; Chang et al., 2021).

**Materials and Methods**

The body of work on Orthoptera, with a particular emphasis on research by various scholars from Bihar, has been examined. In addition, unidentified Orthoptera specimens stored at the National Zoological Collection, ZSI, GPRC, Patna, were also taken into account. Throughout the reporting period, three comprehensive surveys were conducted. The first was a 12-day survey from October 31 to November 11, covering the districts of Muzaffarpur, Valmiki Tiger Reserve, Gopalganj, and Buxar. The second survey lasted 11 days, from November 24 to December 4, and included the districts of Kaimur and Rohtas. Lastly, a 12-day survey was conducted from March 7, 2024, to March 18, 2024, in the regions of Bheembandh, Baraila, and Chakaila.

**Survey localities**

The selected transect route covered by approx. 780 KM in Three survey tour, Tour duration was of 12 days. Orthoptera were captured by using insect net between morning and evening during ideal weather condition. Mostly Orthopteran were collected individually but some are collected by group members. Orthopteran were identified with the help of available literatures at ZSI GPRC Patna (Kirby, 1914; Srinivasan & Prabakar, 2013) by comparing voucher specimens available in National Zoological Collection.

Different survey localities covering different districts like Muzaffarpur; (Barmatpur, Ratanpur, Sai Brijmohan, Baghi Chauk, BishunpurKesho, Raghai), West Champaran; (Ganoli check Naka Jatashankar Beat, RahuaNalaJatashankar Beat, Jatashankar Water hole, Compartment T-21 Ganauli beat, Pipra, Harnatard Range Office Chanakitola) , Gopalganj; (Banjaria, Uchakagaon, Beat Banwa, Manjha, ShekhParsa, Fulugani), Buxar; (Police line, Pakadi, Pawani, Vijarpur, Misraulia), Vaishali: (BheemBhandh, ArniaBaraila Lake, Dulwar, DeehDulwar, Loma, Mahsaur, Amthanwa, Jagdishpur, MataiyaGhat,ChakMahiuddin, Azizpurchande, DihBuchauli, Sitapur, Mahisaur, ChakFateh, Bishunpur Said, Rahimpur) Kaimur; (Telhad, Kakargadhi, SitaKund, DhuaanKund, MaaMundeshwari, Gupta Dham, MaaTutlaBhavani).

**Literature Survey**

A total of 104 species of orthoptera are reported from bihar, 16 species of orthoptera are studied from Usmani, M.K. & M.R. Nayeem (2012). Studies on taxonomy and distribution of Acridoidea (Orthoptera) of Bihar, India. Very recently, one studyKumar et al. (2022) reported 84 species orthopteran from Bihar and documented in the Faunal Diversity of Biogeographic Zones of India: Gangetic Plains. 4 species of orthoptera are studies from NOTES ON A COLLECTION OF GRASSHOPPERS (ORTHOPTERA: ACRIDIDAE) FROM BIHAR STATE, INDIA.

Based on the literature on orthopteran from the state of Bihar, a list of 104 species of Orthoptera were compiled. 28 species of orthopteran collected from the various surveys were examined and their distribution in different districts of Bihar were recorded.

**List of the species of Orthoptera recorded from Bihar**

**Systematic list:**

1. *Acorypha glaucopsis*
2. *Acrida exaltata*
3. *Acrida gigantea*
4. *Acrotylus humbertianus*
5. *Acrotylus insubricus*
6. *Aiolopus simulatrix*
7. *Aiolopus thalassinus tumulus*
8. *Aulacobothrus luteipesinfernus*
9. *Aulacobothrus luteipesluteipes*
10. *Ceracris deflorata*
11. *Ceracris nigricornis nigricornis*
12. *Chloeborag rossa*
13. *Chondracris rosea*
14. *Chorthippus indus*
15. *Clonacris sila*
16. *Crucinotacris decisa*
17. *Cyrtacanthacris tatarica tatarica*
18. *Diabolocatantops innotabilis*
19. *Diabolocatantops pinguis*
20. *Eucoptacra praemorsa*
21. *Eyprepocnemis alacris alacris*
22. *Gastrimargus africanus*
23. *Heteracris littoralis*
24. *Heteracris pulchra*
25. *Heteropternis respondens respondens*
26. *Hieroglyphus annulicornis*
27. *Hieroglyphus banian*
28. *Hieroglyphus nigrorepletus*
29. *Hygracris palustris*
30. *Leionotacris bolivari*
31. *Leionotacris bolivari*
32. *Leva indica*
33. *Leva indica*
34. *Locusta migratoria*
35. *Mesopsis cylindricus*
36. *Morphacris fasciata*
37. *Oedaleus abruptus*
38. *Oedaleus senegalensis*
39. *Oedaleus sengalensis*
40. *Oedipoda miniata*
41. *Oxya fuscovittata*
42. *Oxya hyla*
43. *Oxya japonica japonica*
44. *Oxya nitidula*
45. *Oxya velox*
46. *Pachyacris vinosa*
47. *Pachyacris violascens*
48. *Paraconophyma polita*
49. *Paraconophyma punctata*
50. *Paraconophyma scabra*
51. *Patanga succincta*
52. *Perella insignis*
53. *Phlaeoba infumata*
54. *Phlaeoba panteli*
55. *Pternoscirta bimaculata*
56. *Pusana laevis*
57. *Pusana ruglosa*
58. *Schistocerca gregaria*
59. *Spathosternum prasiniferum*
60. *Sphingonotos balteatus balteatus*
61. *Sphingonotos orissaensis*
62. *Stenocatantops splendens*
63. *Teratodes monticollis*
64. *Trilophidia annulata*
65. *Tristria pulvinata*
66. *Tropidopola longicornis*
67. *Truxalis indica*
68. *Truxalis nasuta*
69. *Tylotropidius varicornis*
70. *Xenocatantops humilis*
71. *Xenocatantops karnyi*
72. *Atractomorpha psittacina*
73. *Atractomorpha sinensis*
74. *Atroactomorpha crenulata*
75. *Chrotogonus trachypterus*
76. *Poekilocerus pictus*
77. *Zarytes squalinus brachycerus*
78. *Coptotettix conioptica*
79. *Coptotettix latifrons*
80. *Coptotettix retractus*
81. *Ergatettix crassipes*
82. *Euscelimena harpago*
83. *Indoscelimena angulata*
84. *Loxilonus acutus parvispinus*
85. *Paratettix histricus*
86. *Saussurella curticornus*
87. *Xya curta*
88. *Xya japonica*
89. *Xya riparia*
90. *Xya variegate*
91. *Cophogryllus brunneus*
92. *Grylloders brunneri*
93. *Gryllodes sigillatus*
94. *Gryllus bimaculatus*
95. *Modicogryllus confirmatus*
96. *Phonarellus monor*
97. *Tarbinskiellus portentosus*
98. *Teleogryllus longipennis*
99. *Teleogryllus mitratus*
100. *Telogryllus occipitalis occipitalis*
101. *Velarifictorus latithorax*
102. *Gryllotalpa africana*
103. *Ducetia japonica*
104. *Letana megastridula*

**Results**

The Orthoptera species in Bihar, India, exhibit significant diversity, with 104 species documented across various families. The Acrididae family is the most prevalent, with 71 species, making up a large part of the Orthopteran fauna in the area. This family's extensive presence throughout Bihar underscores its ecological importance and ability to thrive in different habitats within the state. The Pyrgomorphidae and Tetrigidae families also contribute notably to the region's biodiversity, with 6 and 13 species, respectively, while the Grylloidea and Tettigonidae families have fewer species recorded.

Given the dominance of Acrididae species in Bihar, further investigation into this family could yield valuable insights into local ecosystems, agricultural effects, and biodiversity trends. However, the Tettigonidae family, with only 3 recorded species, indicates a possible gap in current understanding. Concentrating future research on the Tettigonidae family might uncover additional species and provide a more complete picture of Orthopteran diversity in Bihar. Such research endeavors would not only expand our knowledge of the region's insect fauna but also aid in broader conservation and ecological management efforts in this part of India.

**Discussion**

This research offers a detailed overview of the Orthoptera species found in the Bihar region (Chandra et al., 2012; Kumar et al., 2022). However, it is recognized that there are several, and possibly many more, species in the area that have not yet been documented (Chandra et al., 2012; Kumar et al. 2022). The Orthoptera species in Bihar represent a crucial yet under-researched component of the state's biodiversity, requiring comprehensive empirical studies to assess their ecological, agricultural, and conservation roles (Kumar et al., 2022; Nayeem & Kumari, 2024). Bihar's diverse environments, such as the Gangetic floodplains, farmlands, the forested Kaimur regions, and the Himalayan foothills, host various grasshoppers, crickets, and katydids (Kumar et al., 2022; Nayeem & Kumari, 2024; Jha et al., 2021). However, systematic records are sparse compared to adjacent states. Initial studies reveal both endemic species and agricultural pests, with some grasshopper species occasionally posing threats to crops like rice and wheat, while others aid in ecosystem functions like pollination and soil maintenance. The distribution and population of Orthoptera are closely tied to seasonal monsoon patterns and land-use practices, with habitat destruction and excessive pesticide use posing significant risks to their numbers (Das et al., 2021;

Kumar et al., 2022; Nayeem & Kumari, 2024; Jha et al., 2021). Despite their ecological value, conservation initiatives for Orthoptera in Bihar are nearly absent, with no species currently protected by law, underscoring a significant policy shortfall. Future research should focus on field surveys in less-studied areas, molecular techniques to clarify taxonomic uncertainties, and community involvement to track populations (Chandra et al., 2012; Rana & Kumar, 2020). Additionally, incorporating traditional knowledge about Orthoptera, such as their use in folk medicine or as food by indigenous groups, could offer valuable insights. Addressing these gaps through collaborative research, sustainable agriculture, and habitat restoration will be crucial to preserving Bihar's Orthoptera diversity amid growing environmental changes, while also managing their role as agricultural pests (Akhilandeshwari et al., 2024). This dual approach to conservation and management could serve as a model for other agro-ecologically sensitive areas in India. A total of 104 species of orthoptera are reported after consulting different books and research papers. Veryfew books and research papers are available on the fauna of orthopteran from Bihar (Usmani & Nayeem, 2012; Kumar et al., 2022; Nayeem & Kumari, 2024; Jha et al., 2021). Mostly families like Acrididae, Pyrgomorphidae and Tettigonidae got attention by some of workers, working on fauna of Bihar. While Tetrigidae and Grylloidea families of orhtoptera are most neglected and least studies have been made from Bihar. As we know that Gangetic plains are the part of terai region or terai grassland, a most suitable habitat for the grasshoppers (Chandra et al., 2012; Rana & Kumar, 2020). If extensive surveys have been conducted in different districts of Bihar, there are chances to get more species of orthopteran from this region and expected about more than 200 species (Usmani & Nayeem, 2012; Kumar et al., 2022; Nayeem & Kumari, 2024; Jha et al., 2021). Keeping in view of climate change, several grasshoppers particularly which are in the transit phase, may enter to gregarious phase and cause havoc to the mankind directly and indirectly by destroying agriculture and other major crops (Shishodia, 1999; Shishodia et.al. 2010; Usmani & Nayeem, 2012; Kumar et al., 2022; Nayeem & Kumari, 2024; Jha et al., 2021).

**Conclusion**

This mini review explores the diversity of Orthoptera in Bihar, India, identifying 104 species from different families. The Acrididae family is predominant, with 71 species, underscoring its ecological importance. Although this study enhances the understanding of Bihar's Orthopteran fauna, it also highlights gaps in knowledge, especially concerning the Tettigonidae family and species yet to be discovered. Bihar's varied environments, ranging from Gangetic floodplains to forests, harbor abundant Orthoptera populations, but systematic documentation is less comprehensive than in neighboring regions. The study underscores the necessity for more extensive field surveys in less-studied areas and the use of molecular techniques to clarify taxonomic ambiguities. It also emphasizes the importance of balancing conservation efforts with agricultural pest management, given that Orthoptera species offer ecological benefits but also pose risks to crops. A holistic approach involving research, sustainable farming, habitat restoration, and community involvement will be vital to maintaining Bihar's Orthopteran diversity while managing their ecological and agricultural effects. This research enhances the understanding of Bihar's biodiversity and lays the groundwork for future conservation efforts.

Disclaimer (Artificial intelligence)

Option 1: Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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