



## Effects of Temperature and Rainfall Pattern on The Abundance of Orthopteran Insects in Coal Mines Ecological Restoration Areas of Jharia Coal Fields, Jharkhand, India

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Article History	Abstract
Received: 06 June 2023 Revised: 05 Sept 2023 Accepted: 08 Nov 2023	<i>Ecological restoration on coal mines' overburden dumps provides a suitable environment for the study of primary succession. The Abundance and diversity study of orthopteran insects and their diversity pattern with temperature and rainfall provides a lot about the stage of succession and ecosystem complexity in the area. Orthopteran diversity of two sites covering ten years of plantation having different types of vegetation were monitored. Tropical conditions like changes in rainfall and temperature influence the abundance of insects. An increase in monsoon increases the abundance whereas as the temperature increases the abundance decreases. In herbaceous habitats, insects' diversity increases which gives a recolonization pattern for the ecosystem. This helps to increase the livelihood and conservation of the ecosystem and directs to sustain the SDG 15 goal.</i>
CC License CC-BY-NC-SA 4.0	<b>Keywords:</b> <i>Ecological restoration, abundance, orthopteran insects, temperature and rainfall, sustainable development</i>

### 1. Introduction

Insects are one of the pioneer species that have a high adaptive rate. They are the organisms that change its behavior and abundance with change in temperature, humidity, rainfall, and soil organics. The increasing global climate change has disturbed the distribution and abundance of many species. (Malcolm et al., 2006; Coetzee et al., 2009; Anderegg et al., 2015). For a few organisms, climate change had played a major role in the extinction rate. (Chen et al., 2011; Dobrowski et al., 2013). Similarly, change in rainfall patterns had affect the abundance and diversity of insects. (Hamann and Wang, 2006)

But in case of arthropods, there are such mechanisms that reduces the risk of death or decline in population with change in abiotic factors. (Longcore, 2003). During the eggs, pupae, or adult stages, some species have their control mechanism and show low activity. Similarly, the resource availability in seasonal variations also determines the abundance of species. (Joern 1982; Kemp et al. 1990; Parmenter et al. 1991; Bonnet et al. 1997).

In the restored mining areas, the orthopteran insects play special significance as they constitute the primary food source and major arthropod biomass (Shurbs and Phillips, 1991). These communities have a connection with plant communities in progressive seasons. (Joern 1982, Parmenter et. Al 1991, Bonnet et.al, 1997). Several studies confirmed that climatic changes strongly affect the abundance and geographical distribution of orthopteran insects. (Eo et al, 2017, Weiss et al, 2012). Due to their sensitivity to microclimate, orthopteran species are considered as biological indicators. (Baldi and Kisbendek,1997)

Jharkhand is characterized by its native ecosystem and endemic species like *Butea monosperma* (Palash) and *Lantana camara* (Raimunia). However, the increase in mining activities led to a great destruction in the native ecosystem. A large number of ecological restoration projects have been started by BCCL, especially on the overburden dumps. The plantation and natural forest conservation has been since the year 2011. (Paryavaran Darpan, BCCL).

The study of orthopteran species in the coal mines' ecological restoration areas of Jharkhand is almost negligible. As these organisms act as keystone species for grassland ecosystems, they help to indicate the succession of the ecological restoration on coal mines overburden dumps. The recolonization of these insects increases the interactions between their predator organisms. The present study aims to visualize the effect of temperature and rainfall on the orthopteran abundance in Ecological restoration areas.

### Map of the Study area

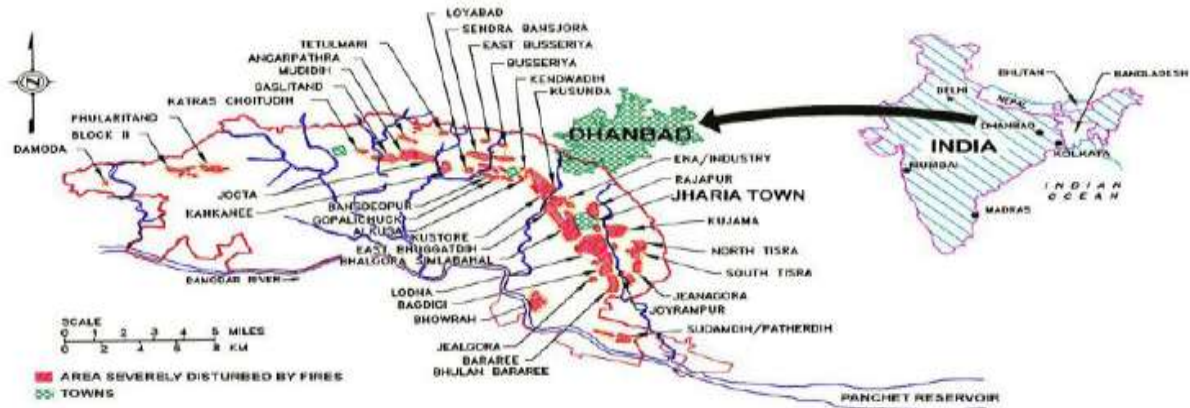


Fig 1: Map of Jharia Coal Fields

The two study areas are selected in Jharia Coal mines:

- 1) The Parasnath Park: The Parasnath Park is the Ecological restoration site of Ramkanali Coliery, JCF, Dhanbad. Its longitude and latitude are  $23^{\circ}78'97''N$  and  $86^{\circ}25'25''E$ . The plantation on the overburden dump was started in the year 2011 follows three -tier restoration method with species like *Azadirachta indica*, *Vachellia nilotica*, *Aegle marmelos*, *Moringa oleifera* and etc. Later the area was converted into a park by planting some fruit trees like *Mangifera indica*, *Artocarpus Heterophyllus*, *Phyllanthus emblica*, etc and some flowering plants like *Tabernaemontana divaricate*, *Clitoria Ternatea*, etc. with an area of 4.5 acres and commonly known as “Hill Park” To local people. A wide variety of native species like *Termmlia arjuna*, *Gmelina arborea*, *Bauhinia variegata* etc are also seen in the park. The park was inaugurated in 2020 and used for many recreational activities. The restoration was been done with three - tier restoration method.
- 2) The Ecological Restoration site, Damoda Colliery: The Damoda Colleiery is situated in the Bokaro district, with longitude and latitude  $23^{\circ}61'81''N$  and  $87^{\circ}10'09''E$ . The plantation on the overburden dump was started in the year 2011 and follows single -tier plantation method with *Bambusa vulgaris*, the dominate species. Species like *Albizia odoratissima*, *Butea monosperma* *Albizia procera* etc grow in the area. The presence of grasses is negligible in the ecorestoration site.

It is to be mentioned here that three -tier plantation was followed for site 1 with many native species, whereas site 2 follows follows single-tier plantation with bamboo as the dominant species.

## 2. Materials And Methods

To study the abundance of species field trips are arranged from Jan 2022 to Dec 2022. Sampling was performed with quadrats. The quadrant method defined for each collection is 10mx10m. Ten (10) quadrats are studied. The insects were sampled with random sampling net sweeping method ( $n=20$ ) in the bushes and the plain area. Ten quadrats were sampled at both sites. Grasshoppers collected using the sweep net were taken to the laboratory and identified by using identification keys for Orthopteroid from North Africa of Chopard (1943), Dirish (1965), and experts of the University Department of Zoology, BBMKU, Dhanbad.

### Climatic Data

The temperature and rainfall data are obtained from the Indian Meteorological Department, India, Ranchi for Jan 2022 – Dec 2022. For the Damoda ecological restoration area of  $23^{\circ}78'N$ ,  $86^{\circ}17'E$ , the average maximum temperature was  $32.03^{\circ}C$  with highest temperature of  $39.05^{\circ}C$  in summer and lowest temperature of  $8.60^{\circ}C$  in winter. The precipitation is although the year but maximum in the month of August with 2.99mm.

For the Parasnath Park Ecological Restoration site of 23° 81' N, 86° 31' E, the average maximum temperature was 32.03 °C with the highest temperature of 39.05 °C in summer and 8.60°C.

The abundance of grasshopper species was estimated in both the sites. Species abundance was calculated by using the Shannon – Weaver Index (H). The Formulae of the Shannon- Weaver Index is:

$$H = - \sum_{n_i=1}^N \left(\frac{n_i}{N}\right) \times \ln \left(\frac{n_i}{N}\right)$$

Where  $n_i$  is the species present in all the quadrats and N is the total species present in all the quadrats.

### 3. Results and Discussion

During the study period of Jan 2022- Dec 2022, specimens of grasshoppers were collected. They belong to families that were common on both sites. The list of grasshoppers is given below.

**Table 1:** The list of grasshoppers found in ecological restoration sites

Sl no	Family	Species	Parasnath Park		Damoda Eco restoration area	
			Visual Scanning	Net Sweeping	Visual Scanning	Net Sweeping
1	Acrididae	Acrida Conica	+	+	+	-
2	Acrididae	Acrida cinerea	+	+	+	+
3	Acrididae	Acrida exaltata	+	-	-	+
4	Acrididae	Locusta migratoria	+	+	+	+
5	Acrididae	Eyprepocnemidinae	+	-	+	+
6	Acrididae	Caelifera.	+	+	+	+
7	Acrididae	Atractomorpha lata	+	+	-	+

Few pictures of orthopteran species that were found in the area were given in fig. 1 through



**Fig.2:** *Acrida cinerea*



**Fig 3:** *Atractomorpha lata*



**Fig 4:** *Locusta migratoria*

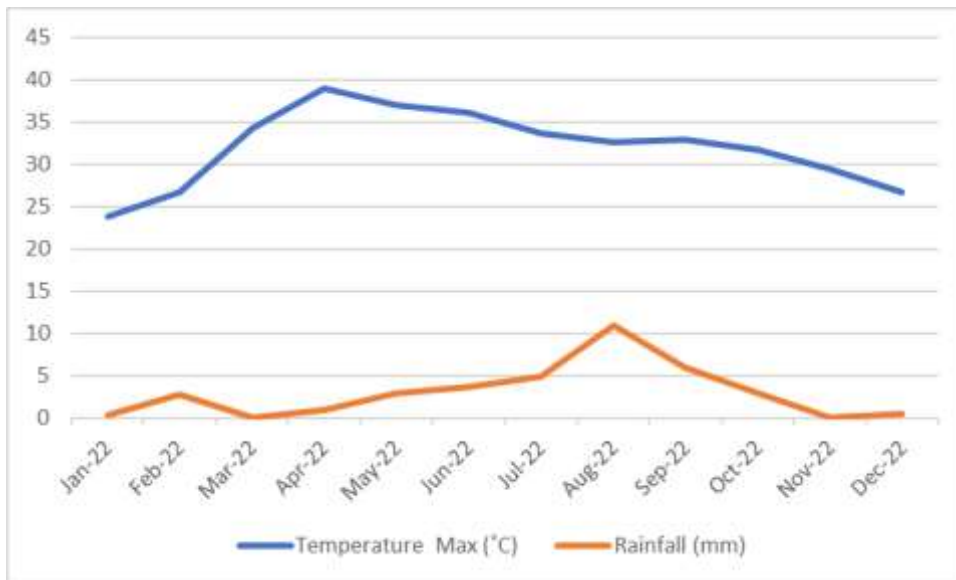


**Fig 5:** *Caelifera.*

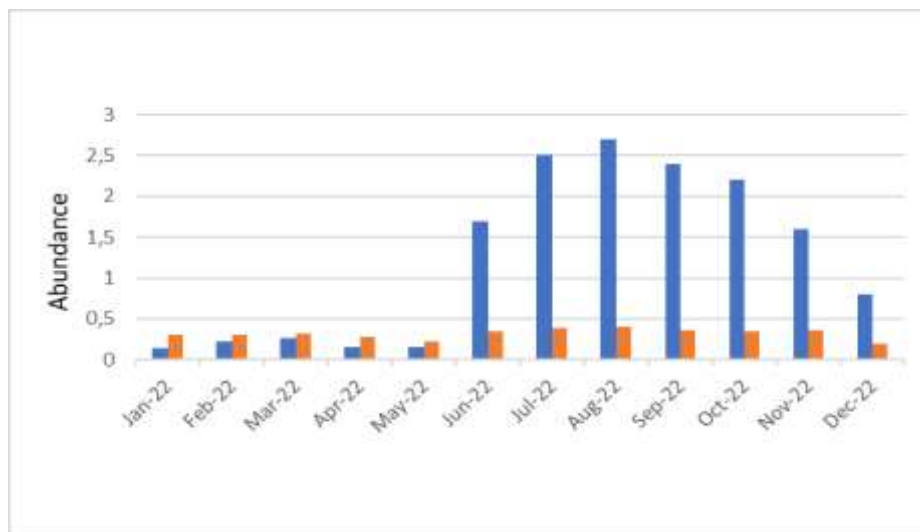


**Fig 6: Eyprepocnemidinae**

The Out of these species found they are common in both the ecological restoration sites. From the taxonomic perspective, most of the species belong to the Acrididae family—Caelifera sp. And Locusta migratoria are maximum in both sites. They are collected in huge numbers when seen by visual scanning and net sweeping methods. Their abundance has been calculated and the species shows maximum abundance in the monsoon season i.e July, august and September. In the post-monsoon season i.e in the months of October and November their diversity starts decreasing and is lowest in January. It has slightly increase in the February and march but again when the summer starts their abundance gets lowered.



**Graph 1: Temperature and Rainfall pattern of Parasnath Park and Damoda Eco restoration site**



**Graph 2: Abundance of o**  **Abundance PH**  **Abundance** da Ecological Restoration Site



The eco-restoration work on overburden dumps of Parasnath park and Damoda Ecological restoration sites is a model step for conserving the environment degraded by coal mines industries. In this study, orthopteran species were found in a good number in both ecological restoration sites. The plantation program was started in the same year on both sites, with different types of plant species. In the Parasnath ecological site tuberous plants and grasses were planted which further led to three-tier plantations. In Damoda Ecological restoration site bamboo species are dominantly planted which leads to single-tier plantation. The absence of grasses in Damoda ecological restoration sites shows low diversity of insects. Hence from this study it is also confirmed that the habitat choice of grasshoppers depends on the structure and composition of vegetation. (De Wysiecki, 2000).

Rainfall and temperature patterns were measured, temperature is maximum in April to June, the abundance of insects gets lowered. High temperatures and low green grasses lowered the insect diversity. (Zerogun, 1994) (Capinera and Horton, 1989) during the winter season December and January, due to cold-blooded and hibernating properties the diversity of insects gets lowered. (Capinera and Horton, 1989). So, the abundance of insects in these ecological restoration sites gets lowered in these seasons.

Rainfall pattern influences the diversity of insects in India and Australia. (Usmani et.al, 2010) (Hunter et.al, 2001) In the eco-restoration sites, the maximum diversity of the insects was in the month of July, August, and September. Monsoon helps to increase the green grasses which is a major food source for these primary consumers. (Joern et. al, 2012) Also host plant species composition, availability and quality also regulate the abundance of these species (Jonas et. al, 2015), since Damoda ecological restoration site has low grass species than Parasnath park so, the abundance of arthropods also becomes low.

Although these two factors don't decide the abundance of arthropods in an area, certainly many other factors like the number of predators, human influence, soil quality etc. also plays a major role.

#### **4. Conclusion**

The ecological restoration work on coal mines overburden areas was in Parasnath park and the Damoda ecological restoration area was started in 2011 with certain native as well as exotic species. The goal was to restore the degraded overburden dumps. At present both sites were fully developed to ecosystem. The study of Orthopteran shows higher diversity in Parasnath Park having three-tier plantations than damoda ecorestoration site where single-tier plantation methods have been used. Tropical climatic conditions i.e., increased temperature, rainfall and resource availability increase the abundance of species in both sites. The presence of other species like Lepidoptera and higher carnivores shows complexity in trophic levels and increases the succession process. Different kinds of recreational activities, and training of goatry, poultry, and forestry were also given by BCCL managers to the nearby people which helped them to recreate their livelihood.

#### **Acknowledgments**

The authors especially thank the officers of the Environment division, BCCL, Dhanbad for their support and help during the project. The authors give heartfelt gratitude to Mr. Somesh Ganguly for his continuous help during site visits were invaluable for the completion of the work.

**Funding Source:** This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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