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A Review on Diversity of Grasshopper Species in India

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ABSTRACT

An important part of a healthy ecosystem is that grasshoppers provide food for other animals and contribute to the natural environment by providing food for other animals. They also show evidence of changes in the environment by their presence. Grasshoppers are in the Caelifera family of insects, which means they belong to the Orthoptera order. Grasshopper species vary widely across India, as India has a wide variety of different plants and animals. Grasshoppers would be found in a number of locations including dry areas, forests, meadows and farms. This study will examine different species of grasshoppers found in India, where they occur, their roles in the environment and the role they play in the economy. Over 1,000 different orthopteran species have been positively identified in India, with a large number of those being grasshoppers. Different factors will determine what types of these insects will live in a particular geographic area including the different species of plants and animals, climate of the location, human activity, and many other environmental conditions. The ecological system can gain benefits or suffer from grasshoppers; while many of them are pests that do great harm to crops, many of them play an important role in cycling of nutrients, and also provide food to animals higher up the food chain. Recent research has established grasshoppers as acceptable indicators of the ecological condition of grassland and forest habitats; yet their distribution and diversity are increasingly threatened by the impacts of habitat alteration, pesticide application and climate change. This paper provides a detailed account of the diversity of grasshoppers in India as a summary of several studies dealing with the ecology, taxonomy and environmental aspects of grasshoppers. The results from these studies indicate that continued support for conservation activities, environmentally-friendly pest control techniques and further investigation of under-explored areas and species is needed.

Introduction

Grasshoppers are one of the most diverse and important groups of insects in the order Orthoptera and suborder Caelifera. They have strong hind legs that let them jump, chewing mouthparts, and antennae that aren't very long (Boris Uvarov, 1966; Reginald Frederick Chapman, 1990). Globally, grasshoppers are a big element of land ecosystems, especially in grasslands, savannas, and agricultural areas. They are primary eaters and are very important for keeping plant communities in check (Capinera, 1993; Belovsky & Slade, 2000). Their broad distribution and ability to thrive in a variety of environments make them a significant topic of ecological and biodiversity research.

India is one of the most biodiverse countries in the world, and it has a lot of different ecological niches that sustain a large range of insect species, including grasshoppers. The country has many different biogeographical areas, including as the Himalayas, Indo-Gangetic plains, Thar Desert, Western Ghats, Deccan Plateau, and Northeastern hill regions. Each of these areas has its own climate and plants (Shishodia *et al*., 2010; Chandra & Gupta, 2013). These changes in the ecosystem have caused a lot of different types of grasshoppers to evolve and spread across the country. India is home to more than 1,000 species of Orthopterans, and grasshoppers make up a large part of this diversity (Gupta & Shishodia, 2012). But the real number could be higher because there are places that haven't been examined and taxonomic gaps.

Grasshoppers are mostly phytophagous insects, which means they eat a lot of different types of grasses, herbs, and crops. Their feeding habits change the structure of plant communities, the distribution of biomass, and the flow of nutrients in ecosystems (Belovsky & Slade, 2000). They change plant material into biomass, which helps move energy between trophic levels and is an important food source for many predators, including birds, reptiles, amphibians, and small mammals (Capinera, 1993). Grasshoppers are very important for keeping the balance of ecosystems and making sure they stay stable. Grasshoppers are important for the environment, but they are also well-known for their effect on the economy, especially in farming systems. Several species, such as Schistocerca gregaria (desert locust) and Oxya spp., are known to inflict serious damage to crops as their populations grow (Latchininsky *et al*., 2011). These epidemics can cause big losses for the economy, which hurts food security and rural lives. In India, recent locust invasions have shown how important it is to know how grasshopper populations change over time and to use good management methods. Grasshoppers are a special category of organisms that can help or hurt human activities. There are several living and nonliving things that affect the variety and spread of grasshoppers. These include temperature, rainfall, humidity, the kind of vegetation, the type of soil, and the way land is used (Belovsky & Slade, 2000; IPCC, 2014). Climate is a very essential factor in deciding when they live, how well they reproduce, and where they live. For instance, higher temperatures and more rain may help plants flourish, which would be good for grasshoppers to grow. On the other hand, major weather disasters like floods and droughts can hurt their populations. In the context of global climate change, variations in temperature and precipitation patterns are anticipated to modify grasshopper distribution and abundance, potentially resulting in alterations in ecosystem dynamics and agricultural production (IPCC, 2014).

Human activities have also had a big effect on the diversity of grasshoppers in India. Rapid urbanisation, deforestation, intensification of agriculture, and the extensive application of chemical pesticides have caused habitat degradation and fragmentation, resulting in a decrease in insect biodiversity (Kremen *et al*., 2007; Geiger *et al*., 2010). Pesticides, especially, don't just kill pests; they also hurt other organisms, like grasshopper species that help ecosystems work. Also, monoculture farming practices make habitats less diversified, which makes it harder for different species to find resources and places to live. These things together are a big threat to grasshopper diversity, therefore we need to use land in a way that is good for the environment.

Recently, grasshoppers have become popular as bioindicators of environmental health because they are very sensitive to changes in habitat quality, climate, and pollution levels (Samways & Sergeev, 1997). Changes in the number and types of grasshoppers in a community can tell us a lot about ecosystem disturbances and biodiversity loss. As a result, keeping an eye on grasshopper numbers can be a useful way to see how environmental changes affect them and to help with conservation efforts. This has resulted in heightened interest in the examination of grasshopper diversity, especially in biodiversity hotspots like the Western Ghats and Northeastern India, characterised by significant endemism (Myers *et al*., 2000).

Taxonomic research on grasshoppers in India has a lengthy history, originating from the colonial era when pioneering entomologists recorded the wildlife of the Indian subcontinent. Researchers like Kirby (1914) and Uvarov (1966) made important contributions by giving detailed descriptions and classifications of Orthopteran species. In the last several decades, Indian researchers and organisations, such as the Zoological Survey of India (ZSI), have done a lot of faunal surveys and taxonomic revisions. This has led to the discovery of new species and the updating of species checklists (Shishodia *et al*., 2010). Nonetheless, obstacles such as inadequate taxonomic proficiency, absence of molecular research, and insufficient financial resources persist in obstructing thorough documenting of grasshopper diversity.

New ways to investigate grasshopper diversity and distribution have come about thanks to modern methods like DNA taxonomy, geographic information systems (GIS), and ecological modelling. Molecular methods can assist clear up taxonomic confusion and find hidden species. GIS-based studies can help us understand how species are spread out and what habitats they like. These techniques are especially helpful when it comes to climate change since they let you guess how species and places will change in the future and find those that are most at risk.

Because grasshoppers are important for both the environment and the economy, we need a full summary of what we already know about how diverse they are in India. There have been a number of regional studies, but there isn't a single review that brings together information on taxonomy, distribution, ecological roles, and conservation status. The current review seeks to address this deficiency by aggregating and examining the existing research on grasshopper diversity in India. It aims to show how species are spread out in different biological regions, look at the things that affect their variety, and talk about how important they are for the environment and the economy.

This assessment also stresses the importance of conservation measures and sustainable management approaches to protect grasshopper variety as environmental problems get worse. This study intends to be a useful resource for academics, ecologists, and policymakers who work on biodiversity conservation and pest management by giving a complete picture of what is known right now.

Taxonomy and Classification

Grasshoppers belong to the order Orthoptera and are divided into several families including Acrididae, Pyrgomorphidae, Tetrigidae, and Eumastacidae (Uvarov, 1966; Shishodia *et al*., 2010). Acrididae is the largest family and includes many economically important pest species (Chapman, 1990).

Diversity and Distribution in India-India hosts more than 1,000 species of grasshoppers, distributed across diverse ecological regions (Gupta & Shishodia, 2012).

Himalayan Region-Grasshoppers in this region are adapted to cold climates and seasonal activity patterns (Mani, 1968).

Indo-Gangetic Plains-Species such as Oxya hyla and Hieroglyphus banian are common in agricultural landscapes (Rao & Rao, 1955).

Desert Region- Xerophilous species dominate the Thar Desert, showing adaptations to arid conditions (Shishodia *et al*., 2010).

Western Ghats-This biodiversity hotspot supports a high number of endemic species (Myers *et al*., 2000).

Northeastern India-Tropical climate and dense vegetation support rich species diversity (Chandra & Gupta, 2013).

People all around the world have researched grasshoppers (Order Orthoptera: Suborder Caelifera) a lot since they are important to the environment, have a lot of different species, and have an economic influence. Boris Uvarov's early work (1966) set the stage for understanding grasshopper biology, behaviour, and population dynamics, especially when it comes to locust swarms. Reginald Frederick Chapman (1990) similarly offered extensive insights into the physiology and ecology of grasshoppers, highlighting their adaptability to many settings.

During the colonial period in India, systematic documentation of grasshopper variety began with the work of Kirby (1914), who put together one of the first faunal records of Orthoptera in the Indian subcontinent. Later research by Dirsh (1965) and Uvarov (1966) built on what was already known about classification and distribution patterns, putting Indian species in a worldwide context. Shishodia *et al*. (2010) and Gupta and Shishodia (2012) have worked on new checklists and taxonomy changes that show that India has more than 1,000 species of Orthopterans.

Numerous regional investigations have substantially enhanced the comprehension of grasshopper diversity throughout various ecological zones in India. Mani (1968) noted that grasshopper species in the Himalayan region demonstrate distinctive adaptations to cold conditions, encompassing seasonal activity patterns and physiological resilience to low temperatures. Research by Kumar and Usmani (2015) in the Western Himalayas underscored species diversity in alpine and subalpine habitats, illustrating the impact of altitude and vegetation on species composition.

Researchers have looked at the diversity of grasshoppers and how they interact with pests in the Indo-Gangetic plains, which are known for their intense agriculture. Rao and Rao (1955) identified numerous economically significant species, including Oxya hyla and Hieroglyphus banian, which are frequently associated with rice and cereal crops. Subsequent research by Usmani and Shafee (1990) and Kumar *et al*. (2017) validated that agricultural practices markedly affect the population structure and variety of grasshoppers in this area.

The Thar Desert in Rajasthan is a one-of-a-kind ecosystem where grasshopper species have adapted to live in dry conditions. Shishodia *et al*. (2010) recorded various xerophilous species that can endure severe temperatures and scarce water resources. Sharma and Gupta's (2018) research showed that the variety of desert grasshoppers is closely related to the patterns of rainfall and vegetation that change with the seasons. The number of grasshoppers is highest during the monsoon season.

The Western Ghats, known as a global biodiversity hotspot (Myers *et al*., 2000), have a lot of grasshopper species that are only found there. Chandra and Gupta (2013) and Senthilkumar *et al*. (2019) found that there are a lot of different species in the forests and grasslands of this area. These investigations underscored the significance of habitat heterogeneity and microclimatic variables in preserving grasshopper diversity.

Northeastern India is another area with a lot of different types of plants and animals. Several researches have found grasshopper species that are only found in this area. Chandra *et al*. (2015) recorded a variety of Orthopteran species in Assam, Meghalaya, and Arunachal Pradesh, attributing this richness to the tropical climate and dense vegetation of the area. But because it's hard to get to and

there haven't been many thorough studies, this area isn't well represented in the literature.

Grasshoppers are really important to how ecosystems work, especially when it comes to eating plants and moving nutrients around. Belovsky and Slade (2000) showed that the way grasshoppers eat has a big effect on the structure and productivity of plant communities. Capinera (1993) stressed their importance in food webs as energy transfer agents and as food for many different predators. Joern and Gaines (1990) emphasised the significance of grasshoppers in the regulation of grassland ecosystems.

Grasshoppers have important economic effects as well as ecological ones, especially when they damage crops. Latchininsky *et al*. (2011) said that locusts like Schistocerca gregaria can build swarms that destroy crops across broad areas. Recent locust outbreaks in India have highlighted the need to keep an eye on and control grasshopper numbers (FAO, 2020). Research conducted by Singh and Singh (2021) emphasised the effects of these epidemics on agricultural productivity and rural economies.

The dual function of grasshoppers as pests and beneficial organisms has resulted in the formulation of integrated pest management (IPM) systems. Altieri (1999) stressed how important ecological methods are for controlling pests, such as habitat diversification and biological control. Lomer *et al*. (2001) investigated the application of biopesticides, including fungal pathogens, as eco-friendly substitutes for chemical pesticides.

Environmental factors are very important in determining the diversity and spread of grasshoppers. Temperature, precipitation, and flora are primary factors influencing species abundance and distribution patterns (Belovsky & Slade, 2000). Climate change has become a significant factor affecting grasshopper populations, with research forecasting alterations in species distribution and a heightened incidence of pest outbreaks (IPCC, 2014; Parmesan, 2006). Bale *et al*. (2002) stated that higher temperatures can speed up the growth and reproduction of insects, which could cause population explosions.

Human activities like destroying habitats, building cities, and using pesticides have had a big effect on the diversity of grasshoppers. Kremen *et al*. (2007) and Geiger *et al*. (2010) established that intensive agricultural methods and pesticide use can diminish insect biodiversity, encompassing grasshoppers. Hallmann *et al*. (2017) found that insect populations are declining all around the world. This has raised worries about the stability of ecosystems and the preservation of biodiversity.

Because they are sensitive to changes in their habitat and pollutants, grasshoppers are being employed more and more as bioindicators of environmental health. Samways and Sergeev (1997) highlighted their efficacy in assessing ecosystem quality, especially within grassland environments. Gardiner *et al*. (2005) showed that changes in the types of grasshoppers in an area can show that the habitat is getting worse or that land use is changing.

New techniques for researching grasshopper diversity have come from advances in molecular biology and ecological modelling. Molecular taxonomy has been employed to address species identification challenges and reveal cryptic diversity (Hebert *et al*., 2003). Geographic Information Systems (GIS) and ecological niche modelling have been utilised to forecast species distribution and evaluate the effects of climate change (Elith & Leathwick, 2009). These methods are very helpful for figuring out what conservation has to be done first and how to deal with pest species.

There are still certain holes in grasshopper research, even though it has come a long way. Many parts of India, especially those that are hard to get to and not studied very much, don't have thorough biodiversity assessments. Taxonomic issues, such as synonymy and misidentification, still make it hard to accurately document species. Also, we need long-term ecological research to learn more about how populations change and how changes in the environment affect them.

Recent research has emphasised the viability of grasshoppers as alternative protein sources, enhancing food security and promoting sustainable agriculture (van Huis, 2013). This has created new opportunities for study on how to use and control grasshopper populations.

The research suggests that the variety of grasshoppers in India is shaped by a complex interaction of ecological, climatic, and anthropogenic variables. There has been a lot of progress in recording the diversity of species and learning about their roles in the environment, but we need to merge taxonomy, ecology, and conservation biology into one method.

Ecological Importance of Grasshoppers-Grasshoppers play essential ecological roles including herbivory, nutrient cycling, and food web dynamics (Capinera, 1993). They regulate plant biomass and contribute to decomposition processes (Belovsky & Slade, 2000).

They are also considered important bioindicators of environmental changes (Samways & Sergeev, 1997).

Economic Importance

Pest Species- Species like Schistocerca gregaria cause severe agricultural losses (Latchininsky *et al*., 2011).

Beneficial Roles-Grasshoppers contribute to ecological balance and can be used as alternative protein sources (van Huis, 2013).

Factors Affecting Grasshopper Diversity- Climate change alters species distribution (IPCC, 2014)

Habitat destruction reduces biodiversity (Kremen *et al*., 2007)

Pesticides negatively impact populations (Geiger *et al*., 2010)

Conservation and Management- Conservation strategies include habitat protection, sustainable agriculture, and integrated pest management (IPM) (Altieri, 1999). Reducing pesticide use and promoting biodiversity-friendly practices are essential (Kremen *et al*., 2007).

The current analysis highlights that a multifaceted interaction of ecological, climatic, and anthropogenic variables affects the diversity of grasshopper species in India. The literature review shows that grasshoppers in India are very diverse because of the types of plants they eat, the different types of environments they live in, and the different types of habitats they live in (Shishodia *et al*., 2010; Gupta & Shishodia, 2012). There is a substantial link between grasshopper richness, habitat variability, and primary productivity on a global scale (Belovsky & Slade, 2000). This fits with the patterns of diversity that have been seen.

Discussion

One of the most surprising things that came out of this study is how closely related the number of grasshopper species is to the number of plant species. Because they rely so heavily on plant communities for food and habitat, grasshoppers are considered phytophagous. There are more kinds of grasshoppers in areas with a lot of plants and thick vegetation than in areas that are dry or semi-dry (Myers *et al*., 2000; Chandra *et al*., 2015). This is especially true in the Western Ghats and northeastern India. Ecological theory backs this link by saying that a bigger range of plant niches leads to a wider range of insect species (Joern & Laws, 2013).

The number and spread of grasshoppers are largely affected by climate variables, especially temperature and precipitation. Research indicates that temperature influences grasshoppers' metabolic rates, growth, and reproductive cycles (Bale *et al*., 2002). The weather in India's tropical and subtropical areas is favourable for many breeding cycles, which is why there are more people living there. On the other side, places with very hot or very cold weather, like the Thar Desert and the Himalayas, have fewer species because of how their bodies work (Mani, 1968; Sharma & Gupta, 2018). Animals that live in such harsh environments have to change how they act and how their bodies react to heat and water stress in very unusual ways.

The impact of climate change on grasshopper diversity is emerging as a significant concern. Changes in rainfall patterns and rising global temperatures are anticipated to change where species live, when they reproduce, and how many of them there are (IPCC, 2014; Parmesan, 2006). Warmer temperatures may result in an increase in agricultural pests and accelerated growth and reproduction of grasshoppers (Bale *et al*., 2002). Changes in climate zones may also cause species to shift. This could change the makeup of

communities and even cause species that are only found in one location to go extinct.

One of the main factors that has changed the diversity of grasshoppers is what people do. Urbanisation, deforestation, and agricultural expansion have fragmented and obliterated natural habitats, resulting in a decline in species diversity (Kremen *et al*., 2007). Intensive agricultural techniques, particularly monoculture cropping systems, have diminished habitat diversity for grasshoppers and reduced resource availability (Altieri, 1999). The increasing use of chemical pesticides has caused biodiversity loss, which has had other bad repercussions, like hurting populations of useful insects like grasshoppers (Geiger *et al*., 2010). It's hard to deal with grasshoppers because they are bad for farmers yet helpful for the environment. During epidemics, some types of grasshoppers can do a lot of damage to crops, but they also make ecosystems run by eating plants, cycling nitrogen, and passing on energy (Capinera, 1993; Latchininsky *et al*., 2011). One type of insect that can swarm and destroy crops over a vast region is the desert locust, Schistocerca gregaria. The recent locust invasions in India have brought attention to the need for new means to keep an eye on and control them so that economic losses are kept to a minimal (FAO, 2020).

Integrated pest management (IPM) is a novel approach to cut down on grasshoppers that is healthy for the environment. According to Altieri (1999) and Lomer *et al*. (2001), the most important parts of integrated pest management (IPM) are using biological control agents, regulating ecosystems, and using fewer chemical pesticides. In the future, locust populations might benefit from biological management approaches that don't harm non-target species, such as entomopathogenic fungi. Natural predators can help keep the number of grasshoppers down, and agroecological measures that keep habitats diverse can help with that.

The study also reveals how crucial grasshoppers are for showing how healthy the environment is. Grasshopper colonies, which are very sensitive to changes in their habitat and other environmental stresses, can tell us a lot about how healthy an ecosystem is (Samways & Sergeev, 1997). Gardiner *et al*. (2005) state that changes in the kinds and quantities of species can signal that the habitat is growing worse, that pollution is happening, or that land use is changing. This is why you can use grasshoppers to keep track of biodiversity and determine how effectively conservation efforts are functioning.

The usage of current technologies has made it much easier to study different kinds of grasshoppers. Molecular approaches, including DNA barcoding, have enhanced the precision of species identification and revealed hidden diversity that may not be discernible by morphological study alone (Hebert *et al*., 2003). Ecological niche modelling and geographic information systems (GIS) have also been used to figure out where species dwell and how changes in the environment can influence them (Elith & Leathwick, 2009). These tools are helpful for discovering places that need to be conserved and for understanding out how climate change can influence where species live.

There are still a lot of challenges with studying and protecting the diverse kinds of grasshoppers in India, even with these changes. One big problem is that there isn't any up-to-date taxonomy data. We should expect to find new species as we explore more places that haven't been studied extensively, especially in the Northeastern states and other remote forest areas. Also, biodiversity research doesn't get enough money, and there aren't enough trained taxonomists.

We also need long-term ecological studies to learn more about how populations change and how changes in the environment affect them. This is yet another problem. The majority of the research conducted to date is short-term and limited to a single region, rendering it less significant on a broader scale. You can only see changes in the number of species and how human activities and climate change affect them through long-term monitoring initiatives.

The report also talks about how grasshoppers could be a long-term resource. Recent studies have examined the feasibility of utilising grasshoppers as sustenance for humans and animals (van Huis, 2013). As the world's population grows, so does the need for protein sources that last a long time. This has a big impact on food security. We need to do further research to figure out if eating grasshoppers is safe, useful, and okay with other people.

A whole conservation plan must involve safeguarding habitats,utilising farming practices that don't harm the environment, and keeping an eye on the diversity of plants and animals. To keep the number of different kinds of grasshoppers down, it's necessary to protect natural areas like meadows and woods. Promoting eco-friendly agricultural methods like crop rotation, intercropping, and using fewer pesticides could also help keep the variety of insects in farming areas safe.

Lastly, a lot of various ecological, climatic, and human-caused factors work together in complicated ways to modify the quantity of different types of grasshoppers in India. We need to employ more full and integrated study methods, even if we know a lot about their variety and ecological roles. Researchers, policymakers, and others who are interested can work together to find solutions to the problems of climate change, pest control, and habitat loss. We can retain the diversity of grasshoppers while reducing their bad effects on farms by employing sustainable management strategies and learning more about their ecology.

Conclusion

The present review provides a comprehensive synthesis of the diversity, distribution, and ecological significance of grasshopper species in India, highlighting their critical role in both natural and agricultural ecosystems. The evidence gathered from various studies indicates that India harbors a rich assemblage of grasshopper fauna, largely shaped by its diverse biogeographical regions and climatic conditions. Regions such as the Western Ghats and Northeastern India exhibit particularly high species richness due to favorable environmental conditions and habitat heterogeneity. Grasshoppers function as key components of terrestrial ecosystems, contributing to herbivory, nutrient cycling, and energy transfer across trophic levels. At the same time, certain species pose serious threats to agriculture, especially during population outbreaks, thereby emphasizing their dual ecological and economic importance. The increasing frequency of such outbreaks, particularly in the context of climate change, underscores the need for improved monitoring and management strategies. Anthropogenic pressures, including habitat destruction, pesticide use, and agricultural intensification, have emerged as major factors contributing to the decline in grasshopper diversity. These activities not only reduce species richness but also disrupt ecological balance, affecting ecosystem services provided by grasshoppers. Therefore, conservation of grasshopper diversity requires a holistic approach that integrates habitat protection, sustainable land-use practices, and reduced reliance on chemical inputs. Furthermore, the role of grasshoppers as bioindicators of environmental health provides valuable opportunities for ecological monitoring and biodiversity assessment. Advances in molecular taxonomy and geospatial technologies have enhanced our ability to study species diversity and predict future distribution patterns, offering new directions for research and conservation. In conclusion, while significant progress has been made in documenting grasshopper diversity in India, substantial gaps remain, particularly in underexplored regions and long-term ecological studies. Future research should focus on integrating traditional taxonomy with modern analytical tools to achieve a more accurate understanding of species diversity and dynamics. Sustainable management practices, combined with increased awareness and policy support, are essential to conserve grasshopper biodiversity while minimizing their adverse impacts on agriculture.

References

Altieri, M. A. (1999). The ecological role of biodiversity in agroecosystems. Agriculture, Ecosystems & Environment, 74(1–3), 19–31.

Bale, J. S., Masters, G. J., Hodkinson, I. D., Awmack, C., Bezemer, T. M., Brown, V. K., … Whittaker, J. B. (2002). Herbivory in global climate change research. Global Change Biology, 8(1), 1–16.

Belovsky, G. E., & Slade, J. B. (2000). Insect herbivory accelerates nutrient cycling. Ecology, 81(10), 2687–2698.

Capinera, J. L. (1993). Grasshoppers as crop pests. CAB International.

Chapman, R. F. (1990). The insects: Structure and function (4th ed.). Cambridge University Press.

Chandra, K., & Gupta, S. K. (2013). Faunal diversity of Northeast India: Orthoptera. Zoological Survey of India.

Chandra, K., Gupta, S. K., & Kumar, S. (2015). Orthopteran diversity in Northeastern India. Journal of Threatened Taxa, 7(5), 7123–7130.

Dirsh, V. M. (1965). The African genera of Acridoidea. Cambridge University Press.

Elith, J., & Leathwick, J. R. (2009). Species distribution models. Annual Review of Ecology, 40, 677–697.

FAO. (2020). Locust watch: Desert locust situation update. Food and Agriculture Organization.

Gardiner, T., Hill, J., & Chesmore, D. (2005). Review of orthopteran bioindicators. Journal of Insect Conservation, 9(2), 121–130.

Geiger, F., Bengtsson, J., Berendse, F., Weisser, W. W., Emmerson, M., Morales, M. B., … Inchausti, P. (2010). Persistent negative effects of pesticides. Science, 329(5994), 170–173.

Gupta, S. K., & Shishodia, M. S. (2012). Diversity of grasshoppers in India. Zoological Survey of India.

Hallmann, C. A., Sorg, M., Jongejans, E., Siepel, H., Hofland, N., Schwan, H., … Goulson, D. (2017). More than 75% decline in insect biomass. PLOS ONE, 12(10), e0185809.

Hebert, P. D. N., Cywinska, A., Ball, S. L., & deWaard, J. R. (2003). Biological identifications through DNA barcodes. Proceedings of the Royal Society B, 270(1512), 313–321.

IPCC. (2014). Climate change 2014: Impacts, adaptation, and vulnerability. Cambridge University Press.

Joern, A., & Gaines, S. B. (1990). Population dynamics in grasshoppers. Annual Review of Entomology, 35, 361–383.

Joern, A., & Laws, A. N. (2013). Ecological mechanisms underlying grasshopper diversity. Annual Review of Entomology, 58, 19–36.

Kirby, W. F. (1914). The fauna of British India: Orthoptera. London.

Kremen, C., Williams, N. M., Aizen, M. A., Gemmill-Herren, B., LeBuhn, G., Minckley, R., … Ricketts, T. H. (2007). Pollination and biodiversity conservation. Ecology Letters, 10(4), 299–314.

Kumar, H., & Usmani, M. K. (2015). Grasshopper diversity in Western Himalaya. Journal of Entomology and Zoology Studies, 3(4), 56–62.

Kumar, P., Singh, R., & Singh, V. (2017). Agricultural pest dynamics in India. Indian Journal of Entomology, 79(2), 234–240.

Latchininsky, A. V., Sword, G. A., Sergeev, M. G., Cigliano, M. M., & Lecoq, M. (2011). Locusts and grasshoppers: Behavior and ecology. BioScience, 61(4), 321–330.

Lomer, C. J., Bateman, R. P., Johnson, D. L., Langewald, J., & Thomas, M. (2001). Biological control of locusts. Annual Review of Entomology, 46, 667–702.

Mani, M. S. (1968). Ecology and biogeography of high altitude insects. Springer.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Fonseca, G. A., & Kent, J. (2000). Biodiversity hotspots. Nature, 403, 853–858.

Parmesan, C. (2006). Ecological responses to climate change. Annual Review of Ecology, 37, 637–669.

Rao, Y. R., & Rao, K. V. (1955). Agricultural pests of India. ICAR Publication.

Samways, M. J., & Sergeev, M. G. (1997). Orthoptera conservation. Journal of Insect Conservation, 1, 217–223.

Senthilkumar, N., *et al*. (2019). Grasshopper diversity in Western Ghats. Journal of Threatened Taxa, 11(3), 13456–13465.

Sharma, G., & Gupta, S. (2018). Desert grasshopper ecology. Indian Journal of Ecology, 45(2), 245–252.

Shishodia, M. S., Chandra, K., & Gupta, S. K. (2010). An annotated checklist of Orthoptera of India. Zoological Survey of India.

Singh, R., & Singh, V. (2021). Impact of locust outbreaks on agriculture. Agricultural Reviews, 42(1), 45–52.

Uvarov, B. (1966). Grasshoppers and locusts: A handbook of general acridology. Cambridge University Press.

van Huis, A. (2013). Edible insects: Future prospects. FAO.