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First checklist of, observations on the moth diversity (Lepidoptera: Heterocera) in and around Jaipur city, Rajasthan, India

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Abstract
The present study deals with the inventorisation of moth fauna recorded from the selected habitats of the Jaipur city. A preliminary first checklist of moths of Jaipur is prepared. The study identifies 28 species of moths belonging to 28 genera from five families and 15 sub-families grouped into four superfamilies. Four sites were studied in which University of Rajasthan Campus contributed comparatively more species richness and diversity than the other sites, lowest being Mansarovar area.

Keywords: insecta, lepidoptera, checklist moths, Jaipur

Introduction
India is very rich in terms of biological diversity. 8.1% of global diversity due to its characteristic bio geographic location diversified climatic conditions and enormous ecological diversity. Insects comprise more than half of the world's well-known animal species [1] of which the second largest and more diverse order is Lepidoptera of class Insecta [2]. Major part of Lepidoptera (Gk. *Lepis* – scale, *ptera* – wing) includes moths and butterflies. Skippers also included in Lepidoptera.

Moths play a considerable role in the natural ecosystem as pollinators and as element in the food chain; on the contrary, their larvae are measured the major insect pest in agricultural fields. Latest estimation report over 1, 35, 700 species of moths from all over the world [3] of which over 12000 species were documented in India [4]. These species have created a network of trophic relationships between autotrophs and heterotrophs, which are included in the stages of larvae, pupae and adults. Larvae and pupae are links in the diets of a variety of birds and parasitic entomophagous insects. The adults are also included in food webs in a much broader range of consumers (including birds, small mammals, reptiles, etc.) [5]. The present study was carried out at four locations in Jaipur city and reflected 28 species belonging to five families and 15 sub-families. Out of the four sites studied, University of Rajasthan Campus (UoR Campus) contributed comparatively more species richness than the other sites, lowest being Mansarovar area (MSA).

Materials and Methods
Sampling sites were located in different geo-morphological territorial areas, with potentially diverse fauna. Following methods were used for collection

a. Net swiping method,
b. Light trap method,
c. Hand picking method.

The present study was carried out from October 2018 to October 2019. Moths were collected seasonally (pre monsoon, monsoon and post monsoon). Collection were made as per the methods mentioned above, following Opportunistic search in selected areas of Jaipur city viz., UoR Campus, Ramnivas Garden (RNG), Jhalana Area (JA) and MSA. The highest population of moths was recorded at UoR Campus followed by RNG, JA and MSA respectively. Sampling carried out twice in a week. For the duration of opportunistic search all the potential microhabitats i.e. leaves, tree bark, bushes, shrubs, herbs/grasses, ceiling/wall and under street light posts were searched at evening hours (6-10 pm). A 160W mercury vapor bulb over a 3x3m^2 white cloth sheet was used for light trap during the same period of time. The cloth sheet was hung between two vertical poles. The moths sitting on the white cloth were photographed by CANON 700D DSLR camera [lens 18-250mm most commonly used] and spot unidentified moths were then captured and transferred into the killing bottles saturated with ethyl acetate and later were stretched properly, dried and pinned in wooden box using entomological pins of different size. Moth were then stored carefully for further study and species identification. Wing size measurements were completed in millimeters by measuring the length of the distance between the two forewing tips. Identification was done through (Hampson, 1892, 1894, 1895, 1896) [6, 7, 8, 9]; (Bell & Scott, 1937) [10]; (Shubhalaxmi, 2018) [11]; various web resources; pictorial data and other literature were also used.

Survey and Study Sites
Surveys were conducted weekly and fortnightly at the proposed sites seasonally. Sites were selected on the basis of size, longitude, vegetation etc. using a stratified unsystematic sampling method. Sites were surveyed in random order through the field season to avoid any spatial predetermined conclusion. Mainly four sites were focused in the present study and others were visited opportunistically.

a. University of Rajasthan Campus (UoR Campus)
b. Ramniwas Garden (RNG)
c. Mansarovar Area (MSA) [Rose Garden (RG) and Woodland Park (WP)]
d. Jhalana Area (JA)

Table 1: The diversity of moths was studied in the following transects. Table shows collection of data

	Location	Vegetation	No of trap night	Specimen collected
SITE I	JA	Hilly/ Forest	6	140
SITE II	MSA	Grassland/Woodland	17	263
SITE III	RNG	Grassland Area	12	252
SITE IV	UOR Campus	Urban Area	25	451
Total			**60**	**1106**

Map showing study locations

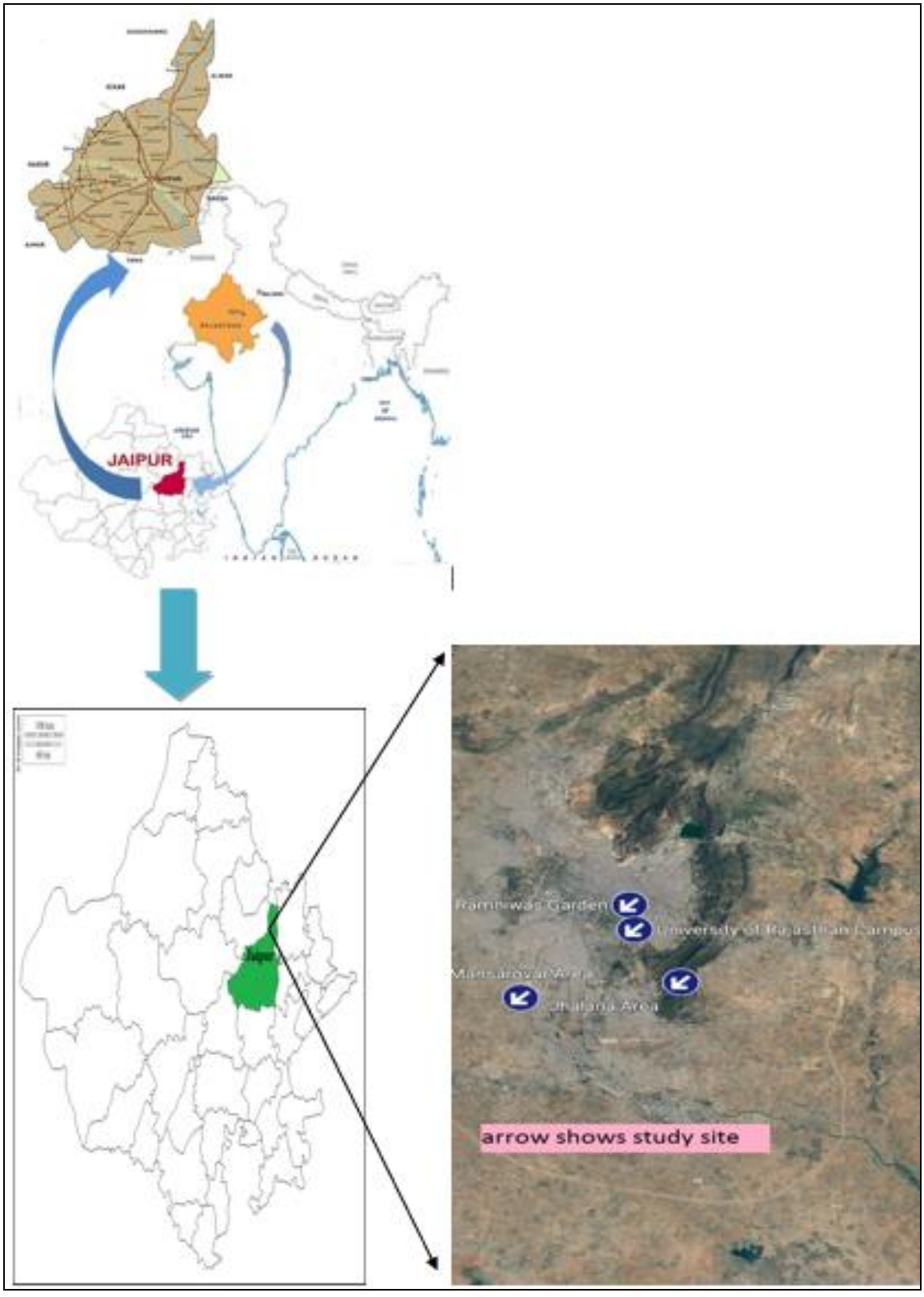

Fig 1: Locations of the study area; arrows indicate sampling areas. (Pic source: google earth, not to scale)

Different Collection Points of Sampling

Vegetation surveys: Daytime vegetation surveys were conducted within a week of each moth survey. Various sampling sites where moth collection was conducted

Fig 2

Result and Discussion

The present study is a first report for the Jaipur City of Rajasthan. The study revealed 28 species that belongs to 28 genera, five families and 15 sub-families. Few other species that are unidentified yet are not being included in the list. The list will be further updated after the final identification and comprehensive results shall be communicated in future.

Table 2: Family wise breakup of the species recorded during survey

Family	Number of Species
Crambidae	4
Geometridae	2
Noctuidae	6
Erebidae	11
Sphingidae	5
Total	28

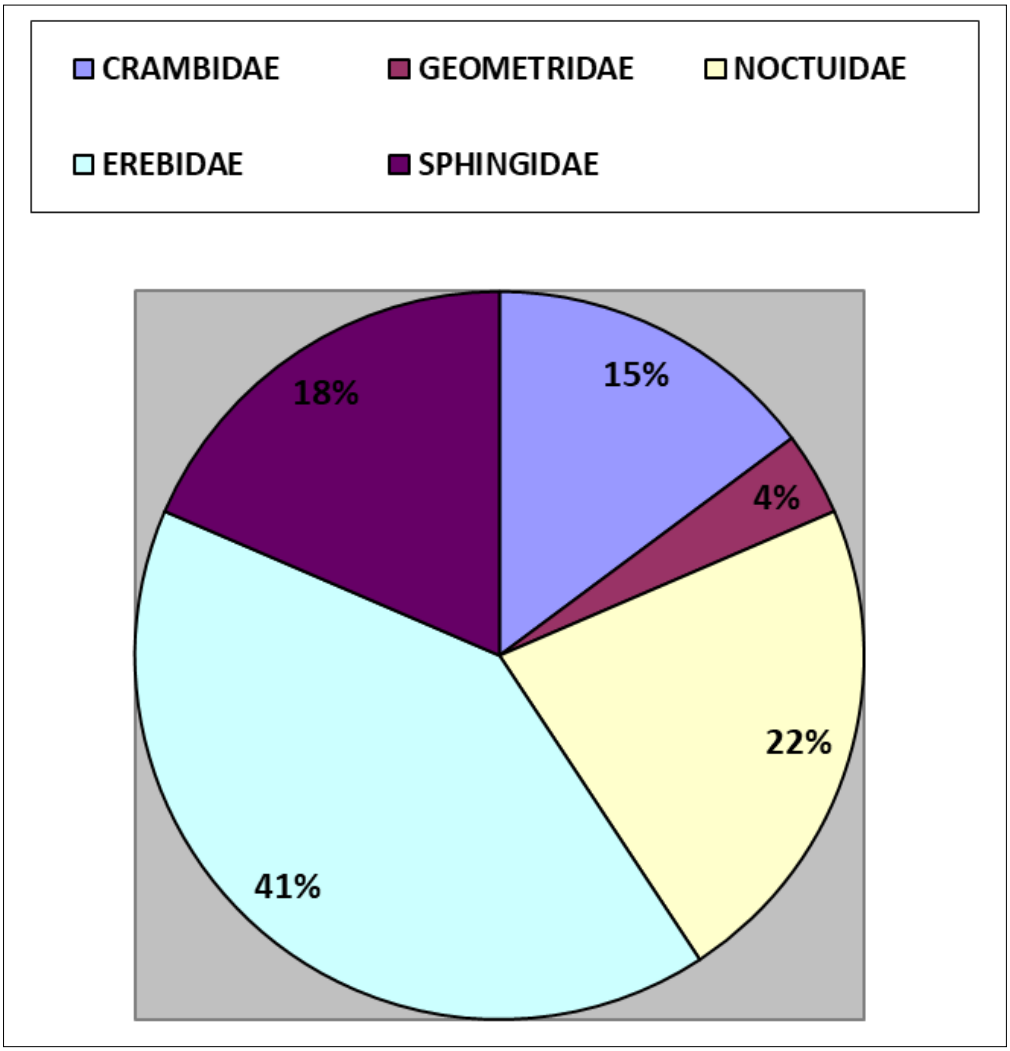

Fig 3: Pie chart depicting the number of species

Table 3: Checklist of moth species, identified from the study area:

Sr.no.	Common name	Scientific name	Family	Genera	Subfamily	Location
(Superfamily- Pyraloidea) Crambidae family						
1	Checkered Snout	*Pygospila tyres* Cramer, 1780	Crambidae	*Pygospila*	Spilomelinae	$UoR Campus
2	Cucumber Snout Moth	*Diaphania indica* Saunders, 1851	Crambidae	*Diaphania*	Spilomelinae	UoR Campus
3	Teak Leaf Roller Moth	*Sameodes cancellalis* Zeller, 1852	Crambidae	*Sameodes*	Spilomelinae	RNG
4	*Beet Webworm	*Spoladea recurvalis* Fabricius 1775	Crambidae	*Spoladea*	Spilomelinae	JA
(Superfamily- Noctuoidea) Erebidae family						
5	Large Eye Owl Moth	*Erebus macrops* Linneaus, 1770	#Erebidae	*Erebus*	Erebinae	UoR Campus
6	Grey Grammodes	*Grammodes stolida* Fabricius, 1775	Erebidae	*Grammodes*	Erebinae	UOR Campus
7	Black Triangle Moth	*Trigonodes hyppasia* Cramer, 1779	Erebidae	*Trigonodes*	Erebinae	UoR Campus
8	Orange-Underwing Thyas	*Thyas coronata* Fabricius, 1775	Erebidae	*Thyas*	Erebinae	UoR Campus
9	Castor Semi-looper	*Achaea janata* Hubner, 1823	Erebidae	*Achaea*	Erebinae	RG
10	Cramer's Passenger Moth	*Bastilla crameri* Moore, 1885	Erebidae	*Bastilla*	Erebinae	UoR Campus
11	Tirhaca Underwing	*Ophiusa tirhaca* Cramer, 1780	Erebidae	*Ophiusa*	Erebinae	UoR Campus
12	Common Owlet Moth	*Spirama helicina* Hubner, 1831	Erebidae	*Spirama*	Erebinae	UoR Campus
13	Greater Mellow moth	*Anomis fulvida* Guenee, 1852	Erebidae	*Anomis*	Scoliopteryginae Tribe-anomini	UoR Campus

14	Citrus Fruit Piercer	*Eudocima materna* Linnaeus, 1767	Erebidae	*Eudocima*	Calpinae	WP
15	Salt-Pepper Moth	*Utetheisa lotrix* Cramer, 1777	Erebidae	*Utetheisa*	Arctiinae Tribe- lithosiini	RG
Noctuidae family						
16	Candid White Glyph	*Chasmina candida* Walker, 1865	Noctuidae	*Chasmina*	Bagisarinae	UoR Campus
17	Hogweed Forester Moth	*Aegocera venulia* Cramer, 1777	Noctuidae	*Aegocera*	Agaristinae	RG
18	Lily Moth	*Polytela gloriosae* Fabricius, 1781	Noctuidae	*Polytela*	Noctuinae	UoR Campus
19	Oriental Leafworm	*Spodoptera litura* Fabricius, 1775	Noctuidae	*Spodoptera*	Noctuinae	WP
20	Cotton Bollworm	*Helicoverpa armigera* Hubner, 1808	Noctuidae	*Helicoverpa*	Heliothinae	RG
21	Tomato Looper	*Chrysodeixis acuta* Walker, [1858] 1857	Noctuidae	*Chrysodeixis*	Plusiinae	UoR Campus
(Superfamily- Bombycoidea) Sphindidae family						
22	Lesser Death's Head Hawkmoth	*Acherontia styx* Westwood, 1848	Sphingidae	*Acherontia*	Sphinginae	UoR Campus
23	Convolvulus Hawkmoth	*Agrius convolvuli* Linnaeus, 1758	Sphingidae	*Agrius*	Sphinginae	UoR Campus
24	Oleander Hawkmoth	*Daphnis nerii* Linnaeus, 1758	Sphingidae	*Daphnis*	Smerinthinae	UoR Campus
25	Celerio Hawkmoth	*Hippotion celerio* Linnaeus, 1758	Sphingidae	*Hippotion*	Macroglossinae	UoR Campus
26	Carissa Hawkmoth	*Nephele hespera* Fabricius, 1775	Sphingidae	*Nephele*	Macroglossinae	UoR Campus
(Superfamily- Geometriodea) Geometridae family						
27	Soft-line Wave	*Scopula inductata*, Guenee, 1857	Geometridae	*Scopula*	Sterrhinae	RNG
28	White Banded Moth	*Chiasmia eleonora* Cramer, 1780	Geometridae	*Semiothisa*	Ennominae	UoR Campus

*most commonly found species
[#]Erebidae is the most dominant family; [$]high species richness.

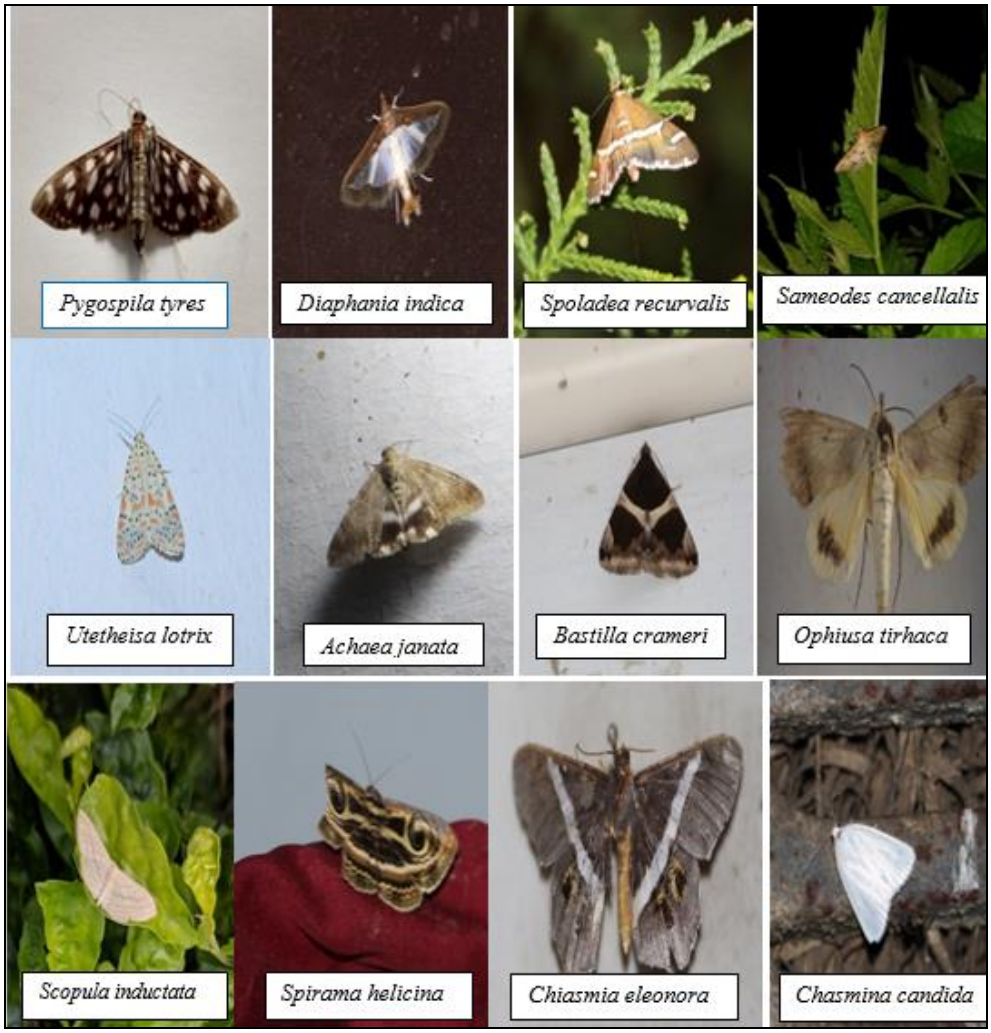

Fig 4


Erebus macrops
Aegocera venulia
A.venulia (open wings)
Grammodes stolida
Polytela gloriosae
Helicoverpa armigera
Eudocima materna
Anomis fulvida
Trigonodes hyppasia
Chrysodeixis acuta
Acherontia styx

Fig 5


Agrius convolvuli
Daphnis nerii
Hippotion celerio
Nephele hespera
Thyas coronata
Spodoptera litura

Fig 6

Conclusion

Jaipur is a fast growing city which has to strike a balance between natural biodiversity and upcoming infrastructures which is challenging for present entomologists. This paper is first report on moth status and diversity along with different land use pattern and seasonality of moth's occurrence which further encourages taking up the challenge of finding out the moth pollination network in the city along with their native host plant relationship. UoR Campus is comparatively less disturbed and pollution free whereas Jhalana Area is supporting heavy traffic. The moths are sensitive creatures and likely to be affected by pollution and population pressures. MSA is highly populated and supporting automobile exhaust all the time. This might be the reason for comparatively lower species occurrence in Mansarovar area.

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