Moths (Insecta: Lepidoptera) of Delhi, India: An illustrated checklist based on museum specimens and surveys

J. Komal‡, P. R. Shashank‡, Sanjay Sondhi§, Sohail Madan¶, Yash Sondhi¶, Naresh M. Meshram#,
S. S. Anooj‡

‡ National Pusa Collection, Division of Entomology, ICAR-Indian Agricultural Research Institute, New Delhi, India
§ Titli Trust, 49 Rajpur Road Enclave, Dhoran Khas, near IT Park, P.O. Gujrida, Dehradun, Uttarakhand, India
¶ Conservation Education Centre - ABWLS, Delhi Asola Bhatti Wildlife Sanctuary, Near Karni Singh Shooting Range, New Delhi, India
# Department of Biology, Florida International University, Miami, Florida, United States of America

Corresponding author: P. R. Shashank (spathour@gmail.com)

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Abstract

Background

There have been several recent checklists, books and publications about Indian moths; however, much of this work has focused on biodiversity hotspots such as North-east India, Western Ghats and Western Himalayas. There is a lack of published literature on urban centres in India, despite the increased need to monitor insects at sites with high levels of human disturbance. In this study, we examine the moths of Delhi, the national capital region of India, one of the fastest growing mega-metropolitan cities. We present a comprehensive checklist of 338 moths species using 8 years of light trapping data (2012-2020) and examining about 2000 specimens from historical collections at the National Pusa Collection of ICAR-Indian Agricultural Research Institute, New Delhi (NPC-IARI) spanning over 100 years (1907-2020). The checklist comprises moths from 32
families spanning 14 superfamilies with Noctuoidea (48.5%) and Pyraloidea (20.4%) being the the two most dominant superfamilies. We provide links to images of live individuals and pinned specimens for all moths and provide detailed distribution records and an updated taxonomic treatment.

**New information**

This is the first comprehensive annotated checklist of the moths of Delhi. The present study adds 234 species to the biodiversity of moths from Delhi that were not reported previously, along with illustrations for 195 species.

**Keywords**

species checklist, biodiversity inventory, Pusa, Heterocera, India

**Introduction**

Lepidoptera Linnaeus, 1758 which includes butterflies and moths, is one of the largest insect orders consisting of 45 super families and having 157,424 species described (Van Nieukerken et al. 2011). It constitutes 10% of the total described species of living organisms (Mallet 2007). Of these, moths form roughly 85% of all known Lepidoptera, with over 12000 known species of moths from the Indian subcontinent (Chandra 2007). Moths are ecologically and economically significant as a primary food source for vertebrate insectivores, as pests of crop plants (Common 1990), pollinators (MacGregor et al. 2015), food for humans (Zagrobelny et al. 2009) and model organisms in scientific research (Roe and Just 2009). Nevertheless, the recent reports on insect decline are alarming and it is also evident in decline in moth diversity and abundance around the world (Hallmann et al. 2020). Numerous factors contribute to the decline of moths, such as rapid urbanisation, habitat loss, artificial light, intensive agriculture, pesticide pollution and lack of conservation policies (Dennis et al. 2019). These reports on global insect declines highlight the need for better conservation and management; however, they need to occur in tandem with ongoing monitoring and cataloguing of insects. Much of the work on Indian moth fauna was done pre-independence, including Hampson (1891), Hampson (1892), Hampson (1894), Hampson (1895), Hampson (1896), Fletcher (1920), Fletcher (1932), Fletcher (1933), Moore (1880), Moore (1882), Moore (1884), Bell and Scott (1937) and while they are extensive contributions to Indian moth fauna, these works are in need of a systematic update with additional modern surveys and current taxonomy. The more recent studies on moth fauna by Indian authors have been growing in number and include surveys, based checklists on the moth fauna of specific regions, viz. Mathew and Rahmathulla (1995) (Silent Valley National Park, Kerala, 318 species), Rose (2002) (Jatinga, Assam, 81 species), Shubhalaxmi et al. (2011) (northern Western Ghats, 418 species), Gurule and Nikam (2013) (northern Maharashtra, 245 species), Sondhi and Sondhi (2016) (Garhwal, Uttarakhand, 248 species), Singh et al. (2017) (North East Jharkhand, 81 species), Dey et
there has been much less work done from regions with higher levels of human disturbance or metropolitan cities in India.

In this study, we focus on the moth fauna of Delhi, the National capital territory of India, one of the largest growing metropolitan centres in the world with an estimated population of 23 million (MPD 2021). Delhi, with a geographical coverage of 783 km², extends on the western bank of River Yamuna between 28°12' and 28°53' N latitude and 76°50' and 77°23' E longitude and is bound on the northeast by the Indo-Gangetic plain and on the southeast by the Thar Desert (Dakshini 1968). The prominent component of the natural vegetation is the Delhi Ridge forest which is an outcrop of the Aravali Hills, one of the oldest chains of hills in the world. Open scrub forest, classified under the Tropical Dry Thorn Forest type (Champion and Seth 1968), covers a large extent of the ridge. Such vegetation type is widely distributed in the arid and semi-arid zones of the Earth where the total annual rainfall ranges from 50-100 mm. Tree species commonly found in Delhi, in such vegetation include, *Acacia leucopachia*, *Prosopis cineraria*, *Ziziphus nummularia*, *Anogeissus pendula* etc. (Maheshwari 1953, Maheshwari 1963). Additionally, *Prosopis juliflora*, an exotic species introduced, as part of the afforestation drive, also dominates this thorny vegetation (Sinha 2014). Another prominent feature of the natural vegetation in Delhi is the Dichanthium-Cenchrus-Lasiurus grasslands (Dabadghao et al. 1973). The fertile alluvial plains of the State support agricultural crops which also influence the moth diversity of the region by favouring many heteroceran agricultural pests. Donahue (1966), in his study of Butterflies of Delhi, identified two distinct habitats in Delhi: the arid xerophytic Aravalli Ridge (Delhi Ridge) and mesophytic urban nursery area. Though the city is a highly urbanised landscape with a human population of about 16.75 million (as per 2011 census), it holds a forest cover of about 13.18% (Forest Survey of India 2019), one of the largest percentages of forest cover when compared to other Indian cities. This, along with factors like the presence of the Yamuna River and its nearness to the Himalayas, adds to factors that augment biodiversity of the area. Much of the rainfall in Delhi is received during the months of July to August during which the otherwise dry vegetation shows luxuriant growth and supports the insect diversity.

In general, the insect fauna of Delhi has received less attention with only very few groups like butterflies (Lepidoptera) (Biswas et al. 2017) and Odonata (Nazneen 2019) being well documented. The studies on moth fauna of Delhi were always insufficient, the State fauna series of Delhi, published by the Zoological Survey of India in the year 1997, included only 11 species of moths (Ghosh and Varshney 1997). Later, after two decades, Paul et al. (2016) added 36 species of moths to the biodiversity of Delhi which included mostly agricultural pests. The recent checklist of moths of Delhi consists of only 74 species (Paul et al. 2017, Paul 2021).
There are limited studies in India that have utilised moth collections preserved in museums and none that have integrated this with primary survey data and secondary data from literature and citizen science projects. In the present work, we have studied the moth collections at National Pusa Collection, Division of Entomology, ICAR-Indian Agricultural Research Institute, New Delhi (NPC-IARI) which is one of the four important Lepidoptera collections in India (Smetacek 2011). NPC houses over 0.4 million specimens, comprising 56000 specimens of Lepidoptera representing 3300 species. NPC has an illustrious history in agriculturally important insect pest collection. Famous lepidopterists such as T.B. Fletcher and Edward Meyrick, worked on these collections prior to India’s independence. However, after independence, there are only a few experts on moths who could visit and work on these collections. In the current study, we studied all the moths that are collected from Delhi housed in NPC-IARI, including our own observations from 2012-2020 and data from different citizen science portals. An illustrated checklist of the 338 moths found in Delhi, along with up-to-date taxonomic treatment, are presented.

**Materials and methods**

**Museum specimens**

In the present study, the biodiversity of moths of the region was studied by an exhaustive exploration of the museum holdings of the National Pusa Collection, Department of Entomology at ICAR-Indian Agricultural Research Institute, Delhi (NPC-IARI) which is one of the largest insect repositories in Asia for agricultural pests since the 1900s. The specimens of moths belonging to Delhi were sorted separately for the present study. A database has been created from individual specimens, based on label data including the name of the collector, date of collection, method of collection, associated host plants and sex. This includes more than 1500 specimens since 1907 up to 2020 which can be accessed at *Moths of Delhi, India dataset*. Furthermore, identification and reconfirmation of all the specimens was done and were updated to their current taxonomic positions. All the representative species were photographed with a Cannon 70D with a 100 mm macro lens. The micromoths were photographed with a digitalised camera Leica DFC 425C on the Leica 19205FA Stereozoom Automountage microscope.

**Field surveys**

Field surveys were conducted from 2012 to 2020 by setting up light traps at different locations, viz. the Indian Agricultural Research Institute (ICAR- IARI), Pusa (28.04°N, 77.12°E), Rashtrapathi Bhawan (28.61°N, 77.19°E) and Asola Bhatti Wildlife Sanctuary (28.4762°N, 77.23°E). This accounted for a total of 73 survey nights. The light traps were set after sunset during the evening hours generally for 5 hours from 6 to 11 PM using a Mercury vapour bulb of 160 W. Most of the time, electrical mains were available for surveys, but a portable diesel-based generator was used to set the light traps at the locations without a source of electricity. All the moths were photographed in the field using a Cannon 70D with a 100 mm macro lens.
Identification and preparation of checklist

The available literature was used to identify the moths, including Barlow (1982), Holloway (1999), Holloway (1998), Holloway (1996), Holloway (1993), Holloway (1989), Holloway (1986), Holloway (1987), Holloway (1983), Holloway (1985), Holloway (2003), Holloway (2011), Holloway (1997), Holloway (1988), Bell and Scott (1937), Kononenko and Pinratana (2005), Kononenko and Pinratana (2013), Moore (1880), Moore (1882), Moore (1884), Schintlmeister and Pinratana (2007), Zolotuhin and Pinratana (2005), Kirti and Singh (2015), Kirti and Singh (2016), Kendrick (2002), Hampson (1891), Hampson (1895), Robinson et al. (1994) and Inoue et al. (1996).

Along with the above museum collection data and surveys, additionally, data from citizen science internet portals, such as the Moths of India (http://www.mothsofindia.org; Sondhi et al. 2021), iNaturalist (https://www.inaturalist.org) and India Biodiversity (http://indiabiodiversity.org), were also used to prepare the checklist. For a few morphospecies, we could not identify up to species and we have mentioned only genera name and numbers.

Finally, a comprehensive checklist has been prepared by including all the data from museum specimens, field surveys, available literature and citizen science portals. The classification system used by Van Nieukerken et al. (2011) was followed. Systematic arrangement was made alphabetically, the checklist being presented below with notes mentioning previous reports. Additional data related to materials studied can be accessed here: http://ipt.pensoft.net/resource?r=moths_of_delhi&v=1.8. Representative species photographs of museum specimens and also those captured in the field are arranged into plates alphabetically.

Checklist

Order Lepidoptera Linnaeus, 1758

*Bombyx mori* (Linnaeus, 1758)

**Notes:** Present study; Fig. 1a

*Trilocha varians* (Walker, 1855)

**Notes:** Present study; Fig. 1b

*Eupterote fabia* (Cramer, 1780)

**Notes:** Paul et al. 2017
Eupterote undata Blanchard, [1844]

Notes: Present study; Fig. 1c

Cephonodes hylas (Linnaeus, 1771)

Notes: Inaturalist, Present study; Fig. 1d
**Daphnis nerii** (Linnaeus, 1758)

**Notes:** Present study

**Hippotion boerhaviae** (Fabricius, 1775)

**Notes:** Present study; Fig. 1e

**Hippotion celerio** (Linnaeus, 1758)

**Notes:** Paul et al. 2017, Present study; Fig. 1f

**Hyles lineata** (Fabricius, 1775)

**Notes:** Present study; Fig. 2a

**Macroglossum neotroglodytus** Kitching & Cadiou, 2000

**Notes:** Present study; Fig. 2b

**Macroglossum stellatarum** (Linnaeus, 1758)

**Notes:** Present study

**Nephele hespera** (Fabricius, 1775)

**Notes:** Present study; Fig. 2c

**Theretra alecto** (Linnaeus, 1758)

**Notes:** Present study; Fig. 2d

**Theretra nessus** (Drury, 1773)

**Notes:** Present study; Fig. 2e

**Theretra oldenlandiae** (Fabricius, 1775)

**Notes:** Paul et al. 2017

**Theretra silhetensis** (Walker, 1856)

**Notes:** Paul et al. 2017
Figure 2.
Adults:

a: Hyles lineata  doi
b: Macroglossum neotrogloamyus  doi
c: Nephele hespera  doi
d: Theretra alecto  doi
e: Theretra nessus  doi
f: Clanis sp.  doi
Clanis phalaris (Cramer, 1777)
Notes: Paul et al. 2017

Clanis sp.
Notes: Present study; Fig. 2f

Leucophlebia lineata Westwood, 1847
Notes: Present study

Acherontia lachesis (Fabricius, 1798)
Notes: Present study

Acherontia styx (Westwood, 1847)
Notes: Paul et al. 2017, Present study; Fig. 3a

Agrius convolvuli (Linnaeus, 1758)
Notes: Kumar et al. 2012, Paul et al. 2017, Present study; Fig. 3b

Psilogramma increta (Walker 1865)
Notes: Paul et al. 2017, Present study; Fig. 3c

Psilogramma sp.
Notes: Paul et al. 2017

Phycodes minor Moore, 1881
Notes: Fig. 3d

Exinotis catachlora Meyrick, 1916
Notes: Present study; Fig. 3e

Coleophora sp.
Notes: Present study; Fig. 3f
**Ascalenia crypsiloga** (Meyrick, 1915)

**Notes:** Present study; Fig. 4a

**Anatrachyntis sp.**

**Notes:** Present study; Fig. 4b
Figure 4.
Adults:

a: Ascalenia crypsiloga  [doi](#)
b: Anatrachyntis sp.  [doi](#)
c: Ethmia acontias  [doi](#)
d: Psorosticha zizyphi  [doi](#)
e: Anarsia ephippias  [doi](#)
f: Helcystogramma engraptum  [doi](#)

**Ethmia acontias** Meyrick, 1906

**Notes:** Present study; Fig. 4c

**Ethmia sp.**

**Notes:** Present study
Psorosticha zizyphi (Stainton, 1859)

Notes: Present study; Fig. 4d

Anarsia ephippias Meyrick, 1908

Notes: Present study; Fig. 4e

Anarsia lineatella Zeller, 1839

Notes: Present study

Helcystogramma engraptum (Meyrick, 1918)

Notes: Present study; Fig. 4f

Helcystogramma hibisci (Stainton, 1859)

Notes: Present study; Fig. 5a

Phthorimaea operculella (Zeller, 1873)

Notes: Kumar et al. 2012, Present study; Fig. 5b

Pseudodoxia albinea Meyrick 1914

Notes: Present study; Fig. 5c

Eretmocera impactella (Walker, 1864)

Notes: Present study; Fig. 5d

Stathmopoda sp.

Notes: Present study; Fig. 5e

Chiasmia fidoniata (Guenee, 1858)

Notes: Present study

Chiasmia frugaliata (Guenee, 1858)

Notes: Paul et al. 2017
**Chiasmia nora** (Walker, 1861)

**Notes:** Present study; Fig. 5f
**Chiasmia sp. 1**

*Notes:* Paul et al. 2017

**Chiasmia sp. 2**

*Notes:* Present study

**Cleora acaciaria** (Boisduval, 1833)

*Notes:* Paul et al. 2017

**Cleora cornaria** (Guenée, 1857)

*Notes:* Paul et al. 2017

**Cleora sp.**

*Notes:* Present study; Fig. 6a

**Hyperythra lutea** (Stoll, [1781])

*Notes:* Present study

**Hyperythra swinhoei** Butler, 1880

*Notes:* Present study; Fig. 6b

**Hyposidra talaca** (Walker, 1860)

*Notes:* Present study

**Isturgia arenacearia** (Denis & Schiffermüller, 1775)

*Notes:* Present study

**Isturgia disputaria** (Guenée, [1858])

*Notes:* Paul et al. 2017

**Petelia medardaria** Herrich-Schäffer, [1856]

*Notes:* Present study
Petelia sp.

Notes: Present study; Fig. 6c
*Rhodometra sacraria* (Linnaeus, 1767)

**Notes:** Paul et al. 2017, Present study; Fig. 6d

*Scardamia metallaria* Guenée, 1858

**Notes:** Present study; Fig. 6e

*Hemithea aestivaria* (Hübner, 1799)

**Notes:** Present study

*Ornithospila avicularia* (Guenée, 1857)

**Notes:** Present study; Fig. 6f

*Pelagodes veraria* (Guenée, 1857)

**Notes:** Paul et al. 2017

*Pelagodes / Thalassodes* sp.

**Notes:** Present study

*Pingasa dispensata* (Walker, 1860)

**Notes:** Present study

*Thalassodes quadraria* (Guenee, 1857)

**Notes:** Paul et al. 2017

*Thalassodes* sp. 1

**Notes:** Present study

*Thalassodes* sp. 2

**Notes:** Present study

*Eupithecia ultimaria* Boisduval, 1840

**Notes:** Present study; Fig. 7a
**Pasiphila rectangulata** (Linnaeus, 1758)

**Notes:** Present study

**Craspediopsis sp.**

**Notes:** Present study; Fig. 7b

**Haematopis grataria** (Fabricius, 1798)

**Notes:** Inaturalist
Problepsis vulgaris Butler, 1889
  Notes: Present study

Scopula nescriaria (Walker, 1861)
  Notes: Present study; Fig. 7c

Scopula relictata (Walker, 1866)
  Notes: Present study; Fig. 7d

Scopula subpunctaria (Herrich-Schäffer, 1847)
  Notes: Present study

Scopula sp. 1
  Notes: Paul et al. 2017

Scopula sp.
  Notes: Present study; Fig. 7e

Traminda mundissima (Walker, 1861)
  Notes: Paul et al. 2017; Fig. 7f

Phazaca theclata (Guenée, 1858)
  Notes: Present study; Fig. 8a

Acrocercops phaeomorpha Meyrick, 1919
  Notes: Present study; Fig. 8b

Acrocercops trissoptila Meyrick, 1921
  Notes: Present study; Fig. 8c

Caloptilia soyella (van Deventer, 1904)
  Notes: Present study; Fig. 8d
Figure 8.

Adults:

a: Phazaca theclata  [doi]
b: Acrocercops phaeomorpha  [doi]
c: Acrocercops trissoptila  [doi]
d: Caloptilia soyella  [doi]
e: Euspilapteryx sp.  [doi]
f: Phyllocnistis citrella  [doi]
*Euspilapteryx* sp.

*Notes:* Present study; Fig. 8e

*Phyllocnistis citrella* Stainton, 1856

*Notes:* Present study; Fig. 8f

*Chilena similis* Walker, 1855

*Notes:* Present study

*Chilena strigula* Walker, 1865

*Notes:* Present study

*Kunugia latipennis* (Walker, 1855)

*Notes:* Present study; Fig. 9a

*Streblote dorsalis* (Walker, 1866)

*Notes:* Present study

*Streblote siva* (Lefèbvre, 1827)

*Notes:* Present study

*Streblote sp.*

*Notes:* Present study; Fig. 9b

*Trabala vishnou* (Lefebvre, 1827)

*Notes:* Paul et al. 2017

*Hyblaea puera* (Cramer, 1777)

*Notes:* Present study; Fig. 9c

*Asota caricae* (Fabricius, 1775)

*Notes:* Present study; Fig. 9d
Figure 9.

Adults:

a: Kunugia latipennis  doi
b: Streblote sp.  doi
c: Hyblaea puera  doi
d: Asota caricae  doi
e: Asota ficus  doi
f: Digama hearseyana  doi
Asota ficus (Fabricius, 1775)

Notes: Paul et al. 2017, Present study; Fig. 9e

Digama hearseyana Moore, 1859

Notes: Paul et al. 2017, Present study; Fig. 9f

Plecoptera reflexa Guenée, 1852

Notes: Present study; Fig. 10a

Agylla pallens (Hampson, 1894)

Notes: Present study; Fig. 10b

Aloa lactinea (Cramer, 1777)

Notes: Present study

Aloa lineola (Fabricius, 1793)

Notes: Present study

Aloa moorei (Butler, 1875)

Notes: Rajesh et al. 2012, Present study; Fig. 10c

Amata cyssea Stoll, 1782

Notes: Paul et al. 2017, Present study; Fig. 10d

Amata sperbius (Fabricius, 1787)

Notes: Present study; Fig. 10e

Argina astrea (Drury, 1773)

Notes: Paul et al. 2017

Creatonotos gangis (Linnaeus, 1763)

Notes: Paul et al. 2017, Present study; Fig. 10f
Figure 10.

Adults:

a: *Plecoptera reflexa* [doi](#)
b: *Agylla pallens* [doi](#)
c: *Aloa moorei* [doi](#)
d: *Amata cyssea* [doi](#)
e: *Amata sperbius* [doi](#)
f: *Creatonotos gangis* [doi](#)

**Eressa confinis** (Walker, 1854)

**Notes:** Present study; Fig. 11a
**Mangina syringa** (Cramer, 1775)

**Notes:** Present study; Fig. 11b

**Olepa ricini** (Fabricius, 1775)

**Notes:** Kumar et al. 2012, Present study

**Psichotoe duvaucelii** Boisduval, 1829

**Notes:** Present study; Fig. 11c
**Spilosoma obliqua** (Walker, 1855)
- **Notes:** Kumar et al. 2012, Present study; Fig. 11d

**Utethesia pulchella** (Linnaeus, 1758)
- **Notes:** Paul et al. 2017, Present study; Fig. 11e

**Autoba olivacea** Walker, [1858]
- **Notes:** Present study; Fig. 11f

**Autoba silicula** Swinhoe, 1897
- **Notes:** Present study; Fig. 12a

**Hiccosa nigripalpis** (Walker, 1866)
- **Notes:** Present study; Fig. 12b

**Metachrostis badia** Swinhoe, 1886
- **Notes:** Paul et al. 2017

**Eudocima materna** (Linnaeus, 1767)
- **Notes:** Present study

**Eudocima phalonia** (Linnaeus, 1763)
- **Notes:** Present study; Fig. 12c

**Lyncestis amphix** (Cramer, 1777)
- **Notes:** Present study; Fig. 12d

**Oraesia emarginata** (Fabricius, 1794)
- **Notes:** Paul et al. 2017

**Oraesia cf. emarginata** (Fabricius, 1794)
- **Notes:** Present study; Fig. 12e
Figure 12.
Adults:

a: Autoba silicula  doi
b: Hicoda nigripalpis  doi
c: Eudocima phalonia  doi
d: Lyncestis amphix  doi
e: Oraesia cf. emarginata  doi
f: Polydesma umbricola  doi
Polydesma umbricola Boisduval, 1833
Notes: Present study; Fig. 12f

Acantholipes circumdata Walker, 1858
Notes: Present study

Achaea janata (Linnaeus, 1758)
Notes: Paul et al. 2017, Present study; Fig. 13a

Antarchaea cucullata Moore, 1885
Notes: Present study

Attatha ino (Drury, 1782)
Notes: Paul et al. 2017; Fig. 13b

Attatha regalis (Moore, 1872)
Notes: Present study

Bastilla crameri (Moore, 1885)
Notes: Present study

Bastilla joviania (Stoll, 1782)
Notes: Present study; Fig. 13c

Buzara onelia (Guenée, 1852)
Notes: Present study; Fig. 13d

Dysgonia crameri (Moore, 1885)
Notes: Paul et al. 2017

Dysgonia nr. torrida (Guenee, 1852)
Notes: Paul et al. 2017; Fig. 13e
Figure 13.
Adults of a. Achaea janata; b. Attatha ino; c. Bastilla joviana; d. Buzara onelia; e. Dysgonia nr. torrida; f. Entomogramma torsa

a: Achaea janata  doi
b: Attatha ino   doi
c: Bastilla joviana  doi
d: Buzara onelia  doi
e: Dysgonia nr. torrida  doi
f: Entomogramma torsa  doi
Figure 14.

Adults of a. Erebus macrops; b. Ericeia inangulata; c. Grammodes geometrica; d. Grammodes stolida; e. Mocis frugalis; f. Ophisma gravata

a: Erebus macrops [doi]
b: Ericeia inangulata [doi]
c: Grammodes geometrica [doi]
d: Grammodes stolida [doi]
e: Mocis frugalis [doi]
f: Ophisma gravata [doi]
Entomogramma torsa Guenée, 1852
Notes: Present study; Fig. 13f

Erebus macrops (Linnaeus, 1768)
Notes: Present study; Fig. 14a

Ericeia inangulata (Guenée, 1852)
Notes: Present study; Fig. 14b

Grammodes geometrica (Fabricius, 1775)
Notes: Present study; Fig. 14c

Grammodes stolida (Fabricius, 1775)
Notes: Present study; Fig. 14d

Mocis frugalis (Fabricius, 1775)
Notes: Present study; Fig. 14e

Mocis undata (Fabricius, 1775)
Notes: Present study

Ophiusa triphaenoides (Walker, 1858)
Notes: Paul et al. 2017

Ophisma gravata Guenée, 1852
Notes: Present study; Fig. 14f

Pandesma anysa Guenée, 1852
Notes: Present study; Fig. 15a

Pandesma quenavadi Guenée, 1852
Notes: Present study; Fig. 15b
Figure 15.
Adults of a. *Pandesma anysa*; b. *Pandesma quenavadi*; c. *Pericyma albidens*; d. *Pericyma glaucinans*; e. *Pericyma umbrina*; f. *Spirama* sp.

*a*: *Pandesma anysa* [doi](#)
b: *Pandesma quenavadi* [doi](#)
c: *Pericyma albidens* [doi](#)
d: *Pericyma glaucinans* [doi](#)
e: *Pericyma umbrina* [doi](#)
f: *Spirama* sp. [doi](#)

**Pandesma sp.**

**Notes:** Paul et al. 2017

**Pericyma albidens** (Walker, 1865)

**Notes:** Present study; Fig. 15c
Pericyma glaucinans (Guenée, 1852)

Notes: Present study; Fig. 15d

Pericyma umbrina (Guenée, 1852)

Notes: Present study; Fig. 15e

Sphingomorpha chlorea (Cramer, 1777)

Notes: Present study

Spirama helicina (Hubner, 1831)

Notes: Paul et al. 2017, Present study

Spirama retorta (Clerk, 1764)

Notes: Paul et al. 2017

Spirama sp.

Notes: Present study; Fig. 15f

Tathorhynchus exsiccata (Lederer, 1855)

Notes: Present study; Fig. 16a

Thyas coronata (Fabricius, 1775)

Notes: Present study

Trigonodes hyppasia (Cramer, 1779)

Notes: Paul et al. 2017; Fig. 16b

Eublemma anachoresis (Wallengren, 1863)

Notes: Paul et al. 2017; Fig. 16c

Eublemma bifasciata (Moore, 1881)

Notes: Present study; Fig. 16d
Eublemma cochylioides (Guenée, 1852)

Notes: Present study; Fig. 16e

Eublemma parva (Hübner, 1808)

Notes: Present study; Fig. 16f
Figure 17.

Adults:

a: *Eublemma roseana*  doi
b: *Eublemma scitula*  doi
c: *Anticarsia irrorata*  doi
d: *Hydrillodes lentalis*  doi
e: *Nodaria cingala*  doi
f: *Hypena laceratalis*  doi
Eublemma roseana (Moore, 1881)

Notes: Present study; Fig. 17a

Eublemma scitula (Rambur, 1833)

Notes: Present study; Fig. 17b

Anticarsia irrorata (Fabricius, 1781)

Notes: Present study; Fig. 17c

Hydrillodes lentalis (Guenee, 1854)

Notes: Present study; Fig. 17d

Nodaria cingala Moore, [1885]

Notes: Present study; Fig. 17e

Hypena laceratalis Walker, 1859

Notes: Present study; Fig. 17f

Hypena peruvialis Schaus, 1904

Notes: Present study

Hypena sp.

Notes: Paul et al., 2017

Rhynchina obliqualis (Kollar, 1844)

Notes: Present study

Rhynchina xyлина Swinhoe, 1886

Notes: Present study

Euproctis cervina (Moore, 1877)

Notes: Present study; Fig. 18a
**Euproctis fraterna** (Moore, [1883])

**Notes:** Present study; Fig. 18b

**Euproctis lunata** Walker, 1855

**Notes:** Paul et al. 2017
Euproctis lutea (Fabricius, 1775)
  Notes: Present study

Euproctis similis (Füssli, 1775)
  Notes: Present study

Euproctis varians (Walker, 1855)
  Notes: Present study

Euproctis virguncula Walker, 1855
  Notes: Present study

Euproctis xanthorrhoea (Kollar, 1848)
  Notes: Present study; Fig. 18c

Euproctis sp. 1
  Notes: Present study

Euproctis sp. 2
  Notes: Present study

Laelia testacea (Walker, 1855)
  Notes: Present study; Fig. 18d

Lymantria sp.
  Notes: Paul et al. 2017

Olene mendosa (Hübner, 1823)
  Notes: Present study; Fig. 18e

Orvasca subnotata Walker, 1865
  Notes: Present study
**Psalis pennatula** (Fabricius, 1793)

**Notes:** Present study

**Somena scintillans** (Walker, 1856)

**Notes:** Kumar et al. 2012, Present study

**Anomis flava** (Fabricius, 1775)

**Notes:** Paul et al. 2017; Fig. 18f

**Anomis involuta** (Walker, [1858])

**Notes:** Present study; Fig. 19a

**Syntomoides imaon** (Cramer, 1780)

**Notes:** Present study; Fig. 19b

**Calesia haemorrhhoa** Guenée, 1852

**Notes:** Present study; Fig. 19c

**Anumeta atrosignata** Walker, 1858

**Notes:** Present study; Fig. 19d

**Chlumetia transversa** (Walker, 1863)

**Notes:** Present study

**Acontia basifera** Walker, [1858]

**Notes:** Present study

**Acontia catenula** (Walker, 1865)

**Notes:** Present study; Fig. 19e

**Acontia lucida** (Hufnagel, 1766)

**Notes:** Paul et al. 2017; Fig. 19f
Acontia marmoralis (Fabricius, 1794)

Notes: Present study; Fig. 20a
Acontia notabilis (Walker, 1857)

Notes: Present study; Fig. 20b
**Acontia opalinoides** Guenée, 1852  
Notes: Present study

**Acontia sexpunctata** (Fabricius, 1794)  
Notes: Present study; Fig. 20c

**Emmelia lunana** (Fabricius, 1794)  
Notes: Present study

**Emmelia semipallida** (Warren, 1913)  
Notes: Present study; Fig. 20d

**Athetis bremusa** (Swinhoe, 1885)  
Notes: Present study

**Athetis obtusa** (Hampson, 1891)  
Notes: Present study

**Athetis placida** (Moore, [1884])  
Notes: Present study

**Aedia leucomelas** (Linnaeus, 1758)  
Notes: Present study

**Aegocera venulia** (Cramer, [1777])  
Notes: Present study; Fig. 20e

**Matopo selecta** (Walker, 1865)  
Notes: Present study; Fig. 20f

**Amyna axis** (Guenée, 1852)  
Notes: Present study; Fig. 21a
Perigea galaxia Butler, 1883

Notes: Present study; Fig. 21b
**Cretonia vegetus** (Swinhoe, 1885)

**Notes:** Present study

**Deltote marginata** (Walker, 1866)

**Notes:** Present study; Fig. 21c

**Maliattha signifera** (Walker, [1858])

**Notes:** Inaturalist; Fig. 21d

**Ozarba mallarba** Swinhoe, 1885

**Notes:** Present study; Fig. 21e

**Ozarba punctigera** Walker, 1865

**Notes:** Present study; Fig. 21f

**Ozarba rufula** Hampson, 1910

**Notes:** Present study; Fig. 22a

**Ozarba venata** Butler, 1889

**Notes:** Present study

**Adisura atkinsoni** Moore, 1881

**Notes:** Kumar et al. 2012, Present study

**Helicoverpa armigera** (Hubner, 1809)

**Notes:** Kumar et al. 2012, Paul et al. 2017; Fig. 22b

**Helicoverpa assulta** (Guenée, 1852)

**Notes:** Paul et al. 2017; Fig. 22c

**Heliothis peltigera** (Denis & Schiffermüller, 1775)

**Notes:** Paul et al. 2017, Present study; Fig. 22d
**Agrotis ipsilon** (Hufnagel, 1766)

**Notes:** Kumar et al. 2012, Paul et al. 2017, Present study; Fig. 22e

**Agrotis segetum** (Denis & Schiffermüller, 1775)

**Notes:** Kumar et al. 2012, Present study; Fig. 22f
Figure 23.

Adults:

a: Agrotis spinifera  doi
b: Dichagyris flammatra  doi
c: Leucania comma  doi
d: Mudaria cornifrons  doi
e: Mythimna separata  doi
f: Polytela cliens  doi
Agrotis spinifera (Hübner, 1808)

Notes: Present study; Fig. 23a

Dichagyris flammatra (Schiffermuller, 1775)

Notes: Paul et al. 2017; Fig. 23b

Leucania comma (Linnaeus, 1761)

Notes: Present study; Fig. 23c

Leucania irregularis (Walker, 1857)

Notes: Present study

Leucania loreyi (Duponchel, 1827)

Notes: Paul et al. 2017

Mudaria cornifrons Moore, 1893

Notes: Present study; Fig. 23d

Mythimna separata (Walker, 1865)

Notes: Paul et al. 2017; Fig. 23e

Polytela cliens (Felder & Rogenhofer, 1874)

Notes: Present study; Fig. 23f

Polytela gloriosae (Fabricius, 1781)

Notes: Present study

Sasunaga tenebrosa (Moore, 1867)

Notes: Present study; Fig. 24a

Sesamia uniformis (Dudgeon, 1905)

Notes: Present study; Fig. 24b
Figure 24.

Adults:

a: Sasunaga tenebrosa  doi
b: Sesamia uniformis  doi
c: Spodoptera exigua  doi
d: Spodoptera litura  doi
e: Autographa nigrisigna  doi
f: Chrysodeixis chalcites  doi
**Spodoptera exigua** (Hubner, 1808)

**Notes:** Kumar et al. 2012, Paul et al. 2017, Present study; Fig. 24c

**Spodoptera litura** (Fabricius, 1775)

**Notes:** Kumar et al. 2012, Paul et al. 2017 Present study; Fig. 24d

**Spodoptera pecten** Guenee, 1852

**Notes:** Present study

**Xestia sp.** (Hübner, 1790)

**Notes:** Paul et al. 2017

**Autographa nigrisigna** (Walker, 1857)

**Notes:** Kumar et al. 2012, Paul et al. 2017; Fig. 24e

**Chrysodeixis acuta** (Doubleday, 1843)

**Notes:** Kumar et al. 2012; Paul et al. 2017

**Chrysodeixis chalcites** (Esper, 1789)

**Notes:** Kumar et al. 2012; Paul et al. 2017; Fig. 24f

**Chrysodeixis eriosoma** (Doubleday, 1843)

**Notes:** Paul et al. 2017, Present study; Fig. 25a

**Ctenoplusia albostriata** (Bremer & Grey, 1853)

**Notes:** Paul et al. 2017, Present study

**Erythroplusia pyropia** (Butler, 1879)

**Notes:** Paul et al. 2017

**Thysanoplusia daubei** (Boisduval, 1840)

**Notes:** Paul et al. 2017
**Thysanoplusia orichalcea** (Fabricius, 1775)

*Notes:* Paul et al. 2017; Present study; Fig. 25b

**Trichoplusia ni** (Hubner, 1803)

*Notes:* Kumar et al. 2012, Present study; Fig. 25c
Arcyophora dentula (Lederer, 1869)
Notes: Present study; Fig. 25d

Aquis orbicularis (Walker, 1858)
Notes: Present study

Carea angulata (Fabricius, 1793)
Notes: Present study; Fig. 25e

Earias cupreoviridis (Walker, 1862)
Notes: Present study; Fig. 25f

Earias insulana (Boisduval, 1833)
Notes: Kumar et al. 2012, Paul et al. 2017, Fig. 26a

Earias vittella (Fabricius, 1794)
Notes: Kumar et al. 2012, Present study; Fig. 26b

Giaura sceptica (Swinhoe, 1885)
Notes: Present study; Fig. 26c

Labanda semipars (Walker, 1858)
Notes: Present study

Maurilia iconica (Walker, 1857)
Notes: Present study; Fig. 26d

Selepa celtis Moore, [1858]
Notes: Present study; Fig. 26e

Selepa docilis Butler, 1881
Notes: Present study; Fig. 26f
Figure 26.

Adults:

a: *Earias insulana*  [doi](#)
b: *Earias vittella*  [doi](#)
c: *Giaura sceptica*  [doi](#)
d: *Maurilia iconica*  [doi](#)
e: *Selepa celtis*  [doi](#)
f: *Selepa docilis*  [doi](#)

**Evonima plagiola** (Hampson, 1898)

Notes: Present study; Fig. 27a

**Meganola** sp.

Notes: Present study
**Nola internella** (Walker, 1865)

**Notes:** Present study

**Exelastis atomosa** (Walsingham, 1885)

**Notes:** Kumar et al. 2012; Present study
Sphenarches caffer (Zeller, 1852)

Notes: Kumar et al. 2012; Present study; Fig. 27b

Sphenarches sp.

Notes: Present study

Elophila sp.

Notes: Present study

Parapoynx diminutalis (Snellen, 1880)

Notes: Present study

Paraponyx fluctuosalis (Meyrick, 1899)

Notes: Present study

Chilo partellus (Swinhoe, 1885)

Notes: Fig. 27c

Chilo suppressalis (Walker, 1863)

Notes: Present study

Hendecasis duplifascialis (Hampson, 1891)

Notes: Present study

Ptychopseustis sp. (Hampson, 1896)

Notes: Present study; Fig. 27d

Crocidolomia pavonana (Fabricius, 1794)

Notes: Kumar et al. 2012, Present study; Fig. 27e

Crocidolomia suffusalis (Hampson, 1891)

Notes: Arora 2000
Figure 28.
Adults:

a: *Autocharis fessalis* [do](#)
b: *Hydriris ornatalis* [do](#)
c: *Pyrausta indistans* [do](#)
d: *Spoladea recurvalis* [do](#)
e: *Scirpophaga incertulas* [do](#)
f: *Scirpophaga nivella* [do](#)
**Hellula undalis** (Fabricius, 1794)

Notes: Kumar et al. 2012, Present study

**Aporodes floralis** (Hübner, 1809)

Notes: Arora 2000, Present study; Fig. 27f

**Autocharis fessalis** (Swinhoe, 1886)

Notes: Present study; Fig. 28a

**Tegostoma baphialis** (Staudinger, 1871)

Notes: Present study

**Tegostoma comparalis** (Hübner, 1796)

Notes: Present study

**Hydriris ornatalis** (Duponchel, 1832)

Notes: Present study; Fig. 28b

**Isocentris filalis** (Guenée, 1854)

Notes: Present study

**Pyrausta indistans** Moore, 1888

Notes: Gupta 1994, Present study; Fig. 28c

**Pyrausta phoenicealis** (Hübner, 1818)

Notes: Present study

**Spoladea recurvalis** (Fabricius, 1775)

Notes: Kumar et al. 2012, Paul et al. 2017, Present study; Fig. 28d

**Scirpophaga incertulas** (Walker, 1863)

Notes: Fig. 28e
**Scirpophaga nivella** (Fabricius, 1794)

*Notes:* Fig. 28f

**Scirpophaga sp.**

*Notes:* Present study

**Aethaloessa calidalis** (Guenée, 1854)

*Notes:* Present study

**Antigastra catalaunalis** (Duponchel, 1833)

*Notes:* Present study; Fig. 29a

**Botyodes asialis** Guenée, 1854

*Notes:* Present study

**Botyodes diniasalis** (Walker, 1859)

*Notes:* Paul et al. 2017; Fig. 29b

**Botyodes sp.**

*Notes:* Present study

**Chabula acamasalis** (Walker, 1859)

*Notes:* Present study

**Cirrhochrista brizoalis** (Walker, 1859)

*Notes:* Present study; Fig. 29c

**Cnaphalocrocis exigua** (Butler, 1879)

*Notes:* Present study

**Cnaphalocrocis medinalis** (Guenee, 1854)

*Notes:* Paul et al. 2017; Fig. 29d
*Cnaphalocrocis trapezalis* (Guenée, 1854)

**Notes:** Inaturalist; Present study

Figure 29.

Adults:

a: *Antigastra catalaunaalis*  doi
b: *Botyodes diniasalis*  doi
c: *Cirrhochista brizoalis*  doi
d: *Cnaphalocrocis medinalis*  doi
e: *Conogethes punctiferalis*  doi
f: *Diaphania indica*  doi
Cnaphalocrocis sp. Lederer, 1863

Notes: Paul et al. 2017

Conogethes punctiferalis (Guenée, 1854)

Notes: Present study; Fig. 29eFig. 29f

Diaphania indica (Saunders, 1851)

Notes: Paul et al. 2017, Present study; Fig. 29f

Eurrhyparodes bracteolalis (Zeller, 1852)

Notes: Present study; Fig. 30a

Eurrhyparodes tricoloralis (Zeller, 1852)

Notes: Arora 2000, Present study

Gadessa nilusalis (Walker, 1859)

Notes: Paul et al. 2017

Glyphodes onychinalis Guenée, 1854

Notes: Present study; Fig. 30b

Haritalodes derogata (Fabricius, 1775)

Notes: Kumar et al. 2012, Present study; Fig. 30c

Herpetogramma bipunctalis (Fabricius, 1794)

Notes: Present study

Herpetogramma licarsalis (Walker, 1859)

Notes: Inaturalist; Fig. 30d

Herpetogramma phaeopteralis (Guenee, 1854)

Notes: Present study
Figure 30.

Adults:

a: Eurrhyparodes bracteolalis  

b: Glyphodes onychinalis  

c: Haritalodes derogata  

d: Herpetogramma licarsisalis  

e: Leucinodes orbonalis  

f: Maruca vitrata
Herpetogramma stultalis (Walker, 1859)

Notes: Present study

Leucinodes orbonalis Guenée, 1854

Notes: Kumar et al. 2012, Inaturalist, Present study; Fig. 30e

Maruca vitrata (Fabricius, 1787)

Notes: Kumar et al. 2012, Paul et al. 2017, Present study; Fig. 30f

Nausinoe geometralis (Guenée, 1854)

Notes: Present study

Nausinoe perspectata (Fabricius, 1775)

Notes: Present study; Fig. 31a

Nomophila nearctica Munroe, 1973

Notes: Present study

Nomophila noctuella (Denis & Schiffermüller, 1775)

Notes: Present study; Fig. 31b

Noorda blitealis Walker, 1859

Notes: Present study

Notarcha aurolinalis (Walker, 1859)

Notes: Present study

Omiodes indicata (Fabricius, 1775)

Notes: Present study

Prorodes mimica Swinhoe, 1894

Notes: Gupta 1994
Figure 31.
Adults:

a: *Nausinoe perspectata* doi
b: *Nomophila noctuella* doi
c: *Pygospila tyres* doi
d: *Sameodes cancellalis* doi
e: *Trachylepidia fructicassiesta* doi
f: *Etiella zinckenella* doi

*Pygospila tyres* (Cramer, 1780)

**Notes:** Present study; Fig. 31c
Sameodes cancellalis (Zeller, 1852)
    Notes: Paul et al. 2017; Fig. 31d

Synclera traducalis (Zeller, 1852)
    Notes: Mandal and Bhattacharya 1979

Achroia grisella (Fabricius, 1794)
    Notes: Present study

Corcyra cephalonica (Stainton, 1866)
    Notes: Arora 2000

Galleria mellonella (Linnaeus, 1758)
    Notes: Present study

Trachylepidia fructicassiella Ragonot, 1887
    Notes: Present study; Fig. 31e

Copamyntis infusella (Meyrick, 1879)
    Notes: Arora 2000

Etiella zinckenella (Treitschke, 1832)
    Notes: Kumar et al. 2012, Present study; Fig. 31f

Euzophera perticella Ragonot, 1888
    Notes: Kumar et al. 2012, Present study

Nephopterix eugraphella Ragonot, 1888
    Notes: Arora 2000

Phycita clientella Zeller, 1867
    Notes: Arora 2000, Present study
**Polyocha depressellus** (Swinhoe, 1885)

**Notes:** Arora 2000

**Pristarthria akbarella** Ragonot, 1888

**Notes:** Paul et al. 2017

![Figure 32.](image_url)

**Adults:**
- **a:** Hypsopygia mauritialis  [doi](#)
- **b:** Acanthocyla balanoptypha  [doi](#)
- **c:** Dudua aprobola  [doi](#)
- **d:** Loboschiza koenigiana  [doi](#)
- **e:** Syntozyga ephippias  [doi](#)
- **f:** Plutella xylostella  [doi](#)
**Hypsopygia mauritialis** (Boisduval, 1833)

*Notes:* Present study; Fig. 32a

**Acanthoclita balanopytha** (Meyrick, 1910)

*Notes:* Present study; Fig. 32b

**Dudua aprobola** (Meyrick, 1886)

*Notes:* Present study; Fig. 32c

**Loboschiza koenigiana** (Fabricius, 1775)

*Notes:* Present study; Fig. 32d

**Syntozyga ehippias** (Meyrick, 1907)

*Notes:* Present study; Fig. 32e

**Typhonia autochthonia** (Meyrick, 1931)

*Notes:* Present study

**Leucoptera sphenograpta** Meyrick, 1911

*Notes:* Present study

**Plutella xylostella** (Linnaeus, 1758)

*Notes:* Kumar et al. 2012, Present study; Fig. 32f

**Yponomeuta sp.**

*Notes:* Present study

**Fulgoraecia melanoleuca** (Fletcher, 1939)

*Notes:* Fig. 33a

**Aergina hilaris** Meyrick, 1913

*Notes:* Present study; Fig. 33b
Altha nivea Walker, 1862

**Notes:** Present study; Fig. 33c

Campylotes histrionicus Westwood, 1839

**Notes:** Paul et al. 2017

**Analysis**

The present study encompasses 338 moth species belonging to 32 different families pertaining to 14 superfamilies. Two hundred and thirty four species were added to the existing moth fauna of Delhi. Amongst the different superfamilies, the highest number of species were recorded in the superfamily Noctuoidea with 164 species accounting for about 48.5% of all the moths, followed by the superfamily Pyraloidea which constitutes about 20.4% of the moths and includes 69 species. The least number of species were observed in the superfamilies Cossoidea, Tineoidea and Hyblaeoidea comprising only one species each as shown in Table 1. Of the superfamilies, more familial diversity was exhibited by the superfamily Gelichioidea having species belonging to eight different...
families, followed by Noctuoidea representing four families. Amongst the different 32 families, the highest number of species (95) were recorded in Erebidae (Table 1). Noctuoidea is the most speciose superfamily recorded in current study with 164 species belonging to four families. In these four families, Erebidae was observed to be the largest family comprising 95 species which constitutes about more than half of the superfamily making up to 56.7%. Pyraloidea is the second largest superfamily in the current study with 69 species belonging to two families. Of the two families, Crambidae dominates with 57 species accounting for about 82.6% of Pyraloidea. All the data regarding the total number of species in different superfamilies and families are presented in Table 1.

Table 1.
Number of species under different superfamilies and families in Delhi.

| Superfamily      | No. of species | Family            | No. of species |
|------------------|----------------|-------------------|----------------|
| Bombycoidea      | 24             | Bombycidae        | 2              |
|                  |                | Eupterotidae      | 2              |
|                  |                | Sphingidae        | 20             |
| Cossoidea        | 1              | Brachodidae       | 1              |
| Gelechioidae     | 15             | Blastobasidae     | 1              |
|                  |                | Coleophoridae     | 1              |
|                  |                | Cosmopterigidae   | 2              |
|                  |                | Elachistidae      | 3              |
|                  |                | Gelechiidae       | 5              |
|                  |                | Oecophoridae      | 1              |
|                  |                | Scythrididae      | 1              |
|                  |                | Stathmopodiidae   | 1              |
| Geometroidea     | 37             | Geometridae       | 36             |
|                  |                | Uranidae          | 1              |
| Gracillarioidea  | 5              | Gracillariidae    | 5              |
| Lasiocampoidea   | 7              | Lasiocampidae     | 7              |
| Hyblaeoidea      | 1              | Hyblaeidae        | 1              |
| Noctuoidea       | 164            | Erebididae        | 95             |
|                  |                | Euteliidae        | 1              |
|                  |                | Noctuidae         | 54             |
|                  |                | Nolidae           | 14             |
| Pterophoroidea   | 3              | Pterophoridae     | 3              |
| Pyraloidea       | 69             | Crambidae         | 57             |
|                  |                | Pyralidae         | 12             |
| Tortricoidea     | 4              | Tortricidae       | 4              |
| Superfamily       | No. of species | Family           | No. of species |
|-------------------|---------------|------------------|---------------|
| Tineoidea         | 1             | Psychidae        | 1             |
| Yponomeutoidea    | 3             | Lyonetiidae      | 1             |
|                   |               | Plutellidae      | 1             |
|                   |               | Yponomeutidae    | 1             |
| Zygaenoidea       | 4             | Epipyropidae     | 1             |
|                   |               | Limacodidae      | 2             |
|                   |               | Zygaenidae       | 1             |

**Discussion**

In most parts of the world, the nocturnal Lepidoptera (such as Noctuoidea, Tortricoidea, Bombycoidea, Geometroidea, Pyraloidea, Yponomeutoidea and Gelechioidea) have received less attention than their more charismatic diurnal cousins, butterflies. However, as herbivores and a food supply as a prey for other insects, birds and bats (Vaughan 1997), these insects play an important ecological role and some of them are important pollinators of specific plant species (e.g. some Orchids and many members of Caryophyllaceae). Moth numbers have been declining dramatically in recent decades (Dennis et al. 2019). For example, macro-moth abundance decreased by 28% in the United Kingdom between 1968 and 2007 (Fox et al. 2013) and similar negative patterns have been observed in Sweden (Franzén and Johannesson 2007) and The Netherlands (Groenendijk and Ellis 2011). Due to the keystone importance of moths in many habitats, such losses are predicted to have cascading consequences at both higher (bats, birds) and lower (plants) trophic levels (Wickramasinghe et al. 2004). The present checklist is an accumulation of surveys in three locations in Delhi which include the Indian Agricultural Research Institute (IARI) campus, Rashtrapathi Bhawan and Asola Bhatti Wildlife Sanctuary and the study of moth specimens housed in NPC-IARI. In the current study, we have added 234 species to the checklist of moths of Delhi. This accounts for 338 species of moths belonging to 32 families of 14 different superfamilies. Many of the specimens studied from the museum collections were previously unidentified and those identified were not published. Interestingly, the identification in these collections was done by Mr. E. Meyrick (Microlepidoptera), Mr. T.B. Fletcher and Dr. S.L. Gupta (Macrolepidotpera and microlepidoptera). Post-independence, there were very few collection events and there is a discontinuity in moth monitoring and collections in Delhi, except for few agriculturally-important pests (Paul et al. 2016) and a few common moths (Paul et al. 2017). This may be because of: 1. Absence of continuous moth monitoring projects in Delhi; 2. Lack of training amongst researchers to collect and deposit moths in museums and 3. Most importantly, photographic identification of common moths has gained momentum during the last decade (Sondhi et al. 2021). The identification of many moth species is difficult with photographs alone and there is a need to collect and study them morphologically. In our study, we found that most of the moths from Delhi in the collections belong to macro-moth families. The under-representation of micro-moths is likely due to a lack of systematic collections and a lack of experts who study micro-moths. Additionally, our study documents
more moth species associated with agricultural and horticultural habitat (e.g. Helicoverpa armigera, Spodoptera litura etc.) likely due to extensive human-led landscaping in Delhi and also due to the greater survey effort in the IARI campus, which contains many agricultural and horticultural research farms.

The paucity of baseline data, both in terms of abundance and diversity of moths, poses a significant hurdle in assessing the impact of various threats like land-use changes, rapid urbanisation, pollution, insecticides and global warming (Dennis et al. 2019) to insect diversity. According to a recent analysis (Sharma et al. 2020), unplanned urbanisation in Delhi that occurred between 1998 and 2018 led to Delhi's forest cover shrinking by half between 1998 and 2018, suggesting the need for development of conservation zones inside and adjacent to the capital, as well as increased interaction with urban citizens to create a better understanding of urban biodiversity. There are examples of the forested land converted into conserved sites, such as the Sanjay Van, Aravalli Biodiversity Parks and Asola Wildlife Sanctuary has assisted in sustaining the biodiversity to an appreciable extent. However, there have been no systematic studies on moth diversity till now in these locations and, given the rapid urban growth, more such sites are needed to prioritise the conservation efforts documenting available biodiversity and continuous monitoring is very important. We strongly recommend the setting up of a study site/sites for long term monitoring of insect populations and their diversity in the State of Delhi. The monitoring programme could be undertaken by public participation in biodiversity documentation involving citizens and it has been proven successful in certain nations (Miller-Rushing et al. 2012, Pocock et al. 2015).

In conclusion, we believe that there will still be many more species that can be added to the present list as moths are sampled more extensively and studied more intensively using modern techniques, such as DNA barcoding. However, our study helps to establish the first comprehensive preliminary dataset on moths of the region, which can be a spring-board for future well-planned moth recording in Delhi. The areas for future investigation include concentrating on developing comprehensive species inventory, studying larval host associations and evaluation and prioritising moth species for conservation.

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Author contributions

JK, SPR, SS, SM: Conducted fieldwork, compiled data, inspected specimens, manuscript writing. SPR: Conceived the project. NMM, YS and AS: Compiled data, verified records, assisted in writing the manuscript. SPR: Supervision. SPR and NMM: Funding acquisition.

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