

Diversity of insect fauna in Rajasthan, India: A Review

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ABSTRACT

Insect diversity is huge and immensely complex with making up an important component of the functional biodiversity of the terrestrial ecosystem. The study of diversity is a systematic approach to assess composition, abundance and comparison of inhabiting species in the various habitats. The Rajasthan state is divided into different climate zones from a western arid desert to a humid region of the south-eastern plateau that represents significant insect diversity. The present review aims to provide baseline information of insect diversity in four eco-geographical regions of the Rajasthan. The exact number of species is still not clear. Although, after perusal of the literature, the study revealed that there were 878 insect species and subspecies recorded belonging to 104 families and 14 orders. Among all, the order Lepidoptera is most diverse representing 234 species followed by Hymenoptera with 208 species and Coleoptera with 129 species. The maximum number of 398 species were recorded from the Aravalli range followed by 283 species in the *Thar* Desert, 225 species from the eastern plain while the Southeastern plateau is less diverse with 86 species of insects. This review will be helpful to assess the comparison and identify species data of the insect fauna for further study.

Figure : 01

References : 76

Table : 01

KEY WORDS : Abundance, Diversity, Ecoregion, Ecosystem, Insect, Rajasthan

Introduction

The insect is a much potent creature, evolved themselves through a long process of evolution, from the Devonian period and disperse and adapt themselves to every kind of available habitat on the earth, from tropics to pole. They are a diverse, dynamic and largest group animal kingdom on the earth in terms of both taxonomic diversity and ecological function⁵³. Insect plays a significant role in various types of ecosystem services like pollination, decomposition, parasitism, predation, etc. They are useful bioindicators of agroecology and environment quality. Insects radiate energy in various directions, which are captured from autotrophs to succeeding trophic levels^{7, 19}. The population and community composition of insects vary significantly, at a temporal and spatial scale. The environmental parameters vary that affect significantly the viable insect population¹⁷. In the last two decades insect diversity decline was very fast due to habitat degradation, insect species invasion, and chemical control. However, this attracts the attention towards the conservation of species in their natural habitat

to achieve sustainable goals of development in a global scenario⁵². The study of biodiversity provides a baseline database to understand the ecology and composition of the species which may be helpful for further study. The present review is based on the study of insect diversity conducted in various regions of the Rajasthan.

Rajasthan is a northwestern state of India that covers 3, 42, 239 km square area, geographically ranging from 23.3 - 30.12 N to 69.30 – 78.17 E. The line of Cancer passes through the southernmost region of the state (Banswara district), hence it is dominated by subtropical climatic conditions. It has various climate zones with differentiated topography that varies geographically. It is inhibited by arid and semi-arid climates with a thorny and dry deciduous type of vegetation. The ancient mountain range of Aravalli limits both habitats (semi-arid and arid) and separates the *Thar* Desert from the eastern fertile Ganges plain. Due to the parallel positioning of the Aravalli range to the Arabian Sea branch of the Indian monsoon, it receives very little rainfall. A comprehensive account of insect species in the Rajasthan is prepared broadly through the following geographic ecoregions-

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TABLE-1 : The documented insect fauna showing the number of species and families of various insect orders

S. No.	Order	Species/ subspecies number	Number of families	References
1	Lepidoptera	234	23	6,22,25,31,32,35-37,39,41,47,50,51,54,60,61,64
2	Coleoptera	132	17	23,31,36-38,43,50,55,62,68,70
3	Hymenoptera	216	7	3,5,10-12,18,31,33,36-37,71-74
4	Diptera	14	9	28,29,36,37,57,65
5	Hemiptera		15	13,14,36,37,50,70,75,76
6	Isoptera	51	9	45,48,49
7	Mantodea	1	1	67
8	Dermaptera	1	1	50,69
9	Neuroptera	3	2	31,36,37
10	Orthoptera	111	5	8,15,20,21,30,42,50,66
11	Odonata	80	10	4,24,27,31,44,56,59-61
12	Thysanura	3	1	16
13	Collembola	2	2	9
14	Thysanoptera	1	1	63

North Western Desert

Most part of the state is occupied by a dry and hot desert, known as the *Thar* Desert. This is populated (human settlement and cattle) and rich in biodiversity, among all hot deserts of the world. It has a great range of faunal endemism (6.4 degrees), acts as a geographical barrier to species transmission¹⁰. The animal and plant species, which occur in this ecoregion, hold a great range of xeric adaptation to minimize water loss. It has 12 districts of the northwestern region of the state, between 24° to 28° N and 68° to 71° E geographically and constitutes 61% of the total geographic area of the state. '*Luni*' is the only river that passes through it and

drains itself into the Runn of Kutchh, which connects semi-arid and arid ecosystems. The geographical structure is represented by saline lakes, dry deciduous forest grasslands, sandy dunes, inland drainage, and rocky & hilly outcrops. The Desert National Park (DNP), Jaisalmer and many other protected areas are situated in this region, established for conservation purposes of the various wild as well as endemic plant and animal species.

The diversity of insects in the *Thar* Desert was explored at various places, from time to time. In this account 9 species of valve ants belonging to 3 subfamilies were reported by Central Arid Zone Research Institute,

Jodhpur³³. At Desert National Park (DNP), Jaisalmer, 16 species of Isoptera belonging to 3 families, 3 species of Lepidoptera belonging to the 3 families, 17 species of Hymenoptera belonging to 1 family, 2 species of Mantoidea, 1 species of Dermaptera, 10 species of Acridoidea and 1 species of Grylloidea, 11 species of Odonata belonging to the 10 genera and 3 families, 7 species of ants belonging to 5 families, and 3 species of Thysanura belonging to 2 genera and 1 family were reported^{16,29,35,44,66,67,69,73,74}. The Tree species, *Prosopis cineraria* (Linn.) (*Khejri*), and *Tecomella undulata* (Sm.) (*Rohida*) are the dominating species in the north-western region of the state having great socio-economic importance. There were 26 insect pest species of Khejri and 64 insect pest species of Rohida were noticed, that revealed long-horned beetle and Curculionid beetle as the most destructive pests¹. Beetles were studied from the *Thar* Desert, with a record of 99 species belonging to 60 genera and 13 families²³. Two species as *Xenylla obscura* and *Isotomodes dagamae* of Collembola were studied at Sriganganagar district⁹. The changing pattern of insect diversity and ecology was studied after launching the Indira Gandhi canal in the *Thar* Desert⁴⁶. A comparative study of diversity and population dynamics of the insect fauna of two diverge agro-ecosystems viz. sewage irrigated and well water irrigated ecosystems at Bikaner district, was made and recorded 46 genera belonging to 5 orders⁵⁰. The ant diversity was studied at the *Thar* desert in Rajasthan and Gujrat state, with a record of 35 species belonging to 16 genera⁷¹. The insect diversity of agroecosystem at the *Thar* Desert, Bikaner district observed the family Scarabaeidae most abundant (74%), followed by Elateridae, Coccinellidae, Curculionidae, and Meloidae⁴³. Short-term surveillance of Lepidopteron fauna at an agro-ecosystem in Western Rajasthan was conducted and recorded 21 species of moth belonging to 6 families and 14 species of butterflies belonging to 4 families⁶⁴. The diversity of bee pollinator species of Khejari tree (*Prosopis cineraria*) was studied, where 15 species of pollinator bees belonging to 3 families were recorded¹². The Hymenopteran floral visitors were studied at Bikaner district in the agriculture farm and recorded 13 species which belong to 7 families³. The Lepidopteron diversity at Machiya Safari Biological Park, Jodhpur was studied, reporting 18 species of butterflies and moths belonging to 15 genera under 9 families⁴⁷. The coleopteran diversity of freshwater ecosystem was studied at various lakes and ponds in the Bikaner district, reporting 19 genera belonging to 9 families⁶⁸. The documentation of the insect fauna by employing cage and light trap at some sewage irrigated Agro-ecosystem in and around Bikaner district, recorded 97 and 40 species by using cage traps and light trap, subsequently². The

diversity of selected invertebrates fauna was studied at Tal Chhappar Wildlife Sanctuary, Churu and reported 9 species of Odonata, and 24 species of Lepidoptera insects²⁴. In addition to the study, recently a new record was added to the account of Lepidoptera diversity, as *Kaniska canace* Linn 1763⁵⁴.

Aravalli Range

The Aravalli range runs from south-west to north-east of the Rajasthan, dissects it into two halves, the western *Thar* Desert and the eastern fertile plain of river Yamuna and its tributaries. The range originates from Gujrat state and runs through Rajasthan, Hariyana upto Delhi, geographically ranging from 23°20' - 28°20' N to 72°10' - 77° E, covers 92771 sq. km area²⁶. It occupies a 9 percent area, expanded into 13 districts of the state and can be divided into three according to physical parameters, northeastern Aravalli, central Aravalli, and south western Aravalli. It is dominated by bare-out rocks and sub-tropical, dry deciduous type of vegetation, sparsely. It has great economic as well as ecological significance and several seasonal and perennial rivers originate from it. There is a wide range of protected lies in this ecoregion, which provides a niche to a large number of animal and plant species.

Comparative diversity of coleopteran fauna of Kharif pulse agriculture was studied at southern Aravalli range of Rajasthan³⁸. The Lepidoptera and Odonatan diversity studied at Mt. Abu, Rajasthan, explored 25 species of Odonata belonging to 5 families, and 187 species of Lepidoptera belonging 10 families, from different points of Mt. Abu⁶¹. There were 50 species of Orthoptera recorded in the southwestern part of Aravalli of the state¹⁵. The Orthopteran faunal diversity of sugarcane farm studied at Udaipur, Rajasthan and recorded the 32 genera of insect visitors belonging to 5 families at respective crop species⁸. The relation between the flowering plants and pollinator species of insect in man-managed agroecosystem at different crop Agro-Ecosystems near Jhunjhunu district was studied and recorded 50 insect species belonging to 25 families under 7 orders⁵⁸. The insect diversity was studied at foothills of the Aravalli range, Rajasthan that recorded 46 Odonatan species belonging to 18 families and 146 species of Lepidopteran species belonging to 17 families, respectively⁶⁰. Orthopteran insects were recorded (37 species) from various parts of Rajasthan³⁰. Aquatic insect fauna was recorded belonging to 10 families and 18 species of aquatic beetles and bugs at Pushkar Lake, Ajmer⁷⁰. The diversity of Odonates was studied at 5 districts of the southern part of the Rajasthan state, where 54 and 28 species of Zygoptera and Anisoptera were recorded, subsequently²⁷. A preliminary study was conducted on the butterflies diversity in M. L. Sukhadia

University Campus, Udaipur, recorded 33 species belonging to the 5 families⁵¹. In Ajmer, which lies in mid part of the Aravalli range of Rajasthan 77 species of butterflies were reported²². A study on floral visitor was conducted on Fennel flower at ICAR- National Research Centre on Seed Spices, Ajmer, that revealed 25 species of floral visitors belonging to 8 species of Hymenoptera, 7 species of Diptera, 3 Species of Hemiptera, 3 species of Coleoptera, 3 species of Lepidoptera, and 1 species of Neuroptera as well³⁷. The Dipteran diversity at Ajmer district observed 12 species of flies, and Culicidae was found the most dominant family⁶⁵. The pollinator diversity on cumin (*Cuminum cyminum* Linn.) at ICAR- National Research Centre on Seed Spices, Ajmer, recorded 20 species, which belong to 11 families and 6 orders of insects³⁶.

Eastern plain

The eastern plain is quite fertile, due to the presence of alluvial soil and western edge of Gangetic plain formed by river *Yamuna* and its tributaries. This region is a flat plain with alluvial soil and bad land topography of river *Chambal*. The seasonal rivers *Banganga* and *Gambhir* flow in this region and drain their water into the Ganges river system. It lies in the eastern side of the Aravalli, with mainly 9 districts and partially 3 southeastern districts of the state, covers about 23 percent of the geographic area of the state.

In this ecoregion, the floral visitor insect and floral interaction of butterflies with selected vegetation (7 nectar plant species) were studied at Keoladeo National Park, Bharatpur and reported 15 species of butterflies belonging to 5 families, visit flowers for nectar-feeding³⁹. Further, there were 71 butterflies, 30 odonates, 30 spiders, and 10 beetles species were recorded³⁴. The Ranthambhore National Park (RNP), Sawai Madhopur and the Keoladeo National Park (KNP) are major protected areas lie in this ecoregion. At RNP, Sawai Madhopur, there were 10 species of Odonata, 21 species of Isoptera under 4 genera and 2 families, 9 species of aquatic & semi-aquatic hemipteran insect, belonging to 7 genera and 5 families and 28 species of dung beetles under 11 genera were recorded^{49, 55, 59, 72, 75}. The KNP Bharatpur possesses a wetland that attracts various migratory species of birds and provides a home to aquatic and semi-aquatic species of insect as well. At KNP, Bharatpur, there were 40 species of butterflies under 7 families, and 37 species of Odonata under 25 genera and 4 families were reported^{41, 56}.

Southeastern plateau

This is more fertile with a diversified topography, mainly 4 southeastern districts and partially 3 districts constitutes 9.6 percent area of the Southeastern plateau. Mukundra Hills National Park (MHNP) is situated in this

ecoregion. This is a northward extension of the central high land (Deccan plateau), named commonly *Malwa* plateau and locally *Hadoti* plateau. River Chambal and its tributaries (Kalisindh, Aahu, Parwan, etc.) flows in this ecoregion and drain their water into the Ganges river system. It receives the highest rainfall among all four ecoregions of the state. It provides a home to various wild species as leopard, tiger, nilgai, gazelle, etc. The diversity of Hymenoptera and Odonata insect orders were studied and showed 17 species of Hymenoptera belonging to 5 families and 12 species of Odonata belonging to 2 families⁴. The diversity of butterflies was studied at Jhalawar district and recorded 20 species³². The insect diversity was studied at the Jhalawar college campus, which recorded 38 species belonging from 16 families and 7 orders³¹.

Result and Discussion

The comprehensive report of insect fauna of the Rajasthan is arranged by studying online research publications. There were 76 open access research papers related to insect diversity that were browsed on Research gate and Google scholar and others. Subsequently, a consolidated database of insect fauna was prepared using previously published literature, from 1995 to 2020. The data of species and subspecies were assembled with the location in different geographic ecoregions viz. North Western Desert, Aravalli Range, Eastern plain and Southeastern plateau. The unidentified species were excluded, while identified genera with unknown species were counted only once excluding duplicate ones.

There were a total of 878 insect species or subspecies which were reported, through above mentioned 4 geographical ecoregions of the Rajasthan state, which belong to 104 families and 14 orders (Fig.1). The order Lepidoptera that includes moths and butterflies, was found most diverse in terms of the number of species as well as families. There were 234 species reported of Lepidoptera belonging to 23 families. Out of these, family Noctuidae was most diverse having 45 species, followed by family Nymphalidae having 41 species. The maximum number of Lepidopteran species was recorded from the Aravalli range with 179 species. Hymenoptera was found the second most diverse order of insects having 208 species of 7 families. Out of these, family Apidae and Halictidae were observed most diverse having 54 and 53 species, subsequently. The maximum number, 88 Hymenoptera species were recorded from the *Thar* Desert region. The order Coleoptera that includes beetles, recorded to be having 129 species of 17 families. Out of these families, Scarabaeidae was most diverse belonging to 47 species and a maximum of 97 species were recorded from the *Thar* Desert ecoregion. The order

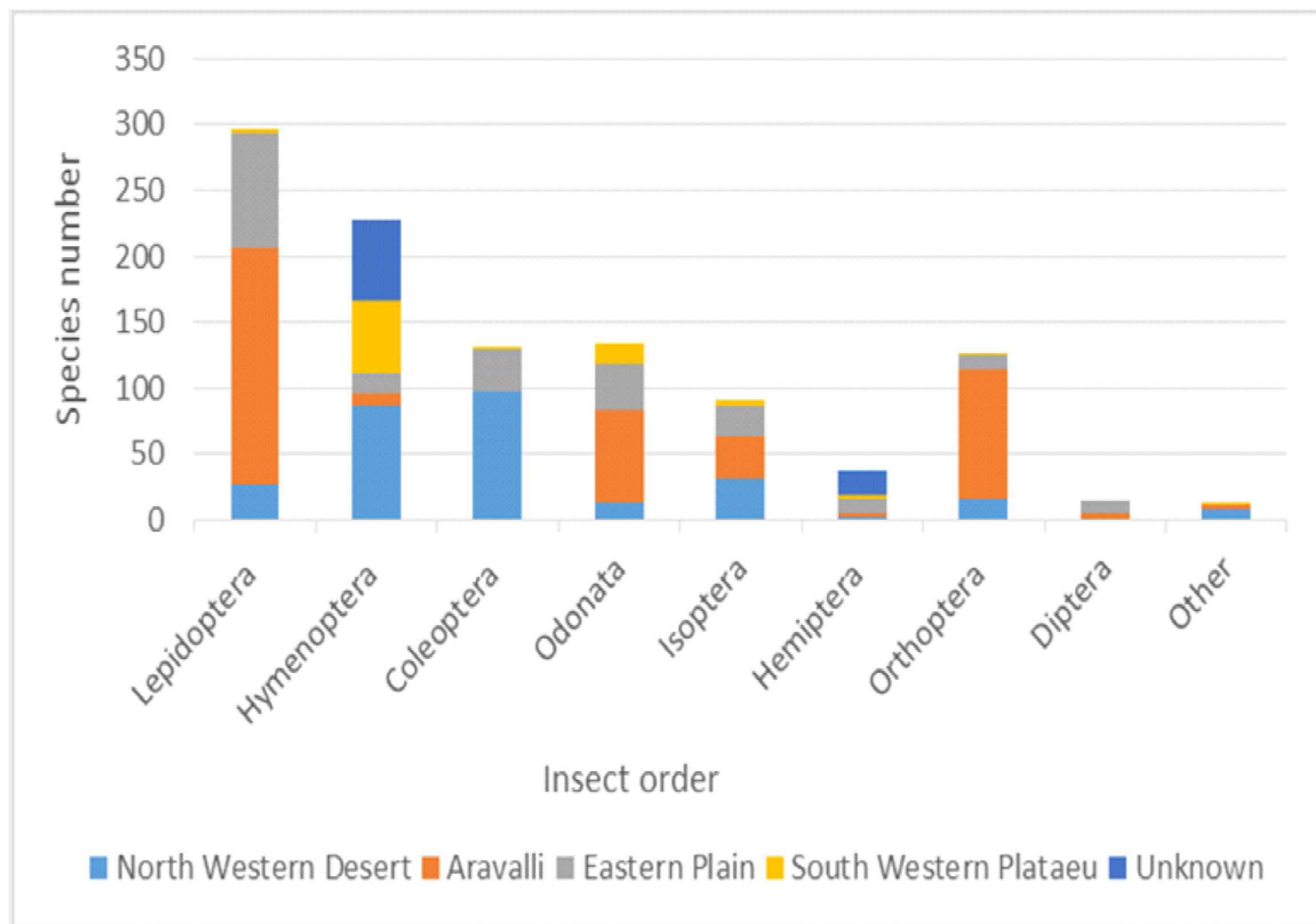


Fig. 1 : Graph showing the number of species of insect orders in different ecoregions

Odonata that includes dragonflies and damselflies, recorded 80 species belonging to 10 families. Out of these, the family Libellulidae was most diverse including 38 families. The maximum number of Odonates, 70 species were reported from the Aravalli range at the southern part of the Rajasthan. There were 51 species reported belonging to 9 families of the order Isoptera that includes white ants or termites. Among them the family, Termitidae was found most diverse having 43 species. The maximum number of Isoptera, 32 species were recorded from the *Thar* ecoregion. Hemipteran insects were recorded as having 38 species, which belong to 15 families. Out of these, the family Gerridae and Notonectidae having 6 species were observed most diverse. There were 111 species belonging to 5 families recorded of the order Orthoptera that includes grasshopper, katydids, crickets and locusts. Out of these, the family Acrididae and Pyrgomorphidae were most diverse, reporting 52 and 50 species, subsequently. The maximum number, 98 species of Orthoptera were recorded from the Aravalli range. The order Diptera that includes true flies, was reported to have 14 species under 9 families. The orders Neuroptera, Thysanura, and

Mantodea were reported having 3 species, while the order Collembola with 2 species. The order Dermaptera and Thysanoptera recorded only having one species from the desert.

In the geographical scenario, the highest number of species, **398** species recorded from the Aravalli range, followed **283** species from the *Thar* Desert, **225** species from the Eastern plain and **86** species from the Southeastern plateau, respectively (Table-1).

Conclusion

Rajasthan state is quite diversified in the ecological and climatic conditions. Among all the ecogeographic regions of the state, the Aravalli range receives high rainfall, lesser anthropogenic activities and possesses a good vegetation cover and protected areas network. Hence, this ecoregion shows the highest richness in terms of insect faunal diversity followed by *Thar* Desert, Eastern plain and Southeastern plateau, respectively.

Present knowledge and research gaps

The majority of study of insect fauna was done at only a few selected areas, like National Parks, Wildlife

Sanctuaries, etc. Although these areas are protected in nature, there is still a possibility of the occurrence of new species, beyond these protected areas. In the insect faunal diversity, the major work was done on terrestrial and day dwellings groups instead of aquatic insects and night dwelling species. Hence in the literature review, the following knowledge gaps were encountered-

1. The *Thar* Desert has a good record of insect fauna, instead of having adverse climatic conditions. The uniform sampling was not done and the remote area of the *Thar* Desert is still unexplored. There is a quite high possibility to encounter with new species with xeric adaptations.
2. The order Lepidoptera is the most studied group of insects throughout of state, while Diptera and Hemiptera are less explored. The economic insects like a pollinator, pest species were well studied, instead of invasive, endemic detritivorous species, etc.
3. Instead of insect faunal diversity, the population structure, population dynamics, community ecology, distribution, foraging behavior, energy transformation, interaction with other insect species and plants were less studied.
4. The economic groups of insects were well documented, like pollinators' species, pest species, etc., but out of these less economic groups like detritivorous, invasive, endemic species were less documented.
5. In the Aravalli range, the majority of insect study was done from the southwestern to the central region, while the northeastern region still has less documentation.

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