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A preliminary study on the moth diversity of Ranjit Sagar conservation reserve of Punjab

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Abstract
We present the preliminary studies on Moth diversity of Ranjit Sagar Conservation Reserve, Punjab. The survey was conducted in the monsoon months of August 2021. A total of 59 species of moths were recorded from Ranjit Sagar Conservation Reserve, Punjab. The present paper deals with the preliminary data collected during the one survey tours conducted in this conservation reserve. During the study period 57 species, 51 genera, 20 subfamilies and 09 families moths were recorded from Ranjit Sagar Conservation Reserve. These include Cossidae, Crambidae, Erebidae, Drepanidae, Eupterotidae, Geometridae, Noctuidae, Nolidae and Notodontidae. The family Erebidae is found to be dominating with 6 subfamilies 16 genera and 19 species followed by Geometridae, Crambidae and Noctuidae.
Along with this study, future studies on similar lines will help documenting the more moth diversity from the Ranjit Sagar Conservation Reserve of district Pathankot of Punjab state.

Keywords: Lepidoptera, moths diversity, Ranjit Sagar conservation reserve, Punjab

Introduction
Ranjit Sagar Dam Conservation Reserve N $32^0$434966' E075^0 778962 is one of the important Dam of India and situated on the Ravi River on the border of two states Punjab and Jammu and Kashmir. The Punjab Government in 2017 declared the Ranjit Sagar Dam is Conservation Reserve of protection of the faunal diversity in and around the dam areas and bring under the Indian Wild Life Protection Act (1972). Ranjit Sagar Dam, also known as the Thein Dam, is part of a hydroelectric project constructed by the Punjab Irrigation Department on the Ravi River. The dam is around and equidistant 30 km from both Pathankot in the state of Punjab and Kathua in Jammu and Kashmir. The project is used for both irrigation and power generation (Fig 1: Plates). The project is the largest hydroelectric dam in Punjab. Also, the dam is amongst the highest earth-fill dams in India and has the largest diameter penstock pipes in the country.
Ranjit Sagar Dam exhibits an enormous diversity of habitats including garden, lake, agricultural land, grassland and bushes having a large number of trees, shrubs, herbs and climbers. The campus gardens and streets are filled with a wide variety of vascular and medicinal plant species like *Azadirachta indica*, *Acacia* spp., *Ailanthus excelsa*, *Cassia* spp., *Cedrus deodara*, *Dalbergia sissoo*, *Mangifera indica*, *Tamarindus indica*, *Tectona grandis*, *Terminalia* spp., *Quercus* spp., *Ziziphus glaberrima* etc.
The order Lepidoptera consists of moths and butterflies, which constitute about 1, 57,424 described species under 15, 578 genera (Van Nieukerken *et al*., 2011) [40] globally. Recent estimate suggests there are about 1, 27,000 species of moths worldwide, over 10,000 to 12, 000 species are recorded from India (Chandra and Nema 2007; Smetacek 2013) [4, 13].Moths are extensively spread terrestrial organisms and have inhabited practically all types of environments. Due to their ecological importance as pollinators, primary consumers, nutrients cyclers and climate change indicators (Kitching *et al*., 2000)[17], they play significant role in the ecosystem (Smetacek and Kitching 2012; Chandra and Sambath 2013; Sivasankaran *et al*. 2017). [34, 5, 32]. Moths are among the most diverse organisms on the Earth, found in many colours, shapes and sizes. They require food in liquid form; their survival depends on nectar that is produced in flowers and also extra-ripe fruits (Sondhi and Sondhi 2016; Lees and Zilli 2019) [35, 18]. Moths play an important role in ecosystems, acting as a pollinator, a food source and an indicator of the ecosystem's well- being. Moths play a major role in pollinating night blooming flowers (Singh *et al*. 2017) [28].
Moths are pests of a number of economically important plants, cause considerable losses to national economy because of their polyphagous in nature, and feed on a diverse agriculture,

horticulture and forest plants (Beeson 1941; Browne 1968; Nair, 2007; Sharma 2008; Paunikar *et al*. 2021) [1, 3, 19, 26, 22]. Moths are one among the major indicator groups of different habitat of ecosystem. Hence, inventorying and documenting of this group results such as seasonal abundance, species richness and diversity and range and distribution of species which together help devise strategies for the conservation and management of insect biodiversity, especially moths (Sondhi *et al*. 2018; Dar *et al*. 2020) [36, 6]

The studies on moth fauna of Punjab were initiated by Hampson (1892; 1894; 1895; 1896) [7, 8, 9, 10] followed by the contribution of Bell and Scott (1937) [2]. Further studies from several researchers have contributed to the knowledge of moth diversity of the different districts and wildlife sanctuaries of the state. The significant contribution given on the studies in the different families of moth fauna from the state by (Pajni and Rose 1978) [20], (Pajni *et al*., 1985) [21], (Walia and Pajni 1987) [39], (Kirti and Rose 1992) [13], (Rose 2001) [25], (Pathania *et al*., 2006, 2014) [23, 24], (Sood *et al*., 2009) [37] , (Kaleka 2010) [11], (Singh *et al*., 2017) [28], (Singh *et al*., 2019) [29], (Singh *et al*., 2021) [30].

But not much information on the moth fauna of Ranjit Sagar Conservation Reserve which is one of the most important Conservation Reserve of Punjab. The present study has prepared a preliminary checklist of moths found in the monsoon season from Ranjit Sagar Conservation Reserve of the district Pathankot and focused on their diversity status. This study reports for the first time the diversity status of moth fauna in the monsoon months from Conservation Reserve of Punjab.

Material and Methods

The survey was conducted in order to collection of moth fauna from Ranjit Sagar Dam Conservation areas of Punjab on August 2021. Moth collection was carried out from evening onwards till morning on next day by using Light Trap (Fig 2: Plates). The moths collected were killed by ethyl acetate and later pinned in insect stretching board. All specimens were preserved in airtight insect box, having naphthalene balls as fumigant (Swafvan and Sureshan 2021) [38]. Each specimen was provided with a label indicating the locality and date of collection. The identification of moths was carried out in Entomology laboratory at Zoological Survey of India, Northern Regional Centre, Dehradun with help of identified specimens and available literature Hampson (1892, 1894, 1895 and 1896) [7, 8, 9, 10], Bell and Scott (1937) [2], Kirti and Singh (2015, 2016) [14, 15]; Shubhalaxmi (2018) [27], Kirti *et al*. (2019) [16] and other published literatures.

Results and Discussion

In the present study, an effort has been made to prepare preliminary list of moths from Ranjit Sagar Conservation Reserve of district Pathankot, Punjab. The present paper deals with the preliminary data collected during the one survey tours conducted in this conservation reserve. A total number of 142 examples of adult moths were collected and identified in around 52 species under 44 genera belonging to 8 different families presented in the Table (Fig 3: Plates).

During the study period, 57 species, 51 genera, 20 subfamilies and 09 families moths were recorded from Ranjit Sagar Conservation Reserve. These include Crambidae, Erebidae, Drepanidae, Eupterotidae, Geometridae, Noctuidae, Nolidae and Notodontidae. Moths from families Erebidae (19) and Geometridae (14) occurred more frequently than species from following families, Crambidae (9), Noctuidae (7), Eupterotidae (2), Nolidae (2).Notodontidae (2) Cossidae (1) and Drepanidae (1). Three families, Crambidae, Erebidae and Geometridae, represented more than 80% of all documented species. The dominance of these families in other parts of Punjab has also been recorded by (Singh *et al*., 2019) [29].

Several reports are available on the moth fauna from different district and wildlife sanctuaries of Punjab. But, this is the first preliminary report on moth diversity of Ranjit Sagar Conservation Reserve, Pathankot district of Punjab. Rose (2001) [25] has given the inventory of the Geometrid moths from Patiala district, Punjab. Kaleka and Rose (2001) [12] studied the tiger moths under the family Arctiidae from Shivalik of Punjab. Recent year, some lepidopterist has given the significant contribution in the moth fauna of Punjab. Pathania *et al*. (2006) [22] studied on the Gelechiid diversity from Shiwalik hills of north-western Himalaya. Sood *et al*. (2009) [37] reported new species of the genus *Zamarada* Moore under Geometridae family from Shivaliks in Punjab. Kalka (2010) [11] reported 24 species, 11 genera of the family lymantriid moth diversity of Punjab. Pathania *et al*. (2014) [23] studied on the micromoths diversity of Takhni Rehmapur Wildlife Sanctuary, Hoshiyarpur. Singh *et al*. (2017) [31] studied on the selected economically important Pyraloidea of Punjab. Singh *et al*. (2019) [29] reported 486 species of moths belonging to 352 genera under 35 families of 15 super families from different districts of Punjab. Recently, Singh *et al*. (2021) [30] reported 17 species moths under 5 families from Lalwan Community Reserve of Punjab.

The present study will provide a baseline data of moths of Ranjit Sagar Conservation Reserve of Punjab, which can be used in planning the conservation strategies and management plans for this conservation reserve. More surveys are needed in the area so that a complete moth fauna from the conservation reserve can be compiled.

Table 1: Preliminary list of Moth fauna of Ranjit Sagar Conservation Reserve

Sr.	Family	Subfamilies	Genus	Species with Author description
1	Cossidae	Zeuzerinae Boisduval, 1828	*Zeuzera*	*multistrigata* Moore, 1881
2	Crambidae Latreiille, 1810	Spilomelinae Guenee, 1854	*Bradina*	*diagonalis* Guenee, 1854
3			*Cnaphalocrocis*	*medinalis* Guenée, 1854
4			*Diaphania*	*indica* Saunders,1851
5			*Parotis*	*marginata* Hampson, 1893
6			*Cydalima*	*laticostalis* Guenee, 1854
7			*Conogethes*	*punctiferalis* Guenée, 1854
8			*Agrotera*	*scissalis* Walker, 1865
9			*Orphanostigma*	*abruptalis* Walker, 1854
10		Pyraustinae Meyrick, 1890	*Spoladea*	*recurvalis* Fabricius, 1775

11	Drepanidae Meyrick, 1895	Cyclidiinae Warren, 1922	*Cyclidia*	*substigmaria* Prout, 1918
12	Erebidae Leach, 1815	Arctiinae Leach, 1815	*Amata*	*passalis* Fabricius, 1781
13			*Barsine*	*orientalis* Černý Pinratana, 2009
14			*Brunia*	*antica* Walker, 1854
15			*Creatonotos*	*gangis* Linnaeus, 1763
16			*Creatonotos*	*transiens* Walker, 1855
17			*Cyana*	*puella* Drury, 1763
18			*Olepa*	*ricini* Fabricius, 1775
19			*Syntomoides*	*imaon* Cramer, 1779
20			*Spilarctia*	*obliqua* Moore, 1872
21		Aganainae Lafontaine & Fibiger, 2006	*Asota*	*caricae* Fabricius, 1775
22		Erebinae Leach, 1815	*Achaea*	*janata* Linnaeus, 1758
23			*Achaea*	*serva* Fabricius, 1775
24			*Pericyma*	*cruegeri* Butler, 1886
25			*Mocis*	*frugalis* Fabricius, 1775
26		Herminiinae Leach, 1815	*Simplicia* spp.	
27		Hypeninae Herrich-Schaffer, 1851	*Dichromia*	*sagitta* Fabricius, 1775
28		Lymantriinae Hampson, 1893	*Lymantria*	*marginata*, Walker, 1855
29			*Lymantria*	*disper* Linnaeus, 1758
30			*Orvasca*	*subnotata* Walker, 18565
31	Eupterotidae Swinhoe, 1892	Eupterotinae Forbes, 1955	*Eupterote*	*undata* Blanchard, 1844
32			*Eupterote*	*gardneri* Bryk, 1850
33	Geometridae Leach, 1815	Ennominae Duponchel, 1845	*Chiasmia*	*eleonora* Cramer, 1780
34			*Cleora*	*cornaria* Guenee, *1858*
35			*Biston*	*suppressaria* Guenée, 1858
36			*Gonodontis*	*clelia* Cramer, [1780
37			*Hyperythra*	*lutea* Stoll, 1781
38			*Hyposidra*	*talaca* Walker, 1860
39			*Zaheba*	*aureata* Moore, 1887
40			*Zamarda*	*excisa* Hampson, 1892
41		Geometrinae Leach, 1815	*Agathia*	*lycaenaria* Koller, 1848
42		Sterrhinae Meyrick, 1892	*Antitrygodes*	*cuneilinea* Walker, 1863
43			*Chrysocraspeda*	*olearia* Guenee, 1857
44			*Problepsis*	*vulgaris* Butler, 1889
45			*Scopula*	*mecysma* Swinhoe, 1894
46			*Traminda*	*mundissima* Walker, 1861
47	Noctuidae	Aediinae Beck, 1960	*Aedia*	*leucomelas* Linnaeus, 1758
48		Noctuinae Latreille, 1809	*Agrotis*	*ipsilon* Hufnagel, 1766
49			*Helicoverpa*	*armigera* Hubner, 1808
50			*Spodoptera*	*litura* Fabricius, 1775
51			*Spodptera*	*pectan* Guenee, 1853
52		Plusiinae Boisduval, 1829	*Thysanoplusia*	*orichalcea* Fabricius, 1775
53			*Chrysodeixis*	*eriosoma* Doubleday, 1843
54	Nolidae Bruand 1847	Chloephorinae Stainton, 1859	*Gabala*	*polyspilalis* Walker, 1866
55		Eligminae Mell, 1943	*Selepa*	*celtis* Moore, 1860
56	Notodontidae Stephens, 1829	Phalerinae Butler, 1886	*Phalera*	*goniophora* Hampson, 1910
57			*Phalera*	*grotei* Moore, 1859

Fig 1: Plates: Ranjit Sagar Conservation Reserve

Fig 2: Plates: Light traps installed at Ranjit Sagar Conservation Reserve

Fig 3: Plates: Moth diversity of Ranjit Sagar Conservation Reserve, Pathankot district, Punjab

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