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EXPLORING THE DIVERSITY OF MAJOR HEMIPTERAN SPECIES IN RAJASTHAN: IMPACTS ON LOCAL CROPS AND INTERACTIONS

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Abstract
The going with survey, "Faunal variety of different hemipterans in and around tonkrelated with Kharif crops," was done in the Kharif of 2021. The social affair of hemipteran bugs from various harvests occupied the space of district tonkand began fairly as of late July. up to the focal point of October.A sum of 2476 bugs was inspected, saved, named, and further morphological and distinguishing proof examinations were led during this time. Bug hemipteran movement crested during the 37th meteorological week (10-16 September). The yield family Gramineae had the most hemipteran bugs (761 bugs out of 2327), trailed by the Leguminosae and Malvaceae families. The diversity of bugs is gigantic and unquestionably perplexing, and they assume a critical part in the earthly biological system's useful biodiversity. The deliberate evaluation of the synthesis, overflow, and examination of staying species in unmistakable biological systems is finished through the investigation of diversity. The territory of Rajasthan is isolated into numerous temperature zones, from a parched desert in the west to a rich level in the south that has a critical diversity of bugs.

Keywords: *Hemipteran, Species, Crops,Interactions,Diversity*

1. INTRODUCTION

The bug is an extremely strong animal that was created over a significant period starting in the Devonian period. It can scatter and adjust a living space on the planet, from the jungles to the shafts. As far as both ordered diversity and biological capability, they are the most various, dynamic, and fluctuating assortment of creatures on planet 53. Bugs are significant for various biological system capabilities, including fertilization, predation, parasitism, and deterioration.

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They are useful agroecological and ecological bioindicators. Bugs radiate energy in different bearings, which are then taken up by progressive trophic levels 7, 19, and autotrophs. On a transient and spatial scale, bugs' populace and local area cosmetics are entirely factors. Ecological variables change, extensively affecting the number of inhabitants in bugs that can survive17.

Because of territory weakening, bug species intrusion, and synthetic control, the diversity of bugs has quickly declined over the beyond 20 years. Nonetheless, to satisfy maintainable improvement objectives in a worldwide setting, this attracts accentuation to the preservation of species in their normal habitat52. A standard information base for understanding the biology and species piece is given by the investigation of biodiversity, which might be helpful for future exploration. The examination of bug diversity that was attempted in a few areas of Rajasthan gives the premise for the ongoing survey.

Rajasthan is a state in the northwest of India, with an all-out size of 3,42,239 km2 and geographic scope of 23.3 to 30.12 N to 69.30 to 78.17 E. The subtropical environment is pervasive in the state's southernmost region (Banswara), where the line of Malignant growth gets through. It has unmistakable geography that differs topographically and in various ecological zones. Environments that are dry and semi-dry, with thorny and dry deciduous vegetation, keep it from developing. Both semi-parched and dry biological systems are limited by the old mountain scope of the Aravalli, which additionally separates the Thar Desert from the eastern prolific Ganges plain. It gets almost no precipitation since the Aravalli range is lined up with the Middle Eastern Ocean part of the Indian storm.

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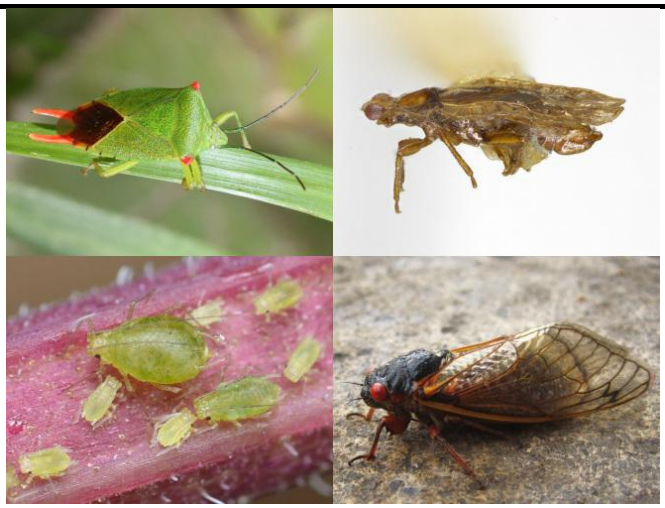

Figure 1: Hemipteran Species

As the human populace has expanded over the entire course of time, a large number of changes in every day residing, culture, innovation, science, the economy, and horticultural result have likewise occurred. Farming transformations — significant changes in rural creation — have likewise happened because of the extension of progress, innovation, and mankind all in all. However, the uncommon populace development throughout the course of recent years has had various horrible impacts that, combined with changes in the climate, affect the well-being of the food supply. By 2021, worldwide agrarian creation would probably have to fourfold to satisfy the expanded interest for crops welcomed on by the growing total populace. Various examinations have proposed that the most feasible way for guaranteeing food security is to increment crop efficiency instead of clearing more land surface for agrarian development. Environmental change and related peculiarities, for example, climbing worldwide temperatures and air carbon dioxide fixations, heat waves, flooding, serious tempests, dry spells, and other outrageous climate events, are the subject of flow logical exploration and agronomy. In this way, when the affinity to lessen yield misfortune attributable to such circumstances creates, a more noteworthy spotlight is put on the abiotic components expressed above in farming examination. Changes in precipitation examples may be more critical for crop yield than expansions in temperature, particularly in locales where dry seasons address a boundary to horticultural efficiency.

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2. REVIEW OF LITERATURE

Mathur, Sharma, and Saini (2017) explored the diversity of hemipteran species in this unusual and arid ecosystem, with a primary focus on the Rajasthani Thar Desert region. They discovered a vast range of species, demonstrating how hemipterans have evolved to survive in the difficult desert environment. The study underscored the significance of understanding how hemipterans contribute to maintaining this ecosystem's delicate balance.

The range of hemipteran insects in the agricultural ecosystems of the Jodhpur district in Rajasthan was investigated by Gaurav and Gupta in their 2017 study. This research was done to assess how hemipteran pests affected agricultural productivity. The research identified a large number of hemipteran species that are known to damage crops to lower agricultural losses. This highlights the need for effective pest management strategies.

S. Sharma and R. N. Mathur (2019). This study provides a complete overview of Hemiptera diversity and abundance in several agroecosystems in Rajasthan. The authors discuss the function of Hemiptera in ecological services, pest dynamics, and pollination. They also underline how changes in agricultural practices, the environment, and topography have influenced the hemipteran community structure.

Gupta and Arora (2019) With an emphasis on the desert ecosystems of Rajasthan, this paper offers a summary of the knowledge that is currently known about the diversity of Hemiptera in these arid settings. The authors discuss the ecological roles that hemipteran species play in the ecology of the desert and how they have evolved to survive in hostile conditions. Additionally, they highlight the threats that hemipterans can encounter as a result of habitat loss and climate change.

Mathur, Devi, and Y. (2021). This study provides a thorough analysis of the Hemiptera variety found in Rajasthan, covering a variety of habitats such as urban areas, wooded areas, and agricultural regions. The authors discuss how Hemiptera are used to control pests, how they interact with other creatures and plants, and why it is important to take conservation measures to preserve the diversity of Hemiptera in the area.

Kumar and R. Saini (2021). With a focus on the diversity and distribution of Hemiptera in Rajasthan, this research studies the richness of hemipteran species throughout several regions

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of the state. The authors examine a variety of factors related to hemipteran diversity, such as climate, habitat type, and vegetation cover. They emphasize the need for additional research to fully understand the hemipteran fauna and its ecological interactions in Rajasthan.

3. MATERIALS AND METHODS

The review site is arranged 9 kilometers fromTonkcity. It has a height of 234.70 meters above mean ocean level and is arranged at 28.01oN scope and 73.22oE longitude towardTonk. This region is essential for India's Western Dry Locale and Rajasthan's Agro Climatic Zone XIV (Hyper Dry To some extent Watered Western Plain Zone). This locale typically has a dry environment, which is set apart by little precipitation and a wide variety of summer and winter temperatures. The temperature can climb as high as 48o C in the mid-year and as low as 5o C in the colder time of year. This parcel gets 250 mm of downpour yearly, most of which tumbles from July to September. The general dampness goes from 8% to 92 %. This region is inclined to both soil disintegration and high wind speeds; high wind speeds make soil float, which thusly causes disintegration.

The review was done in the area oftonkand on research ranches possessed by the School of Farming, the Rural Exploration Station, and Master Keshwanand Rajasthan Horticultural College. During the survey period, moth beans, bunch beans, groundnuts, guava, pearl millet, cowpea, mung beans, millets, brinjal, okra, and wipe screens were created. Neem, Cheri, peepal, and other tree species enveloped the school's investigation farms.

Bug assortment nets, bug-killing jugs, forceps, hand focal points, entomological pins, drying chambers, little hair brushes, sound system zoom magnifying lenses, different shaded century papers, bug protection boxes, and so on were all essential for gathering hemipterans. Family-level distinctive evidence of the hemipteran fauna assembled during the assessments was finished in the Post Graduate Exploration place, Division of Entomology, School of Cultivating, Expert Keshwanand Rajasthan Agrarian School, tonk, during 2020-21 with the aide of the going with requested key The Division of Entomology of the School of Cultivating Science, GKVK, got a part of the models.

4. MEASURES OF DIVERSITY

To acquire data on the example of species extravagance, species overflow information was

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counted and fittingly assessed. Shannon-Weiner diversity list (1948) and Simpson's record (Simpson's, 1949) were assessed. To decide the fleeting change in the diversity of hemipteran bugs on the grounds of the S. K. Rajasthan Farming College, these diversity records were developed for every one of the information assembled over time.Below is a rundown of the diversity lists used in the examination.

4.1 Shannon- Wiener diversity index (1948)

Utilizing the accompanying recipe, Shanon's diversity list was determinedfrom the information on the found vegetation

$$.\boldsymbol{H} = -\sum_{\boldsymbol{i=1}}^{\boldsymbol{s}} \boldsymbol{Pi\ In\ (pi)}$$

H = Shannon's diversity index

Pi = ni/N N = Total number of individuals of all species

Pi = Relative abundance of species

S = Total number of specie

4.2 Simpson's index (Simpson's, 1949)

Using the going-with recipe, Shannon's diversity not entirely settled from the data of the tracked down vegetation.

$$\boldsymbol{D} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{R}} \boldsymbol{Pi}$$

D = Simpson's diversity index

R = Richness

Pi = proportion of ith species and calculated as "ni/N" where, 'ni' is the number of individuals in "ith" species and 'N' is the total number of individuals in the sample.

5. RESULTS AND DISCUSSION

The start of the Hemipteran bug gathering occurred from the last seven-day stretch of July until the center of October. A sum of 2476 hemipterans was accumulated during this time span from fields in different areas utilizing nets and handpicking saved for additional review, and a few hemipterans were gotten from light sources in the review region (table 1). A comparable report

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on the real insect (Hemiptera) fauna of the Pachmarghi Biosphere Hold in M.P., India, was completed by Chandra and Kushwaha in 2012. More than 250 real bug cases from various fields were recorded. The most recent writing, which included the Fauna of English by Far off volumes from 1902 and 1904, was used to complete recognizable proof. Regarding the continuing investigation, Chandra et al. (2012) focused on the diversity and dispersion of the hemiptera fauna of the VeeranganaDurgavati Natural Life Safe-Haven, Damoh, Madhya Pradesh (India). A total of 136 specimens of hemipteran fauna were gathered, and data from Table 1 and Figure 1 revealed that 23 different hemipteran faunal groups, including the Pentatomidae, Lygaeidae, Cicadellidae, Miridae, Delphacidae, Cydnidae, Corixide, Aleyrodidae, Alydidae, and Corei, were identified throughout the review The findings revealed that 22.90% of the entire variety of hemipteran bugs belonged to the family Pentatomidae, which includes 567 different bugs. This was the largest group of the requested Hemiptera in the kharif farming environment, and Nezaravirudala was the most common insect within this family. The second-largest family within the requested Hemiptera, Family Lygaeidae (17.12%), was in second place. There were 424 different types of bugs identified in this family, with the most noteworthy varieties being Oxycarenushylinipennis, Graptostethusquadrisignatus (Far off), Spilostethuspandurus (Scopoli), and Spilostethushospes (Fabricius). The Cicadellidae, the third-largest group of bugs with 330 members, had the Amrascabiguttula, which was the species that was most common (13.33%). With 10.14 percent of the kharif crops, the Miridae family ranked as the fourth-largest family. Family Delphacidae (6.02%) and Cydnidae (5.29%), however, revealed a modest population of hemipterans. In kharif crops, the families Membracidae (0.41%), Hydrometridae (0.20%), and Anthocoridae (0.74%) each showed a decreased hemipteran population. The most recent discoveries support those made by Henry (2009), who said that Pentatomidea, which consists of 1301 genera and 7182 species dispersed across 16 families worldwide, was one of the largest superfamilies of Heteroptera. There are 896 genera and 4722 species in the Pentatomidae family alone, which is divided into 8 subfamilies. Chandra et al. (2012) noticed eight families, including Reduviidae, Lygaeidae, Phyrrhocoridae, Coreidae, Alydidae, Pentatomidae, Dinidoridae, and Cydnidae, and expressed similar perceptions. a focus on the variety and dispersion of VeeranganaDurgavati'shemiptera fauna untethered life Safe-haven The findings are consistent with those of Kumar and Naidu

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(2010) who found that among the Hemiptera, the Pentatomidae family had the highest rate (17%), followed by the Coriedae (15%), Reduviidae (10%), Aphididae (8%), and Lygaeidae (7%) families, while the remaining 17 families had lower rates (2-5) of event. Pentatomid bugs including Halysdentatus, Eusarcocorismontivagus, Nezaragraminea, and Eucantheconafurcellata were present in all of the regions.

The family Belostomastidae and Eurybrachidae had very little fauna in the area of Akola, according to Narayan (2016), while the family Aphididae had a rich fauna throughout the review, contributing about 28.11%, followed by the Pentatomidae, Cicadellidae, and Pyrrhocoreidae.

The diversity of hemipteran fauna in the area of kharif crops in the region of tonk (Rajasthan), as estimated by the Shannon-Wiener file of biodiversity, was clearly excellent. The Pentatomidae family fauna had the least population overflow (-0.3376), according to Table 2's results, followed by the Lygaeidae (-0.3022), Cicadelidae (-0.2668), Miridae (-0.2320), Delphacidae (-0.1691), and Cydnide (-0.1555) families, which had a considerable wealth of hemipterans. However, the Hydrometridae (-0.0125), Membracidae (-0.0226), Anthocoridae (-0.0364), and Scutelleridae (-0.0389) families had a lower abundance of hemipteran species. Because of the abundance of hemipteran assemblages, tonk's kharif crops displayed a strong Shannon biodiversity record (H= 2.4825). A few workers on this project have identified the diversity indicators.

The primary feeding plants for hemipterans in horticulture areas, according to Kumar and Naidu include rice, sugarcane, pigeon pea, and gram. An incentive for hemipteran fauna in agricultural environments was (3.727) on the Shannon Weiner list. In essence, Nandini and Jadesh noticed the Shannon-Wiener list of the request Hemiptera, with a value of 1.609.

The outcomes of the current investigations are comparable to those reported by Dorlikar who noted Shannon-Weiner list values between 2.91 and 1.85.

The Shannon-Wiener record reached its highest value during the stormy season in June and its lowest value during the late spring in April.

The Shannon-Wiener diversity record was greatest before a downpour (0.58), and it was lowest after the storm (0.28), according to research by Gogoi and Guha Additionally, the Pentatomidae family fauna of the Hemipteran fauna (0.05244) shown great extravagance, followed by

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Lygaeidae (0.02932), and Cicadelidae (0.01776) demonstrated intermediate wealth, according to Table 2's Simpson's file. Simpson's record esteem was 0.1213, however the hemipteran fauna showed decreased extravagance in the Hydrometridae (0.0001), Membracidae (0.00002), Anthocoridae (0.00005), Scutelleridae (0.00007), Stenocephlidae (0.00008), and Belastomidae (0.00008) families.

Nonetheless, there is a moderate Simpson's list in tonk, Rajasthan, that shows the lavishness of hemipteran fauna in Kharif crops. Comparative discoveries were made in Meeran et al's. research, where they noticed that the Simpson's List for the lavishness and diversity of the Hemiptera request in paddy fields was 0.01.

Table 1: Family wise percent creation of hemipteran bugs on kharif crops during 2021

Suboder	Family	No.of insects Collected	Percent (%)
Heteroptera	Pentatomidae	500	21.31
Heteroptera	Lygaeida	412	25.31
Achenorrhyncha	Cicadellidae	310	22.14
Heteroptera	Miridae	325	12.51
Achenorrhyncha	Delphacidae	150	13.44
Heteroptera	Cydnida	151	15.41
Heteroptera	Corixide	82	11.96
Achenorrhyncha	Aleyrodidae	77	15.44
Heteroptera	Alydidae	69	22.33
Heteroptera	Coreidae	68	11.55
Heteroptera	Dinidoridae	50	12.11
Achenorrhyncha	Aphididae	48	18.36
Heteroptera	Reduviidae	76	17.44
Heteroptera	Pyrrhocoridae	82	19.22
Heteroptera	Geocoridae	11	20.11
Heteroptera	Rhyparochromidae	18	21.22
Heteroptera	Tingidae	45	23.22
Heteroptera	Belastomidae	16	25.41
Heteroptera	Stenocephlidae	19	28.12
Heteroptera	Scutelleridae	22	29.33
Heteroptera	Anthocoridae	25	12.11
Heteroptera	Membracidae	30	15.36
Heteroptera	Hydrometridae	39	19.23

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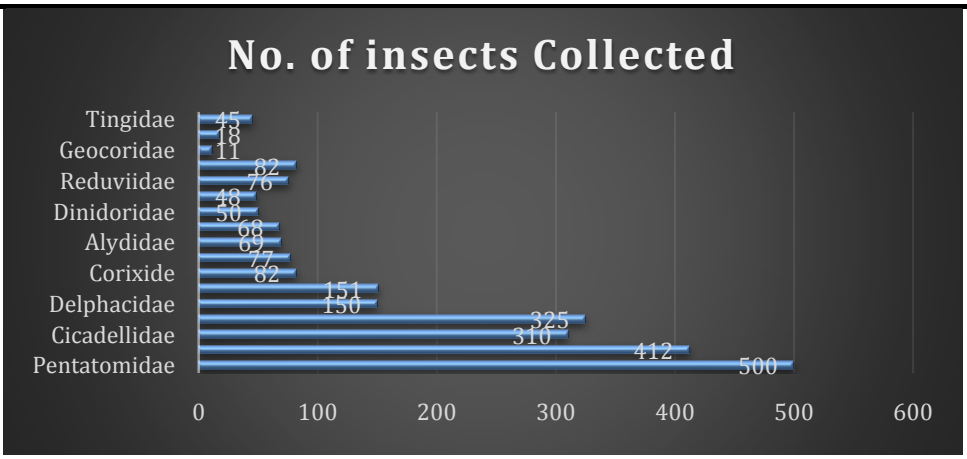

Figure 2: Family wise percent creation of hemipteran bugs on kharif crops during 2021

Table 2: Family-based Simpson index and Shannon- Wiener biodiversity index of hemipteran fauna in kharif crops in 2021

Family	Shannon's index Pi (LN (pi)	Simpson index $\sum pi^2$
Pentatomidae	-0.2285	0.14355
Lygaeidae	-0.2133	0.11845
Cicadellidae	-0.1575	0.12264
Miridae	-0.1219	0.10137
Delphacidae	-0.2582	0.11251
Cydnidae	-0.2444	0.00171
Corixide	-0.2210	0.00205
Aleyrodidae	-0.2117	0.00074
Alydidae	-0.1877	0.00089
Coreidae	-0.1812	0.00074
Dinidoridae	-0.1788	0.00053
Aphididae	-0.1617	0.00055
Reduviidae	-0.1568	0.00036
Pyrrocoridae	-0.1424	0.00024
Geocoridae	-0.1416	0.00024
Rhyprochromidae	-0.1382	0.00022
Tingidae	-0.1382	0.00022
Belastomidae	-0.1419	0.00009
Stenocephlidae	-0.1318	0.00009
Scutelleridae	. -0.1275	0.00006
Anthocoridae	-0.1436	0.00004
Membracidae	-0.1334	0.00003
Hydrometridae	-0.1036	0.00002

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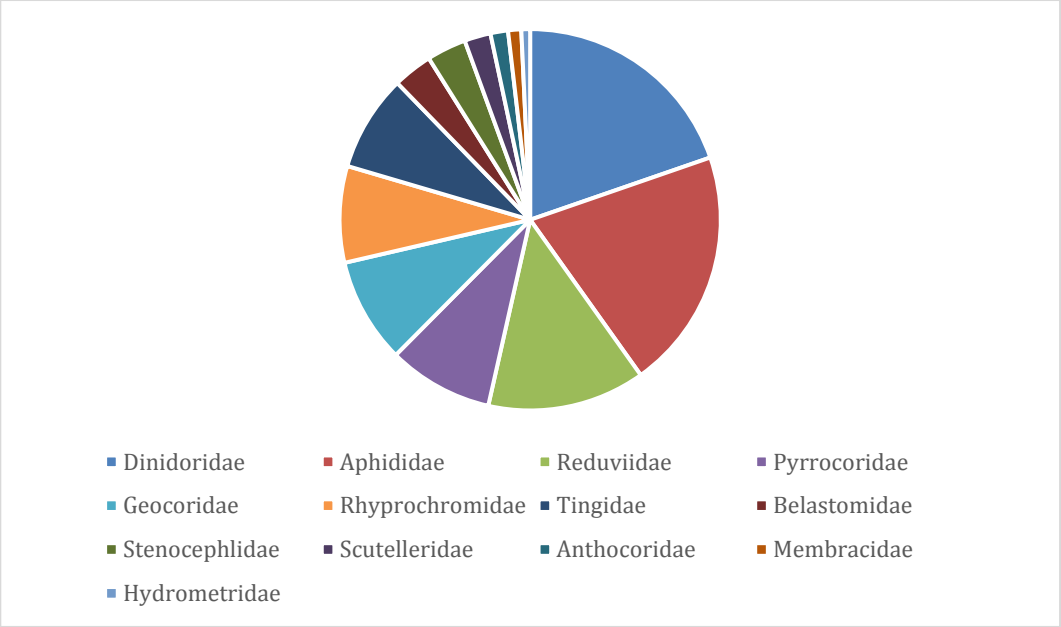

Figure 2: Indicators of hemipteran fauna Shannon- Wiener biodiversity and Simpson index, family-wise, in kharif crops in 2021

6. CONCLUSION

Tonk(Rajasthan), has a moderate Simpson's list that shows the extravagance of hemipteran fauna in kharif crops. Comparative discoveries were made in Meeran et all's. Research, where they noticed that the Simpson's Record for the wealth and diversity of the Hemiptera request in paddy fields was 0.01.The natural and climatic circumstances in Rajasthan state are profoundly shifted. The Aravalli range gets the most precipitation, has the least anthropogenic movement, and has the most safeguarded regions network out of all the ecogeographic zones in the state. Accordingly, this ecoregion, which is trailed by the Thar Desert, Eastern Plain, and Southeastern Level, displays the most elevated extravagance as far as bug faunal assortment.

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