



Research Article



Impact of Climate Change on Biodiversity of Grasshoppers (Orthoptera: Acrididae) in Koshi Division of Bihar, India

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ABSTRACT

Bihar has been facing the most fluctuating climate change for years, especially the Koshi division, which comprises the three districts i.e, Saharsa, Madhepura and Supaul. Koshi River flows through and around the districts, affecting the area when water is released from the Nepal barrage. Thirty-two species of grasshoppers under twenty genera and ten subfamilies have been reported from the area of research. A maximum of eight species are represented by the subfamily Oedipodinae, while least one species is represented by the subfamily Spathosterninae. The main host is rice and maize among crops and grasses. Simpson's Diversity index calculated is 0.97, indicates rich diversity of grasshoppers and suggests a stable site. Population density is recorded highest at 30°C temperature and 50% humidity where reproduction and survival rates are maximum. Moderate rainfall stimulates plant growth, providing abundant and high quality food which in turn also favours population growth.

Keywords: Grasshoppers, Koshi division, Bihar, Diversity, Simpson's, Climate

INTRODUCTION

Orthoptera is the sixth largest order of insect constituting 22,500 species (Ghosh and Sengupta, 1982) all over the world out of which 1,750 species, 400 genera and 21 families are known from India (Tandon and Hazra, 1998). It is divided into two suborders ensifera and caelifera (Ander, 1939). Members of the suborder caelifera are commonly known as short-horned grasshoppers. Superfamily Acridoidea comprises 11,000 species worldwide and 290 species from India (Shishodia et al. 2010). Family Acrididae is the largest and most diverse family of the order Orthoptera shows 8,000 species with 136 endemic species (Chandra and Gupta 2013), are characterized by their relatively short, robust antennae, powerful hind legs adapted for jumping, with a variety of colours and variable body sizes.

Members of Acrididae play significant ecological and economic roles. Ecologically, they are primary consumers that feed on a wide range of grasses and herbs, influencing vegetation structure and nutrient cycling (Mulkern 1967). Economically, this cause loses to crops and act as notorious agricultural pests worldwide (Joshi et al. 1999). Many of these grasshoppers are highly specialized in their habitat and food preferences, making them sensitive to environmental changes. As a result, they are often used as bioindicators to assess the ecological health of their environments (Joern, A. 1979).

The Koshi division of Bihar, located in the eastern part of India, supports a variety of grasshopper species due to its complex mosaic of habitats and climatic conditions. However, despite their ecological importance, grasshopper diversity in this region remains understudied with some sporadic work. Despite these favourable conditions, studies on the diversity and ecology of grasshoppers in Bihar remain limited. Most of the available research focuses on economically significant species, while the broader taxonomic and ecological diversity of grasshoppers is underexplored (Singh and Singh, 2010). Thirty-seven species of grasshoppers representing twenty-nine genera have been reported from Bihar (Nayeem et al 2013) and 14 species of grasshoppers representing ten genera have been reported from Patna districts only (Tabrez and Nayeem 2024). Understanding the species composition and distribution of grasshoppers in the Koshi division is essential for ecological monitoring, pest management and biodiversity conservation. This paper aims to document the diversity of grasshoppers in the Koshi division of Bihar, highlighting their taxonomic composition, habitat preferences, and ecological significance. By providing a comprehensive inventory of grasshopper species in this region, the study seeks to fill a critical gap in the understanding of Orthopteran biodiversity in eastern India.

Weather is the most important factor determining the grasshopper population. Moderate increases in temperature can promote grasshopper population growth, extreme deviations negatively affect populations. This balance is crucial in managing grasshopper outbreaks, especially in agricultural areas where they can cause significant crop damage. Temperature and humidity are important factors responsible for the grasshopper population fluctuation (Khan and Aziz, 1973). Hatching time is influenced by temperature, cool and wet conditions reduce hatching (Das and Ganguly, 2012). High populations fall in the moderate range (40–60% relative humidity) which supports their physiological processes. Grasshopper populations are highest in regions with moderate rainfall (20–50 mm) because a shower of rain helps in the hatching of eggs (Uvarov, 1977).

MATERIALS AND METHODS

Study area: (Fig. 1)

Bihar is a state located in the eastern part of India, sharing its borders with Nepal to the north and West Bengal to the east, Uttar Pradesh to the west, and Jharkhand to the south. The state is situated in the fertile Gangetic Plain, which makes it one of the most agriculturally productive regions in India. Koshi division of Bihar constitutes three districts Saharsa, Madhepura, and Supaul. These districts lie in the northeastern part of the state and are part of the Koshi region, named after the Koshi River, which is one of the major rivers flowing through this area. The terrain is mostly flat and fertile, making it suitable for agriculture and major crops include paddy, wheat, maize, pulses, and jute.

Saharsa is situated in the heart of the Koshi region. It is characterized by flat plains and is crisscrossed by various rivers and streams, primarily influenced by the Koshi River. The economy of Saharsa is largely agrarian, with a focus on crops such as paddy, wheat, maize, pulses, and sugarcane. Despite the challenges of flooding, the fertile soil allows for productive farming. Madhepura is located to the west of Saharsa and has a similar geographical setup. The region is affected by the flow of the Koshi River, which makes it vulnerable to floods. The landscape is primarily rural and agricultural. Agriculture remains the backbone of Madhepura's economy produces rice, wheat, maize, and vegetables. Supaul lies to the east of Saharsa and is close to the border with Nepal. It is also part of the flood-prone Koshi belt, with the Koshi Barrage located nearby. The district has a diverse landscape with rivers, agricultural fields, and some hilly areas and the economy is largely dependent on agriculture. The fertile land supports the cultivation of paddy, maize and pulses.

Collection:

Grasshoppers were collected monthly from different habitats like crops, grasses, and meadows through sweep nets during day time when the sun bakes them. Collections started from a fixed place and extended the site as per the need. From the sweep, net was transferred

to killing jars to kill the adult grasshoppers using potassium cyanide soaked in cotton.

Preservation:

Immediately on arrival to the laboratory, killed grasshoppers were taken out, stretched and pinned on a stretching box. During stretching special attention was given to wings, antennae, legs and abdomen to display basic taxonomic characteristics. Pinned specimens were left for a week to dry and completely dried specimens were labelled and stored in standard entomological boxes with naphthalene balls to prevent the attack of ants and other insects.

Identification:

Identification of specimens was carried out under the stereoscopic dissecting binocular microscope using the identification keys of Dirsh (1965) and available literature.

Data analysis:

Simpson's Index of Diversity (D) is a quantitative measure of how many different species are present in a habitat and how evenly the individuals are distributed among those species. The index is often used in ecological studies to measure species diversity. The high value of D indicates a more diverse and stable environment, while a low value of D indicates an unstable and low diversity. Simpson's Index denoted as D whose value ranges from 0 to 1 where 0 represents infinite diversity and 1, no diversity. That is, the bigger the value of D, the lower the diversity. This is neither intuitive nor logical, so to get over this problem, D is often subtracted from 1 to give Simpson's Index of Diversity (1 - D).

$$D = 1 - \left(\frac{\sum n(n-1)}{N(N-1)} \right)$$

n = the total number of organisms of a particular species
N = the total number of organisms of all species

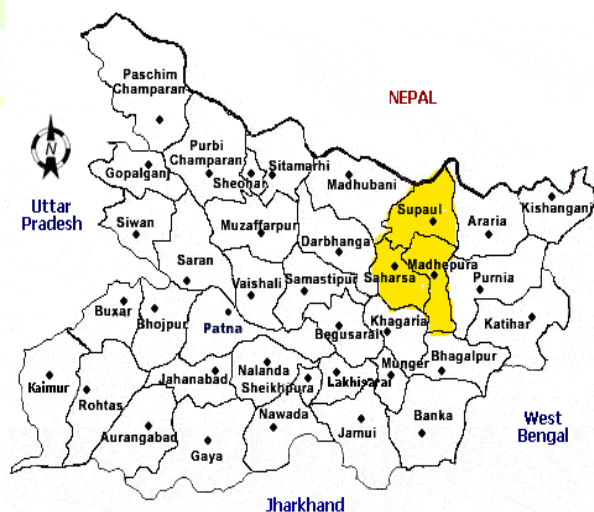


Fig. 1. Map of Bihar with highlighted Koshi division (Source- Google)

RESULTS AND DISCUSSION

Thirty-two species of grasshoppers under twenty genera and ten subfamilies have been reported from the area of research (Table 1). A maximum of eight species are represented by the subfamily oedipodinae followed by acridinae by four species while at least one species is represented by subfamily spathosterninae (Fig. 2). Main host is rice, and maize among crops and grasses. Simpson's index of 0.03 and Simpson's index of diversity calculated as 0.97, indicates that the area is showing more diversity of grasshoppers. A high value of D suggests a stable, complex and older site. A low value of D could suggest pollution, recent colonization or agricultural management. The value of D indicates the richness and evenness of the species found within the area sampled.

Temperature significantly influences the population dynamics of grasshoppers, as it affects their growth, reproduction, development, and survival. The maximum population of grasshoppers was recorded at 35°C temperature (Table 3). Humidity plays a significant role in shaping grasshopper populations as it affects their physiology and survival and the maximum population is recorded at a moderate range (40–60% relative humidity). Rainfall significantly influences grasshopper populations, both directly and indirectly, by affecting their habitat and food availability.

Research on Acrididae includes both agriculturally significant pests and ecologically important species and detailed study on their diversity, distribution and ecological roles can provide valuable insights for pest management and biodiversity conservation, particularly in agro-ecosystems where human and environmental interactions are intense. Grasshoppers are primary consumers of grasses and kin to predators) of in the food chain to balance the ecosystem (Branson et al. 2006). A study on the biodiversity of grasshoppers in the Koshi division of Bihar reveals a rich and diverse assemblage of species, underscoring the ecological significance of this region. This is an initial step toward documenting grasshopper diversity in the Koshi division and continuous research should include long-term monitoring, behavioural studies, and genetic analyses to better understand species adaptations and interactions. The region provides a home to generalist and specialist grasshopper species that reflect the unique agro-climatic conditions and habitat heterogeneity of the region. Grasshoppers exhibit habitat-specific preferences which indicates the importance of preserving diverse habitats to maintain ecological balance. The population of grasshoppers fluctuate with seasons, during monsoon and post-monsoon periods goes at peak than other seasons which is influenced by various climatic factors and types of vegetation.

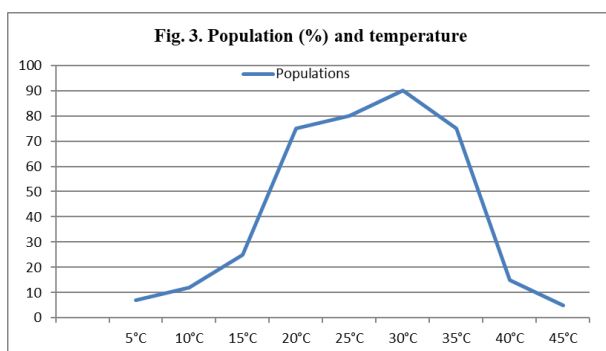
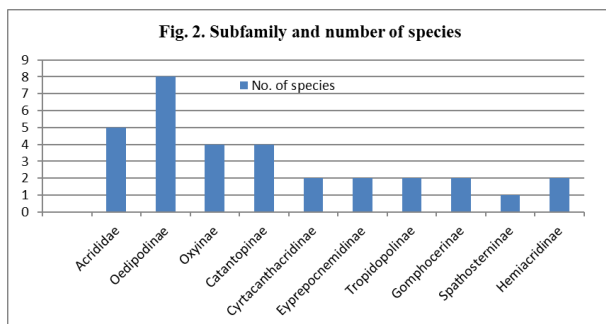
Grasshoppers are ectotherms and their body temperature and metabolic processes depend on external temperatures. Warmer temperatures generally increase their metabolic rate, leading to faster growth and shorter life cycles but extremely high or low temperatures can

Table 1. Number of species with subfamily and number of individuals

Species	Sub family	n	N (n-1)
<i>Ochrlidia gracilis gracilis</i> (Kraus, 1902)	Gomphocerinae	51	2550
<i>Aulacobothrus luteipesluteipes</i> (Walker, 1871)	Gomphocerinae	45	1980
<i>Truxalis nasuta</i> Linnaeus, 1758	Acridinae	102	10302
<i>Acrida exaltata</i> Walker, 1859	Acridinae	111	12210
<i>Acrida gigantea</i> Herbst, 1786	Acridinae	105	10920
<i>Phlaeoba panteli</i> Bolivar, 1902	Acridinae	96	9120
<i>Phlaeoba infumata</i> Brunner, 1893	Acridinae	90	8010
<i>Oedaleus senegalensis</i> Krauss, 1877	Oedipodinae	87	7482
<i>Oedaleus abruptus</i> Thunberg, 1815	Oedipodinae	93	8556
<i>Aiolopus simulatrix</i> Walker, 1870	Oedipodinae	87	7482
<i>Heteropternis respondense</i> (Walker, 1859)	Oedipodinae	78	6006
<i>Oedipoda miniata</i> Pallas, 1771	Oedipodinae	99	9702
<i>Gastrimargus africanus</i> Saussure, 1888	Oedipodinae	75	5550
<i>Trilophidia repleta</i> Walker, 1870	Oedipodinae	102	10302
<i>Trilophidia annulata</i> Thunberg, 1815	Oedipodinae	99	9702
<i>Oxya fuscovittata</i> (Marschall, 1836)	Oxyinae	123	15006
<i>Oxya velox</i> (Fabricius, 1787)	Oxyinae	126	15750
<i>Oxya hyla hyla</i> Serville, 1831	Oxyinae	87	7482
<i>Oxya japonica japonica</i> (Thunberg, 1815)	Oxyinae	81	6480
<i>Hieroglyphus nigrorepletus</i> Bolivar, 1912	Hemiacridinae	121	14520
<i>Hieroglyphus banian</i> (Fabricius, 1798)	Hemiacridinae	108	11556
<i>Spathosternum prasiniferum prasiniferum</i> (Walker, 1817)	Spathosterninae	126	15750
<i>Tristria pulvinata</i> (Uvarov, 1921)	Tropidopolinae	66	4290
<i>Tropidopola longicornis</i> (Fieber, 1853)	Tropidopolinae	60	3540
<i>Cyrtacanthacris tatarica</i> (Linnaeus, 1758)	Cyrtacanthacridinae	72	5112
<i>Chondaeris rosea</i> (De Geer, 1773)	Cyrtacanthacridinae	69	4692
<i>Eyprepocnemis a. alacris</i> (Surville, 1838)	Eyprepocnemidinae	63	3906
<i>Heteracris littoralis</i> (Rambur, 1838)	Eyprepocnemidinae	66	4290
<i>Xenocatantops humilis</i> (Serville, 1838)	Catantopinae	78	6006
<i>Xenocatantops karnyi</i> (Kirby, 1910)	Catantopinae	90	8010
<i>Diabolocatantops pinguis</i> (Stal 1861)	Catantopinae	75	5550
<i>Diabolocatantops innotabilis</i> (Walker, 1870)	Catantopinae	72	5112
N=2797		N(N-1)= 7820412	Σ n(n-1)=306926

stress grasshoppers and may cause mortality also. Grasshoppers thrive in low to moderate humidity, as these conditions mimic their preferred habitats dry conditions often favour egg survival in soil and promote faster development of nymphs. High humidity can negatively impact reproduction by creating unfavourable

conditions for egg incubation and increasing the risk of various pathogen infections. Grasshopper outbreaks are often linked to rainfall. During dry periods eggs remain dormant in the soil, and after rain mass hatching and rapid vegetation growth occur thus creates ideal conditions for population explosions.



CONCLUSION

The diversity and distribution of grasshoppers highlight the intricate interplay between species and their environments, decline in specific grasshopper populations may signal either habitat degradation or climatic shifts. The presence of specialist species in undisturbed habitats underscores the need for habitat protection. Grasshopper population dynamics reflect ecosystem health, making them valuable bioindicators. By bridging gaps in knowledge, this study serves as a foundation for ecological research, conservation strategies, and sustainable agricultural practices. Protecting grasshopper diversity is not only vital for maintaining ecosystem balance but also for supporting the livelihoods of local communities that depend on agriculture. The findings are expected to contribute to conservation strategies and the sustainable management of natural and agricultural ecosystems in the Koshi division.

CONFLICT OF INTEREST

The author here declares that there is no conflict of interest in the publication of this article.

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REFERENCES

- Ander. 1939. Division of Orthoptera into two suborders, Ensifera and Caelifera. *Opuscula Entomologica*, **2**: 306
- Branson, D.H., Joern, A., Sword, G.A. 2006. Sustainable management of insect herbivores in grassland ecosystems: new perspectives in grasshopper control. *Bioscience*. **56**:743-755.
- Chandra, K. and Gupta, S.K. 2011. Endemic Orthoptera (Insecta) of India. *Prommalia*, **1**: 17-44
- Das, M., Ganguly, A. and Haldar, P. 2012. Determination of optimum temperature and photoperiod for mass production of *Oxya hyla hyla* (Serville). *Turkish Journal of Zoology*, **36**(3): 329-339.
- Dirsh, V.M. 1965. The African genera of Acridoidea. *Cambridge university Press*. **8**: 1-578.
- Ghosh, A.K. and Sengupta T. 1982. Handbook- Insect collection, Preservation and study. *Zoological Survey of India*. 1-64.
- Joern, A. 1979. Feeding pattern in grasshoppers (Orthoptera: Acrididae): factors influencing diet specialization. *Oecologia*, **38**: 325-347
- Joshi, P.C., Lockwood, J.A., Vashishth, N. and Singh, A. 1999. Grasshopper (Orthoptera: Acridoidea) community dynamics in a moist deciduous forest in India. *Journal of Orthoptera Research*, **8**: 17-23.
- Khan, H.R. and Aziz, S.A. 1973. Influence of different levels of temperature and moisture on the development and hatching of eggs of *Oedaleus abruptus* (Thunberg) (Orthoptera: Acrididae). *Indian Journal of Entomology*. **35**(1): 29-31
- Mulkern, G. B. 1967. Food selection by grasshoppers. *Annual Review of Entomology*. **12**:59-78
- Nayeem, M.R. and Usmani, M.K. and Akhtar M.H. 2013. Preliminary checklist of grasshoppers and locust fauna (Orthoptera: Acrididae) of Bihar, India. *World Journal of Applied Sciences and Research*, **3** (1): 35-38.
- Shishodia, M.S. and Hazra, A.K. 1985. Insect: Orthoptera. *Record Zoological survey of India*, **82** (1-4): 15-32
- Shishodia, M.S., Chandra, K. and Gupta, S.K. 2010. An annotated checklist of Orthoptera (Insecta) from India. *Record. Zoological Survey of India*. **31**: 1-366
- Singh, B. and Singh, O. P. 2010. Ecological studies on grasshoppers as agricultural pests in India. *Journal of Insect Science*, **25**(2), 115-123.
- Tabrez, S., and Nayeem, M.R. 2024. Studies on distribution of Acridoidea (Orthoptera) of Patna district, Bihar (India). *International Journal of Entomology Research*. **9** (7) 9-12.
- Tandon, S.K. 1988. Distributional pattern of grasshoppers in India: The distribution of Oxyinae (Orthoptera: Acridoidea: Acrididae) in

- Indian region. *Record Zoological Survey of India*, **85**(1): 101-110
- Tandon, S.K. 1990. Distributional pattern of grasshoppers in India: The distribution of genus *Hieroglyphus* (Orthoptera: Acridoidea: Acrididae) in Indian region. *Hexapoda*, **2**(2):1-8
- Tandon, S.K. and Hazra, A.K. 1998. Faunal diversity in India Orthoptera: *ENVIS Center, Zoological Survey of India*. 183-188.
- Usmani, M.K. and Nayeem, M.R. 2012. Studies on taxonomy and distribution of Acridoidea (Orthoptera) of Bihar, India. *Journal of Threatened Taxa*, **4**(13): 3190-3204.
- Usmani, M.K. and Shafee, S.A. 1990. Classification of Indian Acrididae (Orthoptera: Acridoidea). *Indian Journal of Systematic Entomology*, **7**(2): 89-102.
- Uvarov, B.P. 1977. Grasshoppers and locusts: A handbook of general Acridology, ecology, biogeography and population dynamics. *Centre for overseas pest research, London*. **2**: 1-613.

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