



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

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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 (Zagrobelyny 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

al. (2018) (Wildlife Institute of India, Dehradun, 291 species), Sondhi et al. (2018) (Agasthyamalai Biosphere Reserve, Kerala, 282 species), Dar et al. (2020) (Jammu and Kashmir, 461 species) and Bhagat (2020) (Jammu and Kashmir, and Ladakh, 55 species). There has been a tendency to focus on studying regions of higher biodiversity, including the Western and Eastern Himalayas and the Western Ghats; however, 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 leucoplachia*, *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 Automontage 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 Nieuwerkerken 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

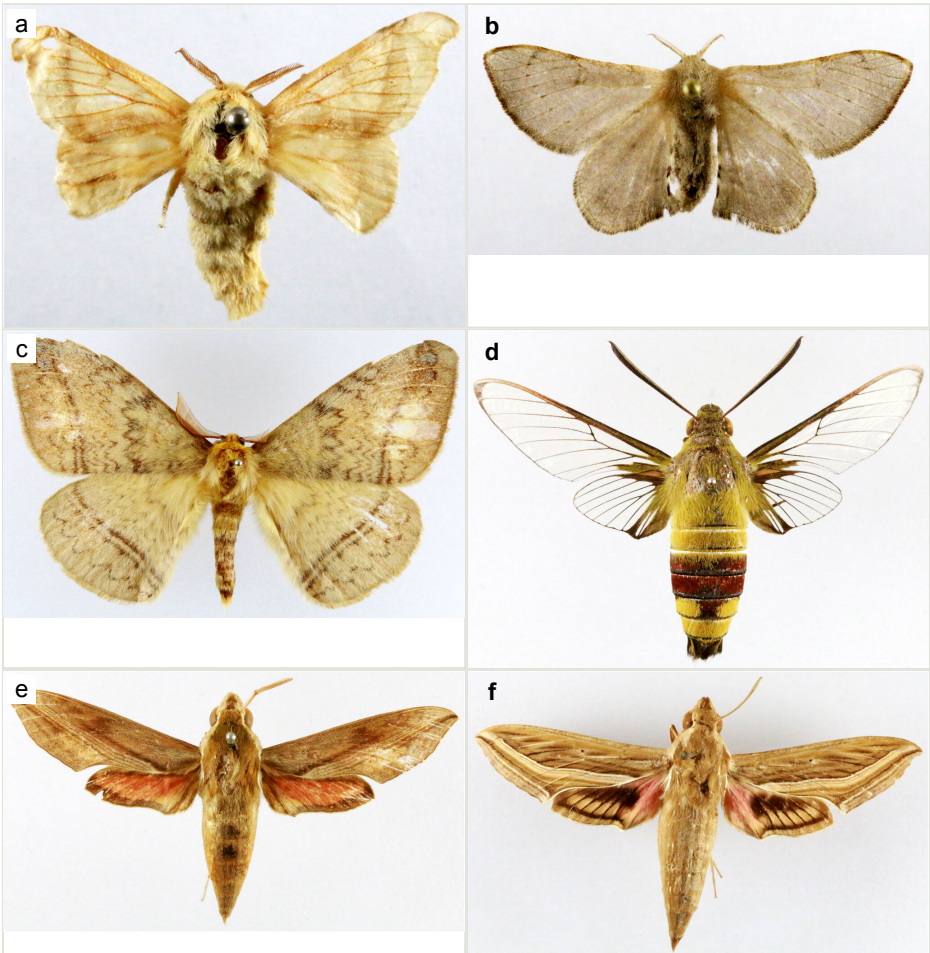


Figure 1.

Adults:

a: *Bombyx mori* [doi](#)

b: *Trilocha varians* [doi](#)

c: *Eupterote undata* [doi](#)

d: *Cephonodes hylas* [doi](#)

e: *Hippotion boerhaviae* [doi](#)

f: *Hippotion celerio*. [doi](#)

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 neotrogodytus* [doi](#)

c: *Nephela 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

***Psilogamma increta* (Walker 1865)**

Notes: Paul et al. 2017, Present study; Fig. 3c

***Psilogamma* 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

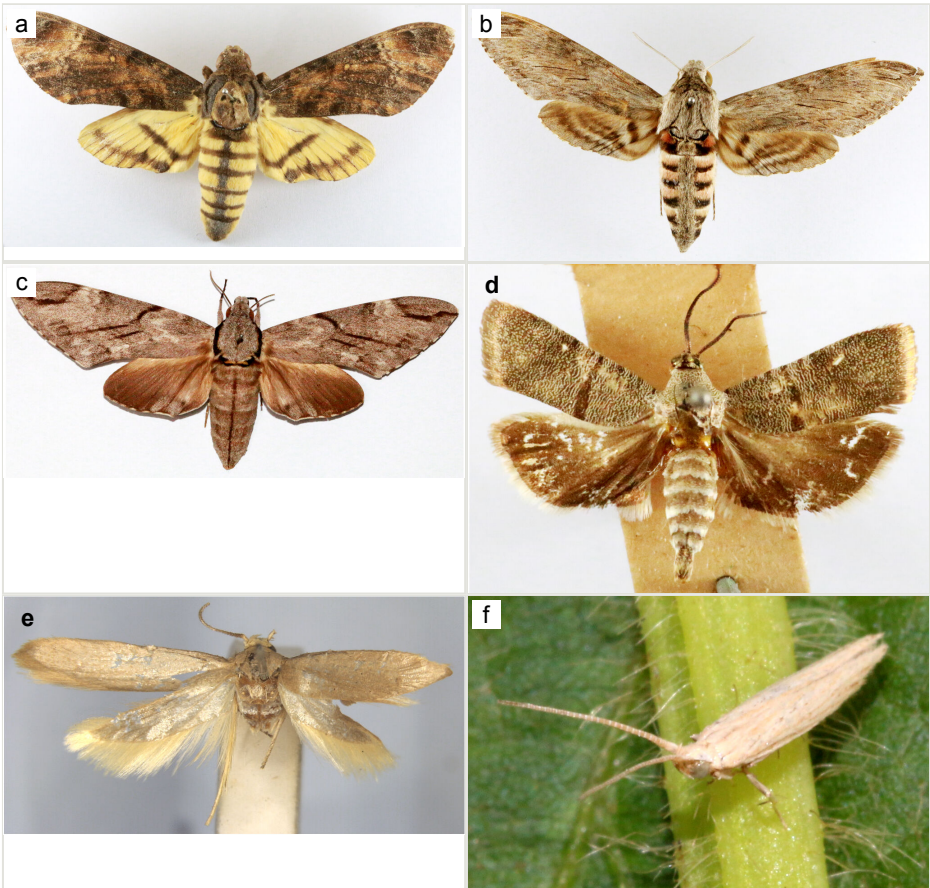


Figure 3.

Adults:

a: *Acherontia styx* [doi](#)

b: *Agrius convolvuli* [doi](#)

c: *Psilogamma increta* [doi](#)

d: *Phycodes minor* [doi](#)

e: *Exinotis catachlora* [doi](#)

f: *Coleophora* sp. [doi](#)

Ascalenia crypsiloga (Meyrick, 1915)

Notes: Present study; Fig. 4a

Anatrachyntis sp.

Notes: Present study; Fig. 4b

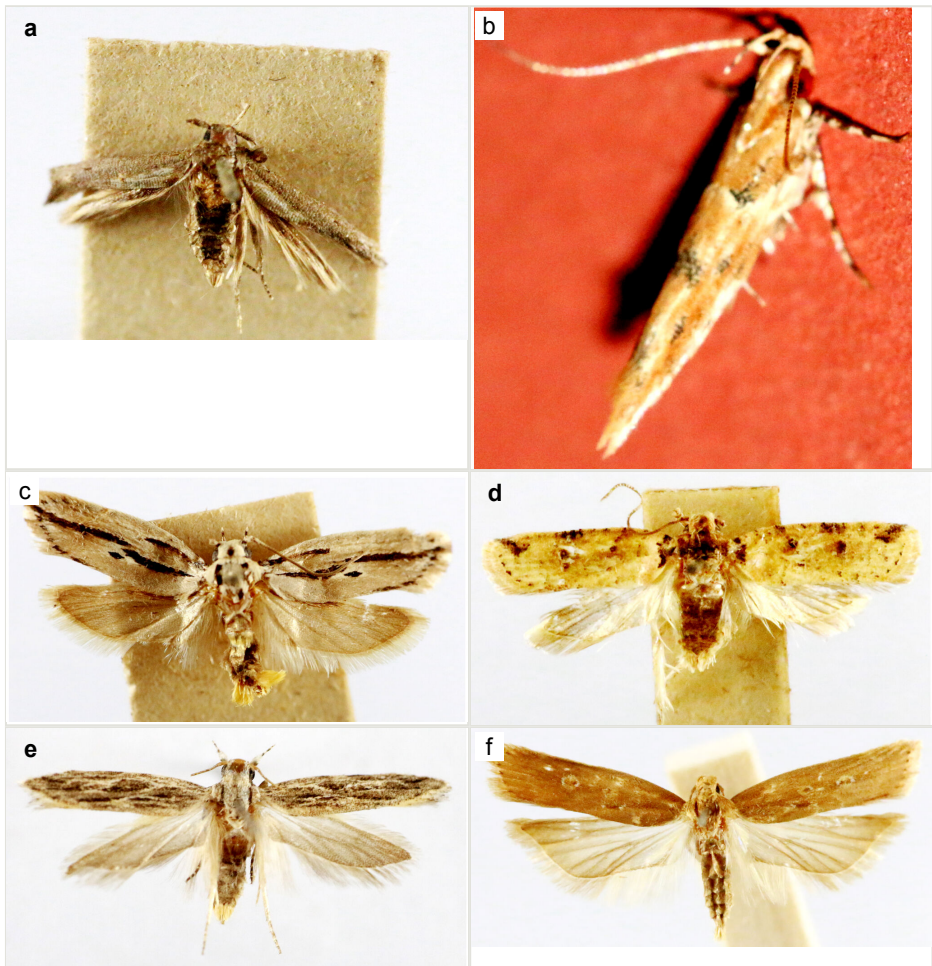


Figure 4.

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

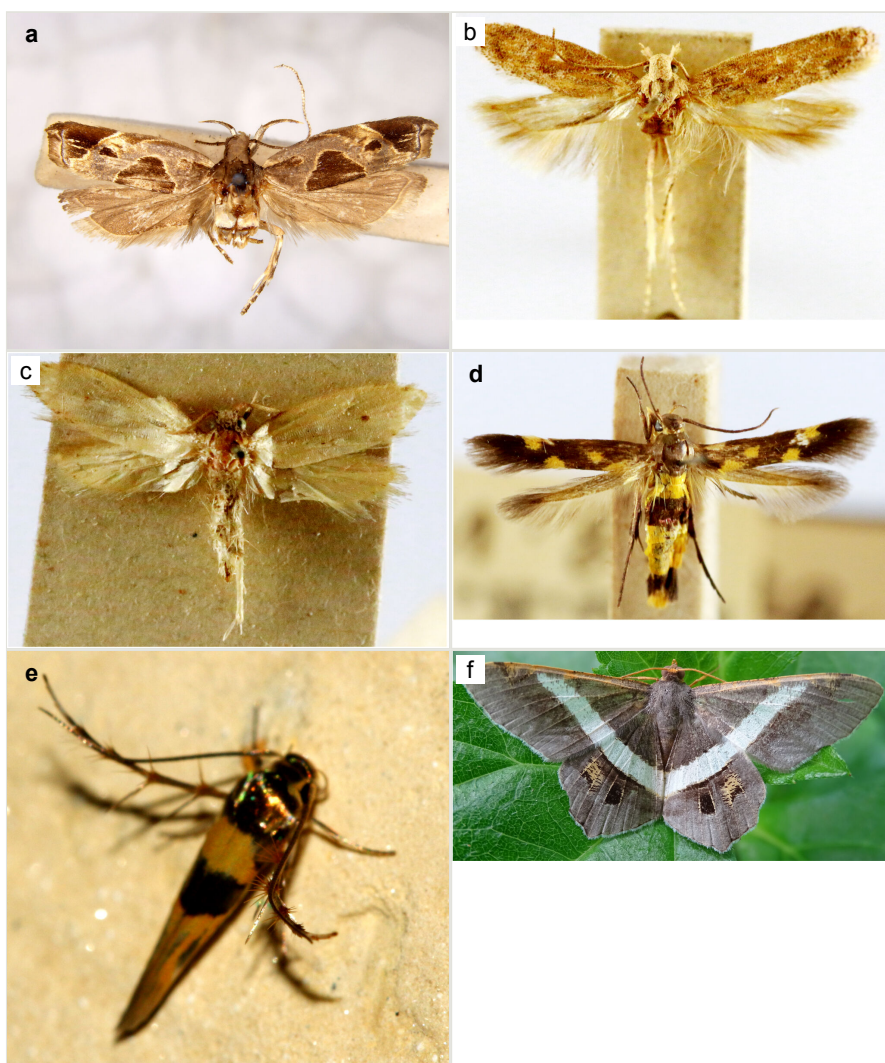


Figure 5.

Adults:

a: *Helcystogramma hibisci* [doi](#)b: *Phthorimaea operculella* [doi](#)c: *Pseudodoxia albinea* [doi](#)d: *Eretmocera impactella* [doi](#)e: *Stathmopoda* sp. [doi](#)f: *Chiasmia nora* [doi](#)***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

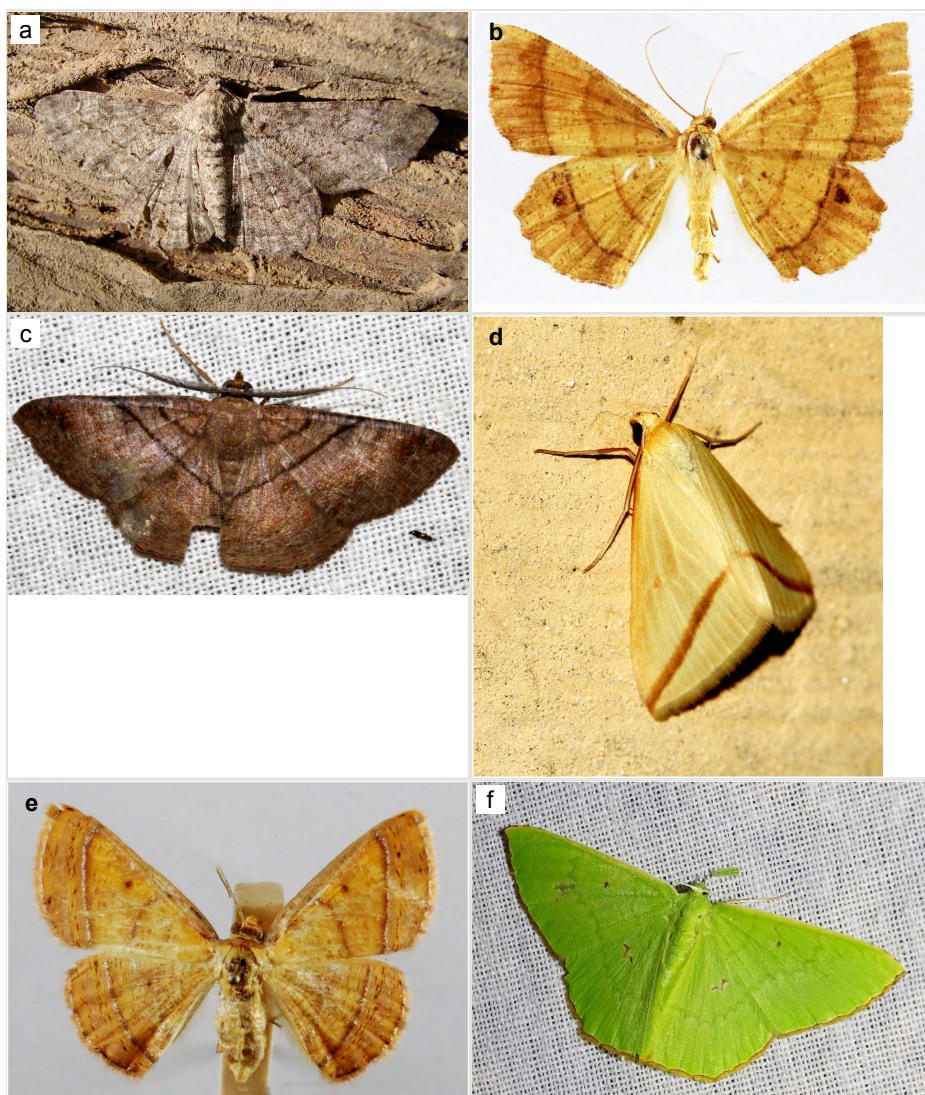


Figure 6.

Adults:

a: *Cleora* sp. [doi](#)b: *Hyperythra swinhoei* [doi](#)c: *Petelia* sp. [doi](#)d: *Rhodometra sacraria* [doi](#)e: *Scardamia metallaria* [doi](#)f: *Ornithospila avicularia* [doi](#)***Petelia* sp.**

Notes: Present study; Fig. 6c

***Rhometra 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* (Guenée, 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

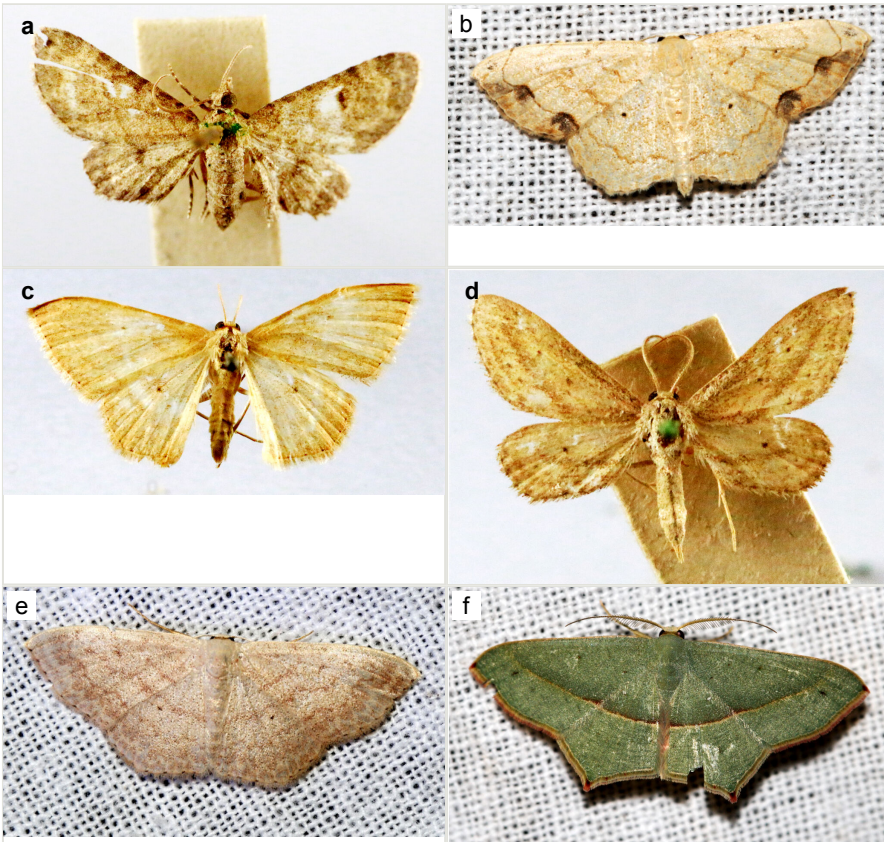


Figure 7.

Adults:

a: *Eupithecia ultimaria* [doi](#)b: *Craspediopsis* sp. [doi](#)c: *Scopula nesciaria* [doi](#)d: *Scopula relictata* [doi](#)e: *Scopula* sp. [doi](#)f: *Traminda mundissima* [doi](#)***Pasiphila rectangularata* (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 nesciaria* (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

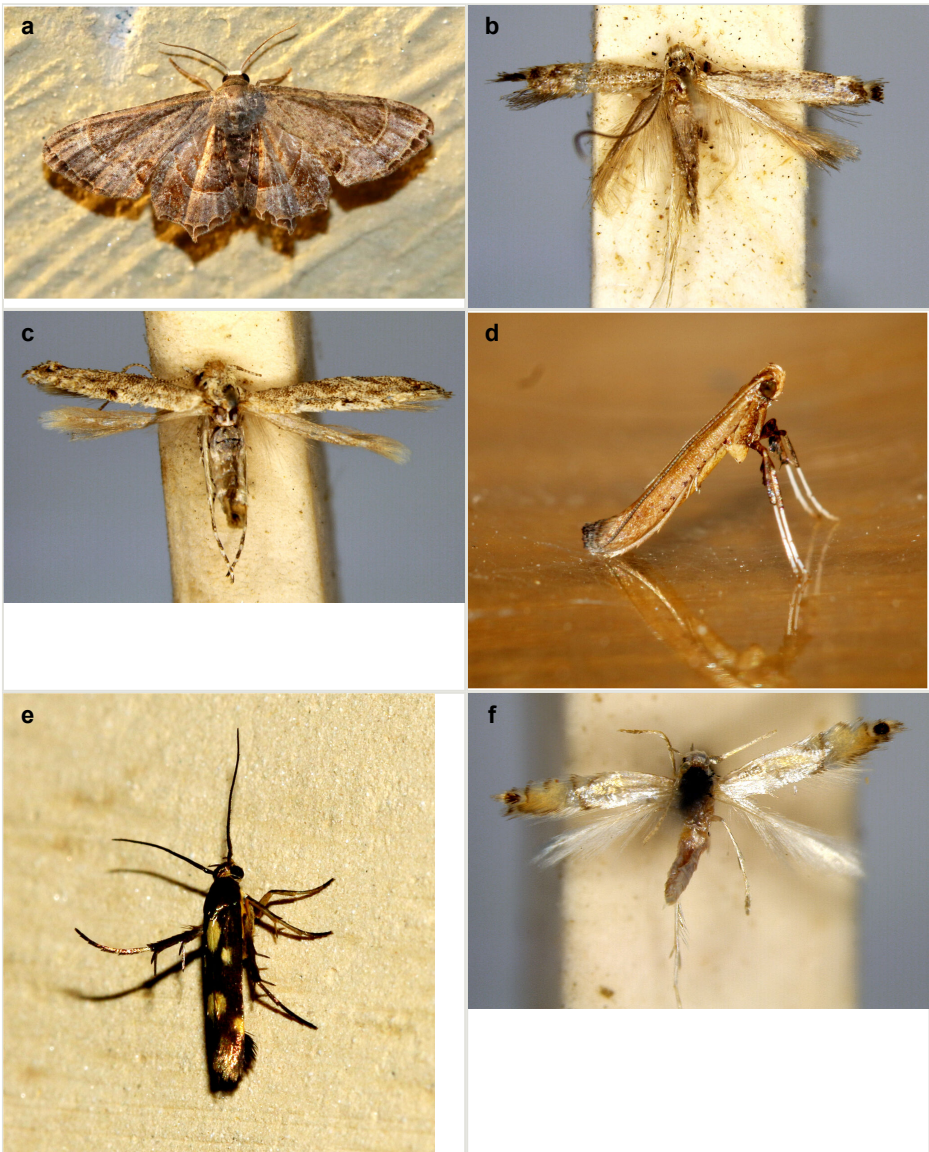


Figure 8.

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

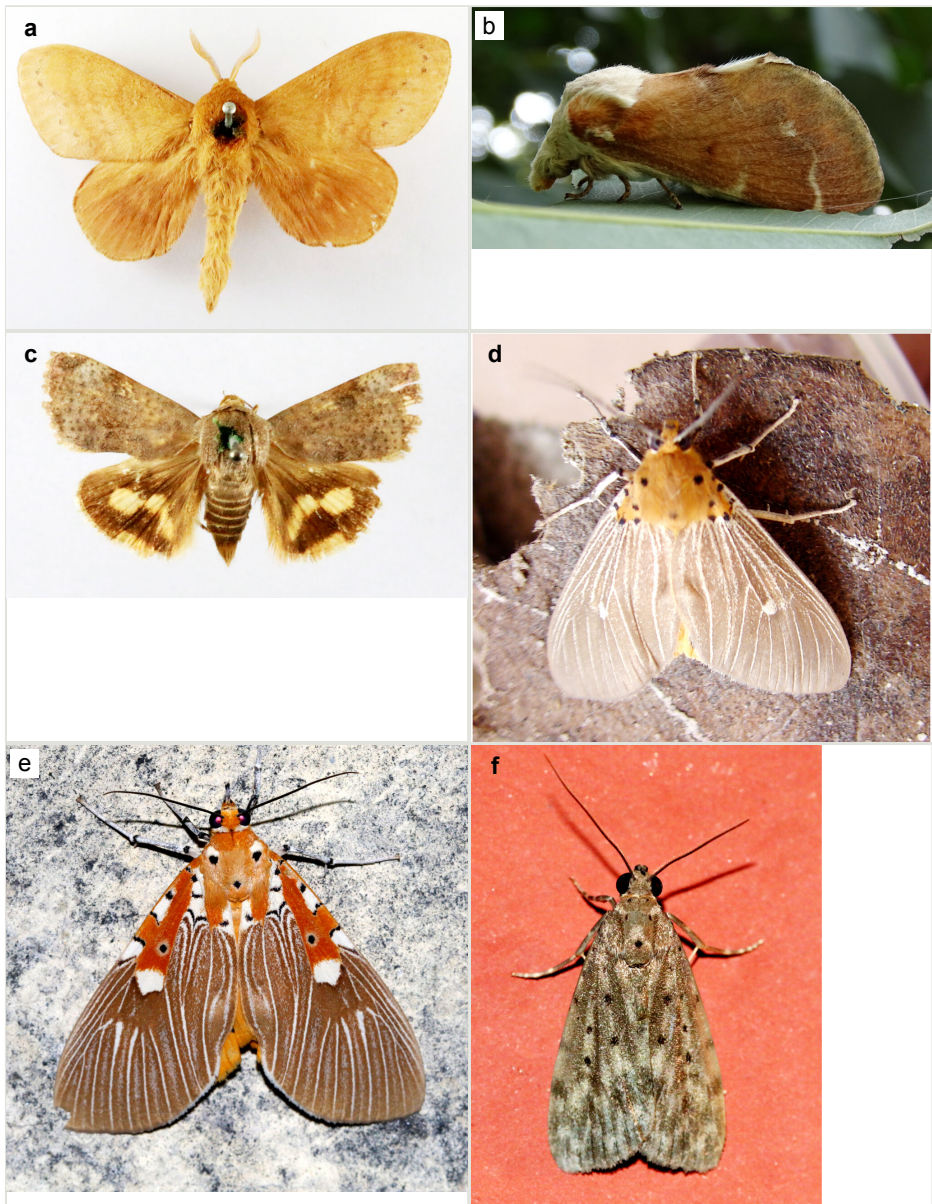


Figure 9.

Adults:

a: *Kunugia latipennis* [doi](#)b: *Streblothele* 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

***Cretonotos gangis* (Linnaeus, 1763)**

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

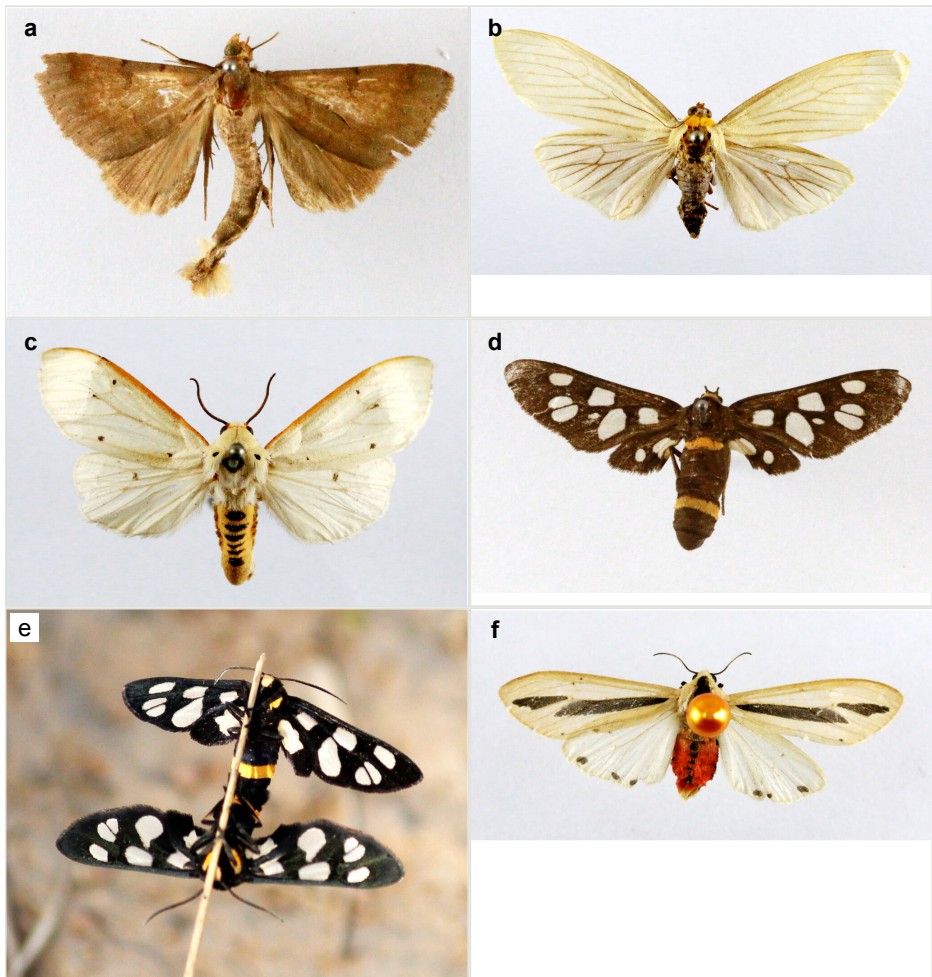


Figure 10.

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

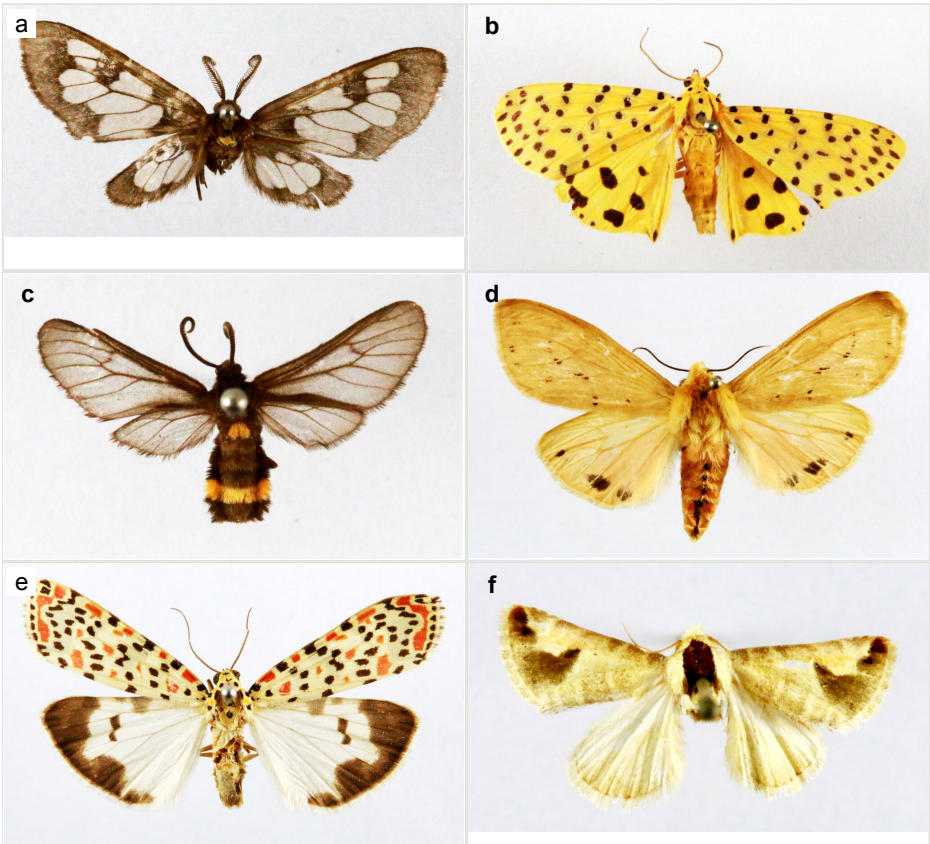


Figure 11.

Adults:

- a: *Eressa confinis* [doi](#)
- b: *Mangina syringa* [doi](#)
- c: *Psychotoe duvaucelii* [doi](#)
- d: *Spilosoma obliqua* [doi](#)
- e: *Utethesia pulchella* [doi](#)
- f: *Autoba olivacea* [doi](#)

***Mangina syringa* (Cramer, 1775)**

Notes: Present study; Fig. 11b

***Olepa ricini* (Fabricius, 1775)**

Notes: Kumar et al. 2012, Present study

***Psychotoe 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

***Hiccoda 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

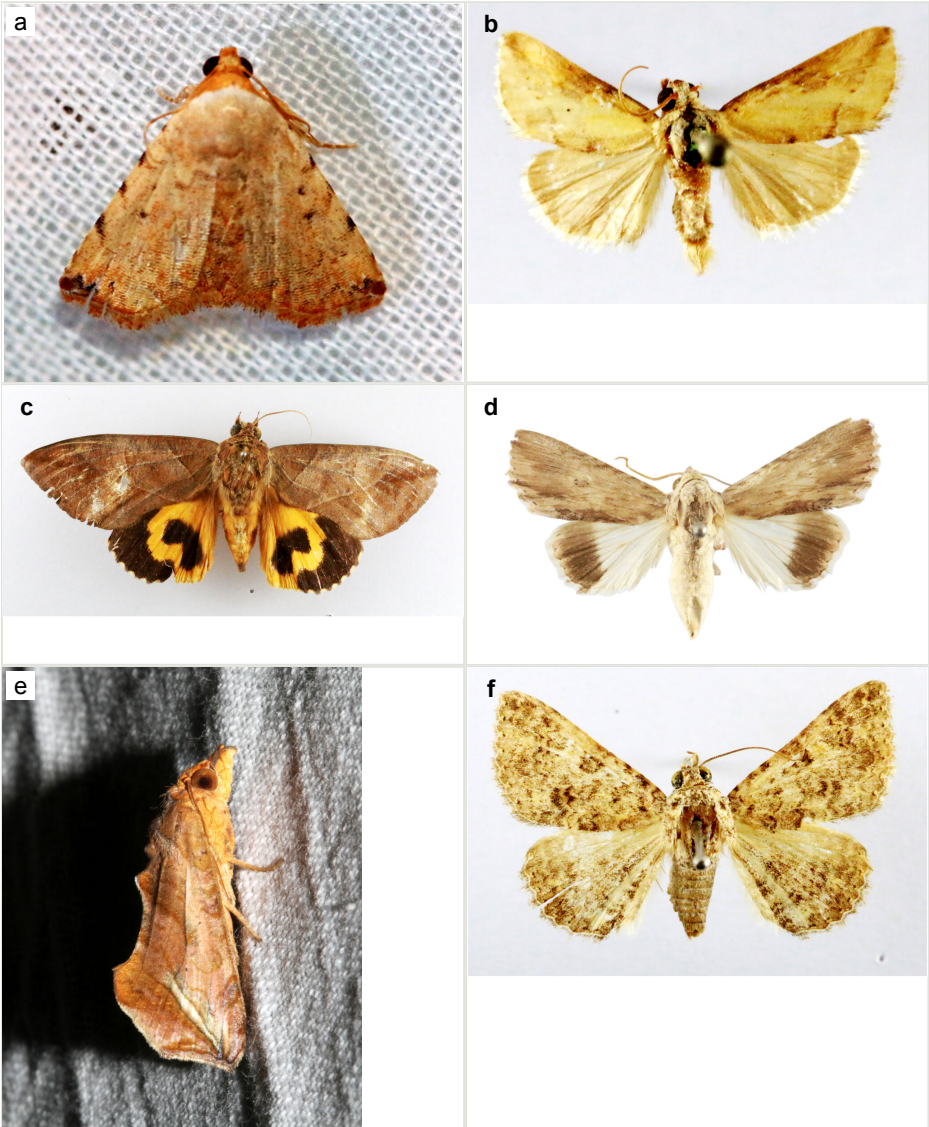


Figure 12.

Adults:

a: *Autoba silicula* [doi](#)

b: *Hiccoda 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

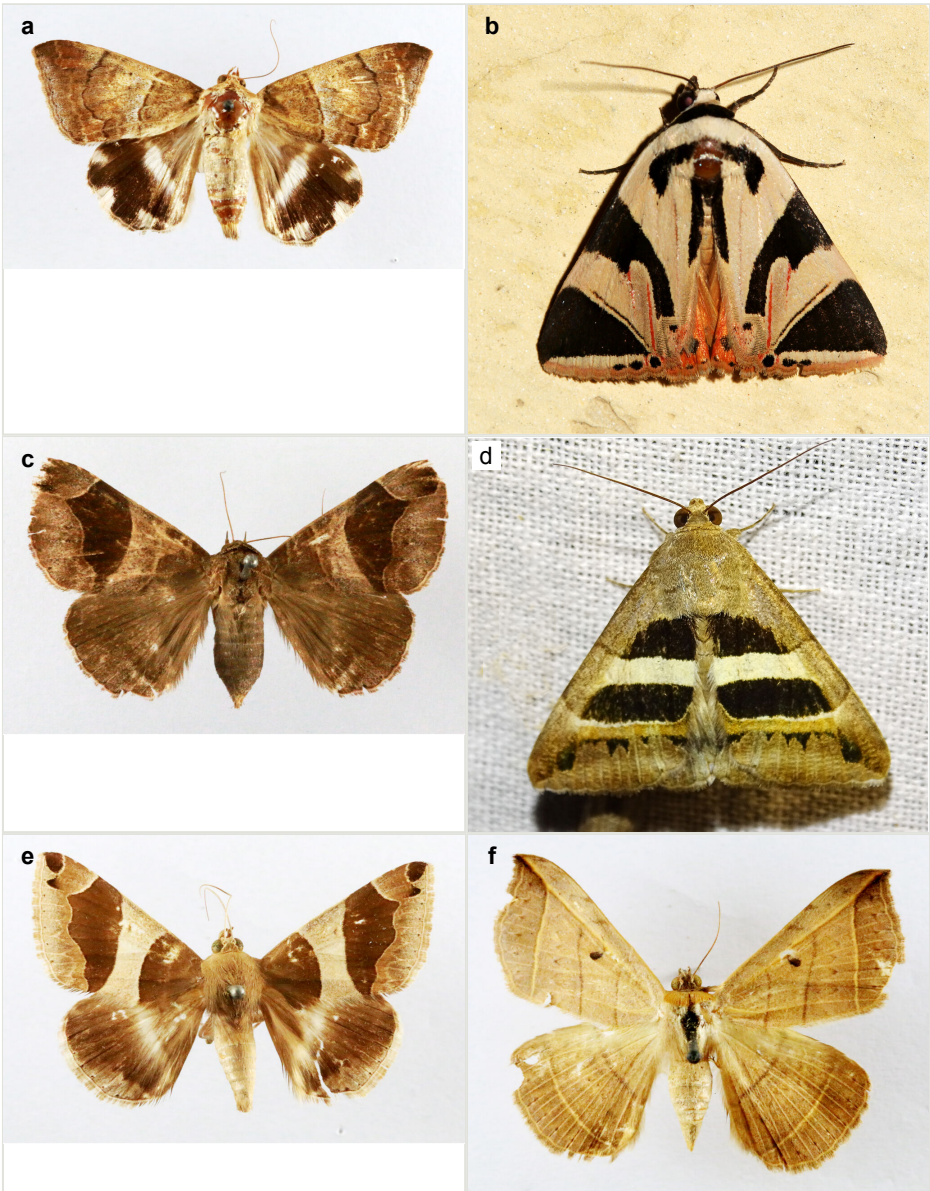


Figure 13.

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](#)

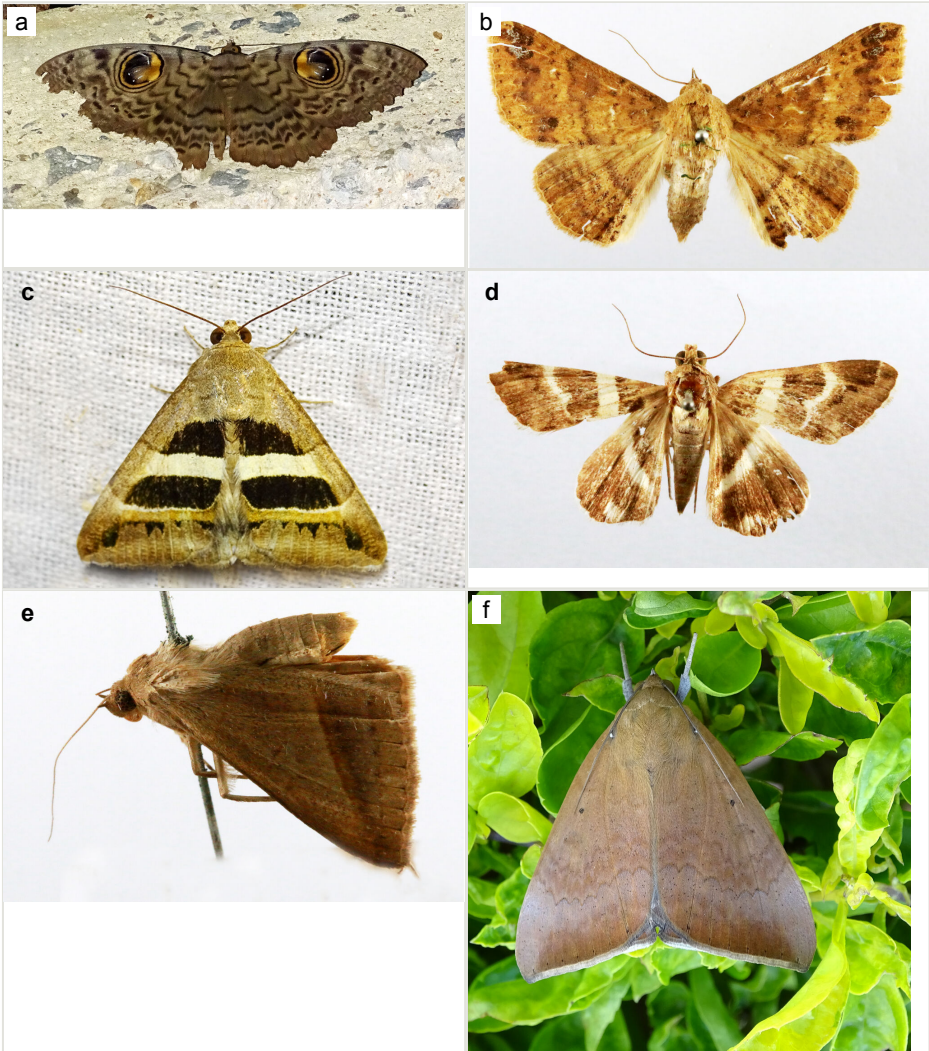


Figure 14.

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

a: *Erebus macrops* [doi](#)

b: *Ericeia inangulata* [doi](#)

c: *Grammodes geometrica* [doi](#)

d: *Grammodes stolidia* [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 stolidi* (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



Figure 16.

Adults:

a: *Tathorhynchus exsiccate* [doi](#)b: *Trigonodes hyppasia* [doi](#)c: *Eublemma anachoresis* [doi](#)d: *Eublemma bifasciata* [doi](#)e: *Eublemma cochylioides* [doi](#)f: *Eublemma parva* [doi](#)***Eublemma cochylioides* (Guenée, 1852)**

Notes: Present study; Fig. 16e

***Eublemma parva* (Hübner, 1808)**

Notes: Present study; Fig. 16f

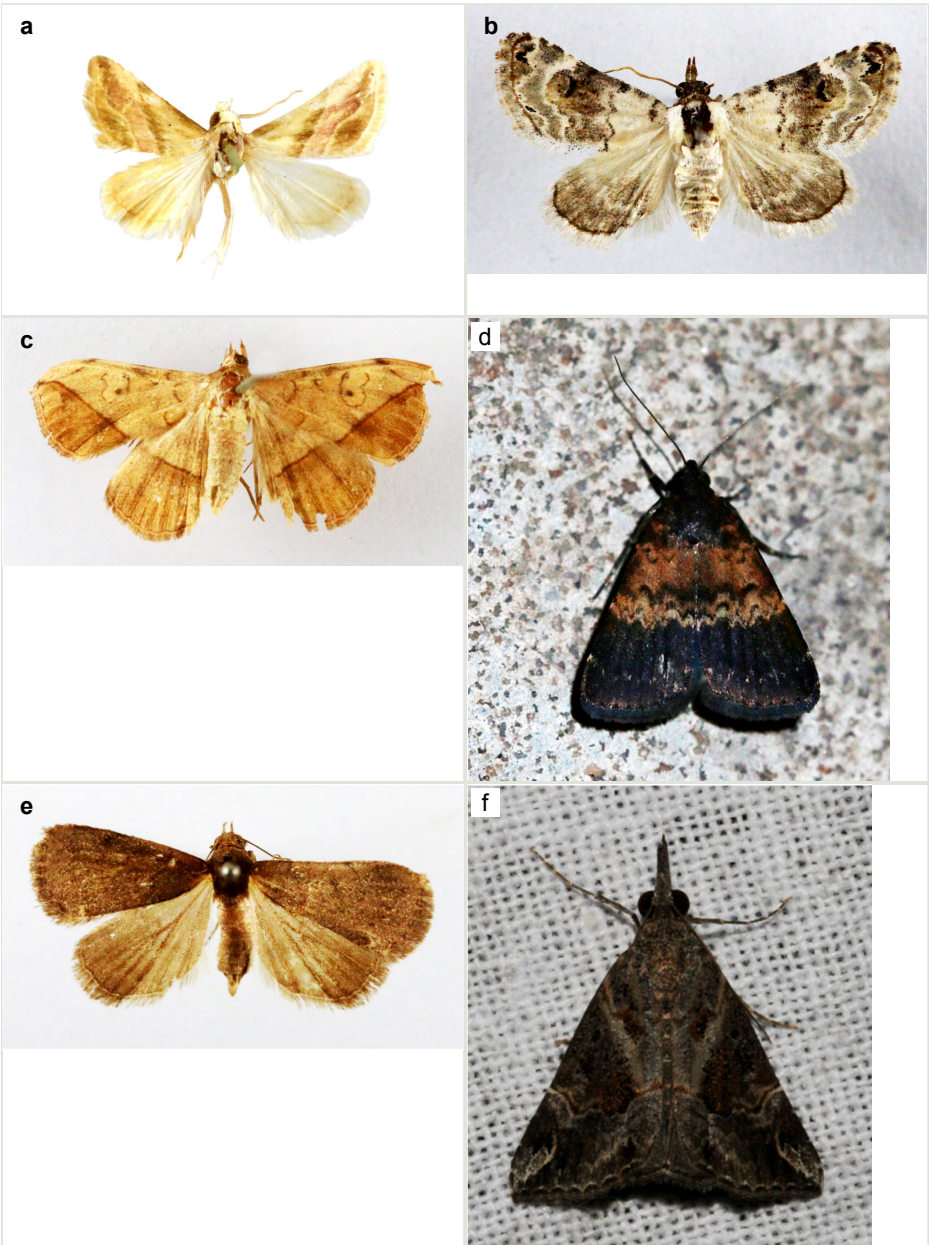


Figure 17.

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 xylina* Swinhoe, 1886**

Notes: Present study

***Euproctis cervina* (Moore, 1877)**

Notes: Present study; Fig. 18a

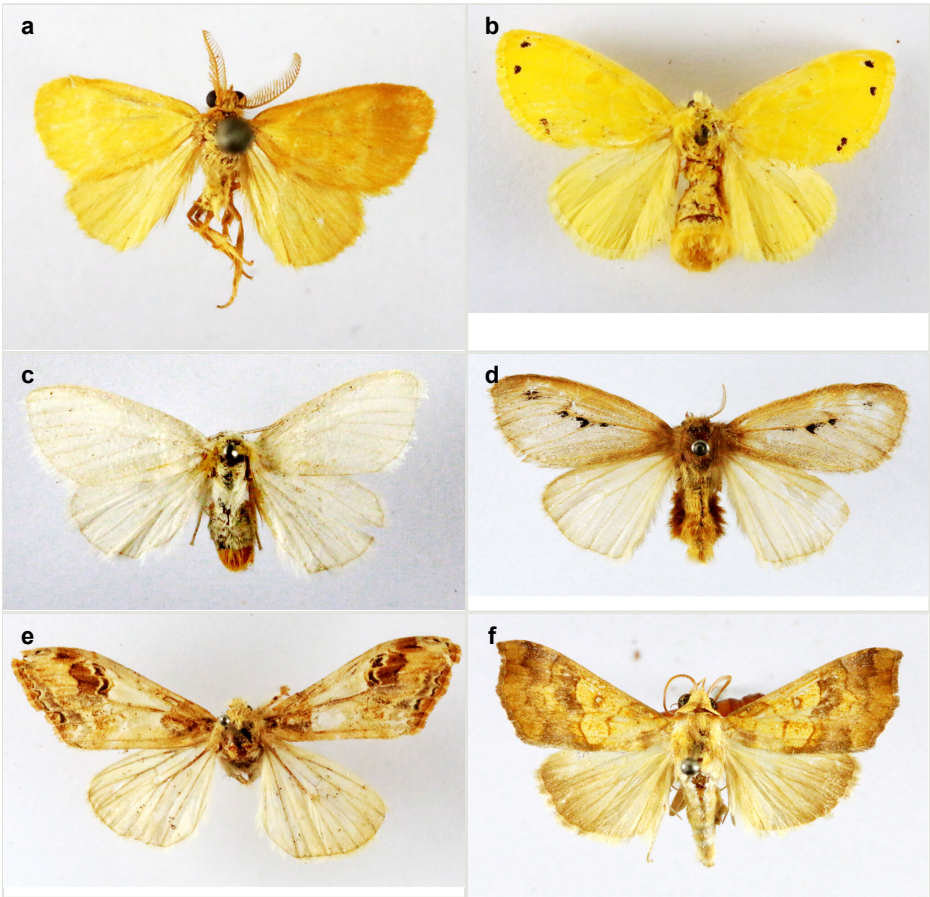


Figure 18.

Adults:

- a: *Euproctis cervina* [doi](#)
 b: *Euproctis fraterna* [doi](#)
 c: *Euproctis xanthorrhoea* [doi](#)
 d: *Laelia testacea* [doi](#)
 e: *Olene mendosa* [doi](#)
 f: *Anomis flava* [doi](#)

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 haemorrhoea* 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



Figure 19.

Adults of a. *Anomis involuta*; b. *Syntomoides imaon*; c. *Calesia haemorrhhoa*; d. *Anumeta atrosignata*; e. *Acontia catenula*; f. *Acontia lucida*

a: *Anomis involuta* [doi](#)

b: *Syntomoides imaon* [doi](#)

c: *Calesia haemorrhhoa* [doi](#)

d: *Anumeta atrosignata* [doi](#)

e: *Acontia catenula* [doi](#)

f: *Acontia lucida* [doi](#)

Acontia marmoralis (Fabricius, 1794)

Notes: Present study; Fig. 20a



Figure 20.

Adults:

a: *Acontia marmoralis* [doi](#)

b: *Acontia notabilis* [doi](#)

c: *Acontia sexpunctata* [doi](#)

d: *Emmelia semipallida* [doi](#)

e: *Aegocera venulia* [doi](#)

f: *Matopo selecta* [doi](#)

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



Figure 21.

Adults:

a: *Amyna axis* [doi](#)

b: *Perigea galaxia* [doi](#)

c: *Deltote marginate* [doi](#)

d: *Maliattha signifera* [doi](#)

e: *Ozarba mallarba* [doi](#)

f: *Ozarba punctigera* [doi](#)

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



Figure 22.

Adults:

a: *Ozarba rufula* [doi](#)

b: *Helicoverpa armigera* [doi](#)

c: *Helicoverpa assulta* [doi](#)

d: *Heliothis peltigera* [doi](#)

e: *Agrotis ipsilon* [doi](#)

f: *Agrotis segetum* [doi](#)

***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

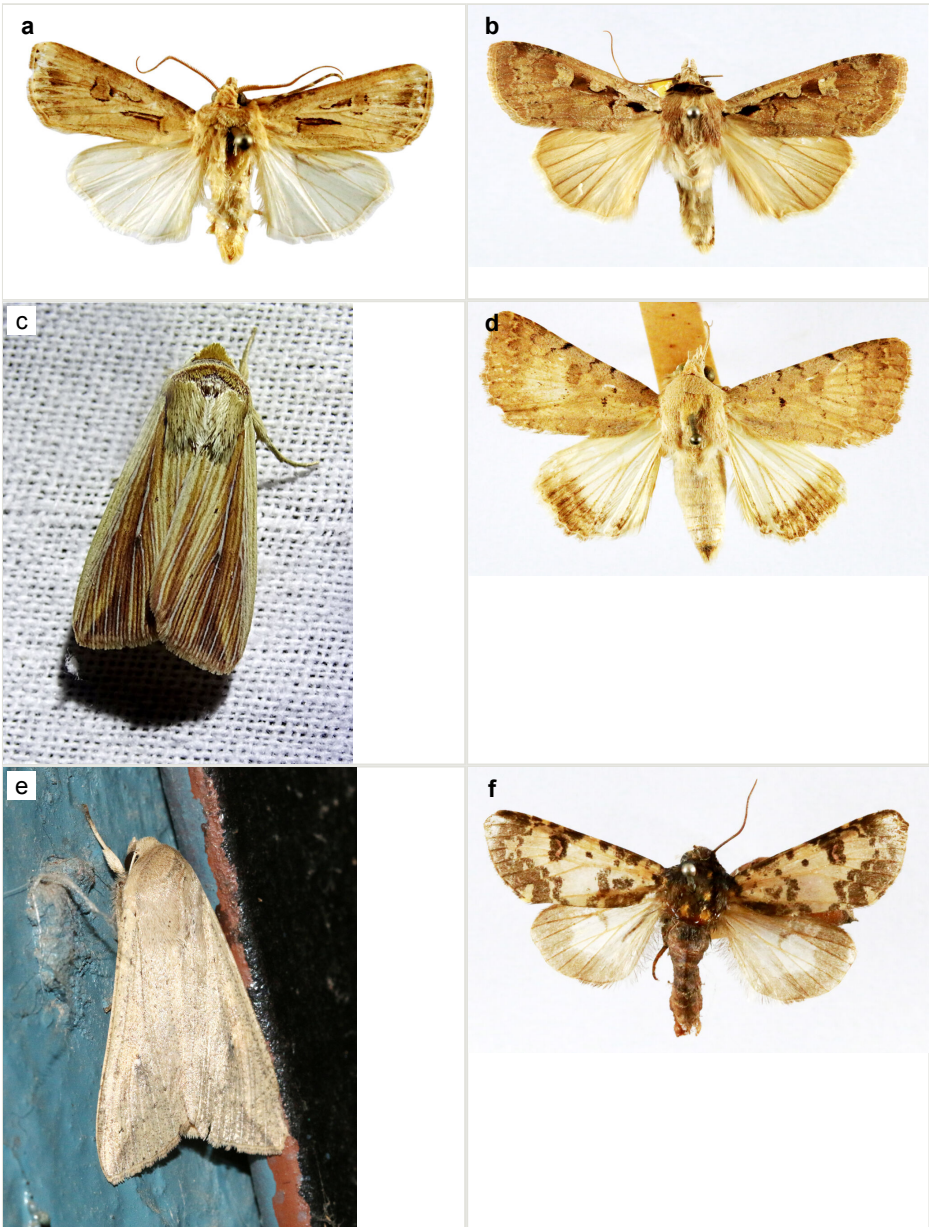


Figure 23.

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 albostrigata* (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



Figure 25.

Adults:

a: *Chrysodeixis eriosoma* [doi](#)

b: *Thysanoplusia orichalcea* [doi](#)

c: *Trichoplusia ni* [doi](#)

d: *Arcyophora dentula* [doi](#)

e: *Carea angulata* [doi](#)

f: *Earias cupreoviridis* [doi](#)

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: *Gjaura szeptica* [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

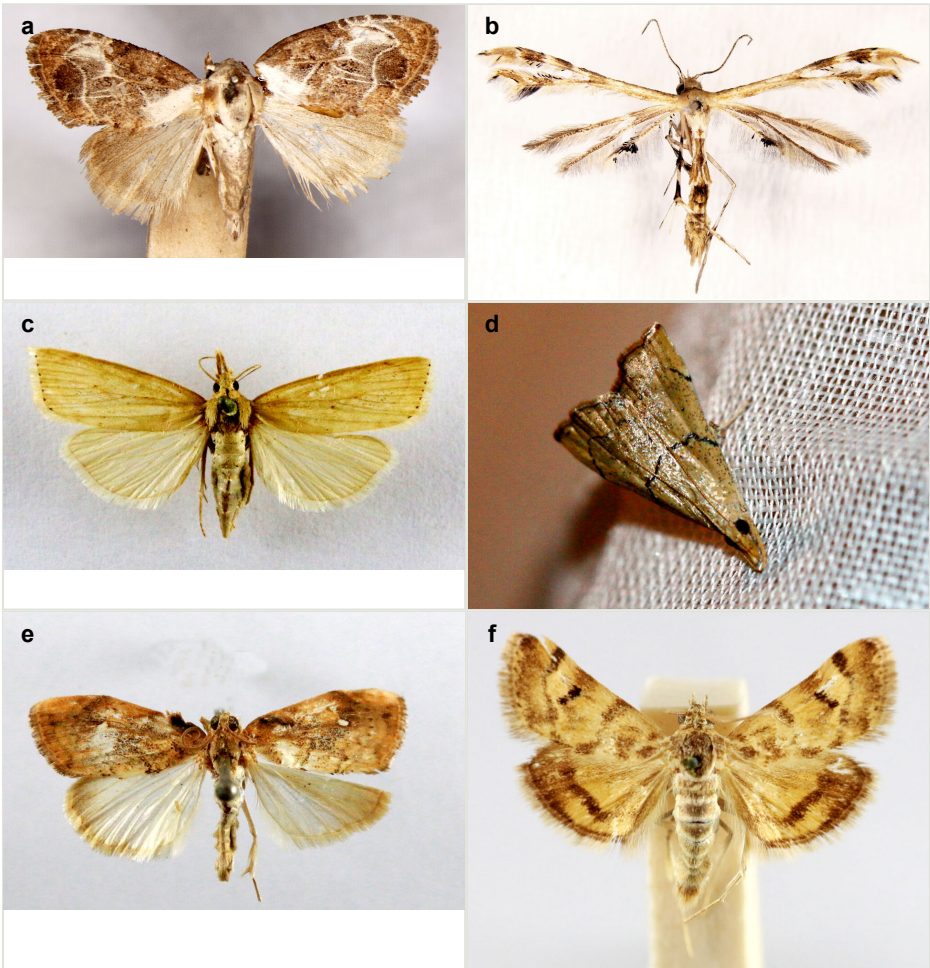


Figure 27.

Adults:

a: *Evonima plagiola* [doi](#)

b: *Sphenarches caffer* [doi](#)

c: *Chilo partellus* [doi](#)

d: *Ptychopseustis* sp. [doi](#)

e: *Crocidolomia pavonana* [doi](#)

f: *Aporodes floralis* [doi](#)

***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

***Paraponyx 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* [doi](#)

b: *Hydriris ornatalis* [doi](#)

c: *Pyrausta indistans* [doi](#)

d: *Spoladea recurvalis* [doi](#)

e: *Scirpophaga incertulas* [doi](#)

f: *Scirpophaga nivella* [doi](#)

***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* (Guenée, 1854)**

Notes: Paul et al. 2017; Fig. 29d

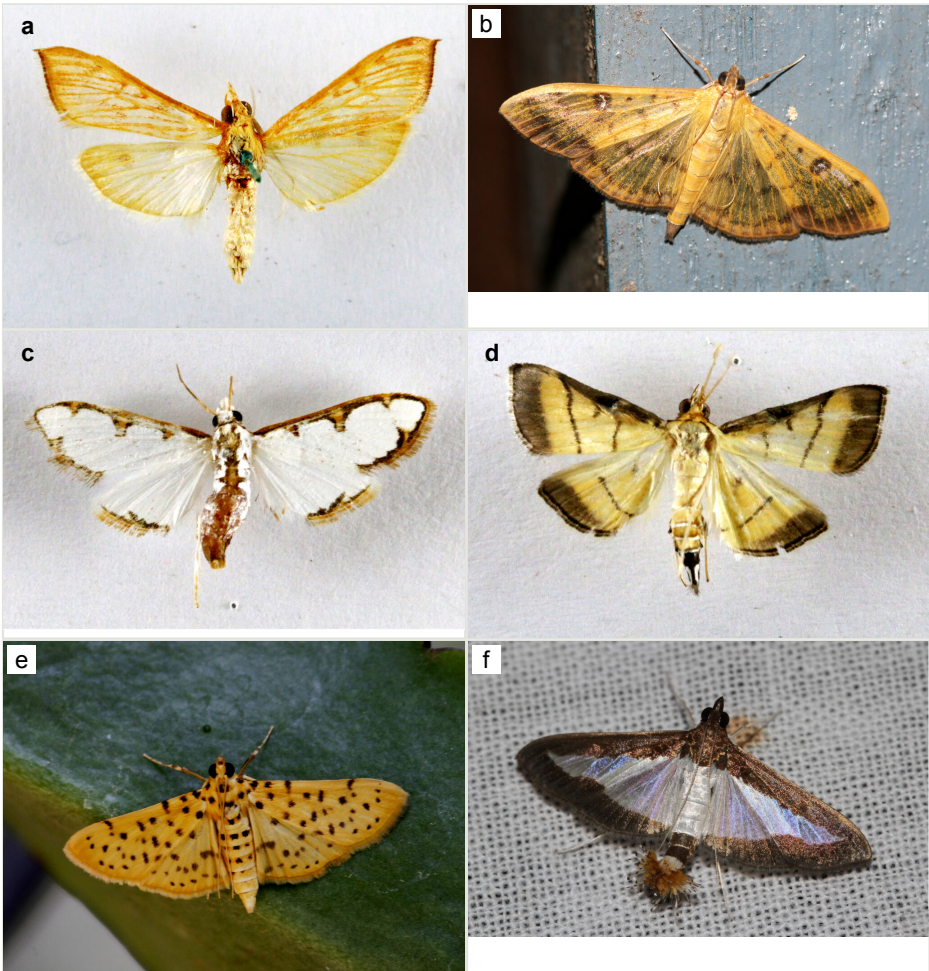


Figure 29.

Adults:

- a: *Antigastra catalaunalis* [doi](#)
 b: *Botyodes diniasalis* [doi](#)
 c: *Cirrhochrista brizoalis* [doi](#)
 d: *Cnaphalocrocis medinalis* [doi](#)
 e: *Conogethes punctiferalis* [doi](#)
 f: *Diaphania indica* [doi](#)

Cnaphalocrocis trapezalis (Guenée, 1854)

Notes: Inaturalist; Present study

***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

***Eurrhyarodes bracteolalis* (Zeller, 1852)**

Notes: Present study; Fig. 30a

***Eurrhyarodes 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 licarsisalis* (Walker, 1859)**

Notes: Inaturalist; Fig. 30d

***Herpetogramma phaeopteralis* (Guenee, 1854)**

Notes: Present study

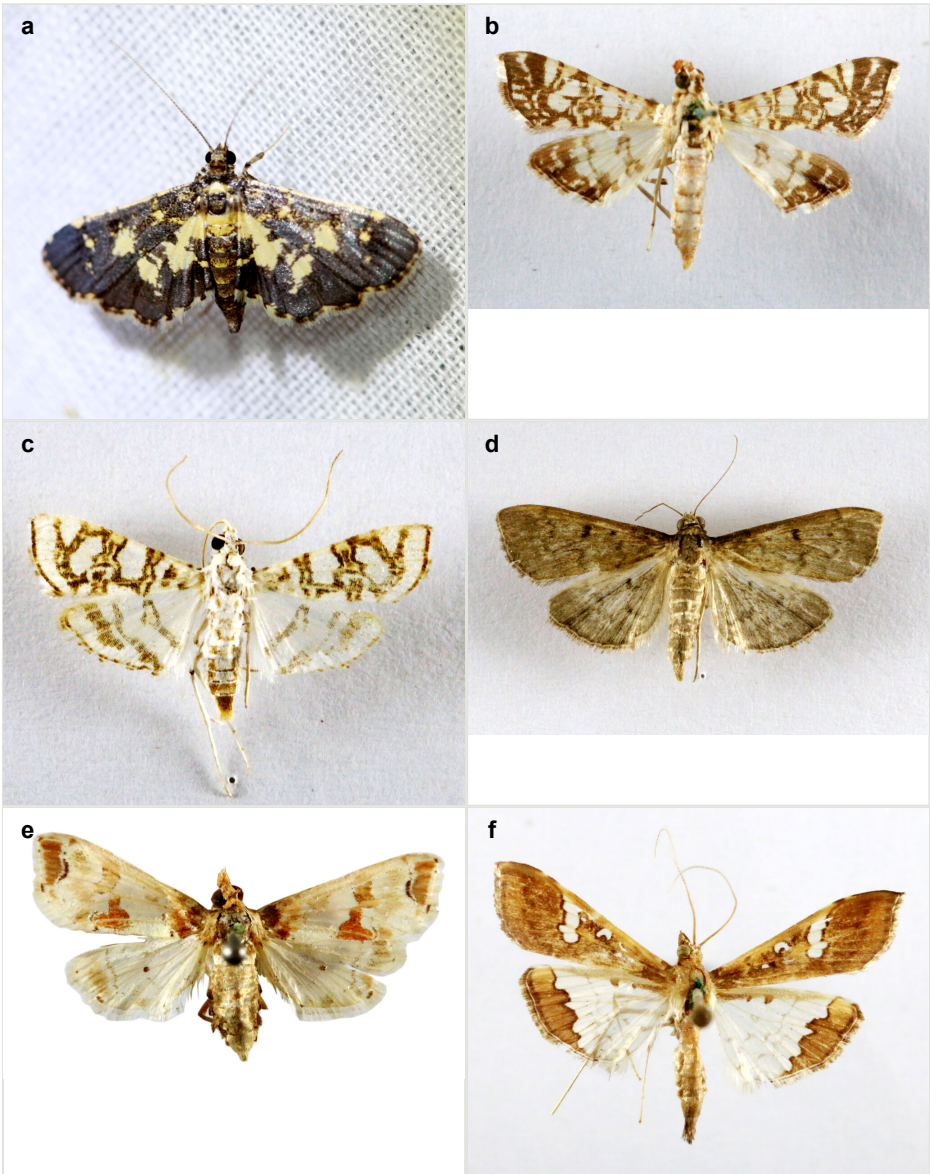


Figure 30.

Adults:

a: *Eurrhyarodes bracteolalis* [doi](#)b: *Glyphodes onychinalis* [doi](#)c: *Haritalodes derogata* [doi](#)d: *Herpetogramma licarsisalis* [doi](#)e: *Leucinodes orbonalis* [doi](#)f: *Maruca vitrata* [doi](#)

***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 aurolinealis* (Walker, 1859)**

Notes: Present study

***Omiodes indicata* (Fabricius, 1775)**

Notes: Present study

***Prorodes mimica* Swinhoe, 1894**

Notes: Gupta 1994

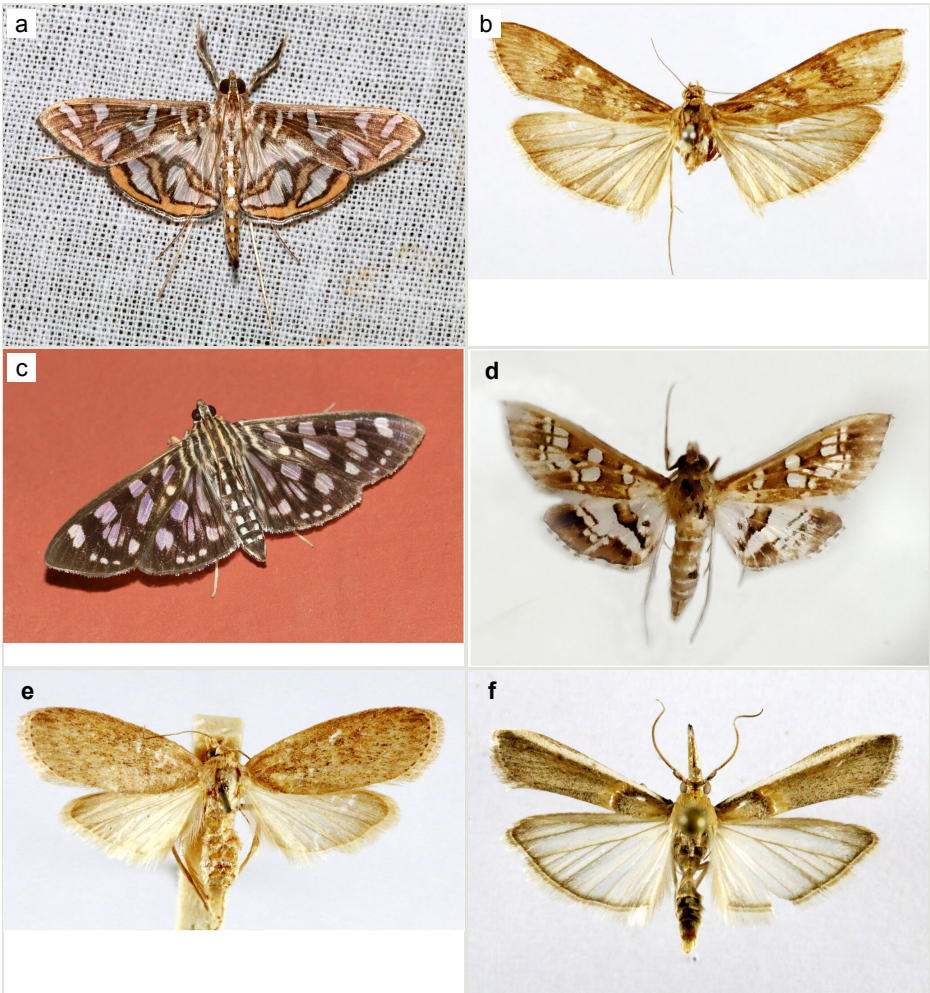


Figure 31.

Adults:

a: *Nausinoe perspectata* [doi](#)b: *Nomophila noctuella* [doi](#)c: *Pygospila tyres* [doi](#)d: *Sameodes cancellalis* [doi](#)e: *Trachylepidia fructicassella* [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

***Nephoterix 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

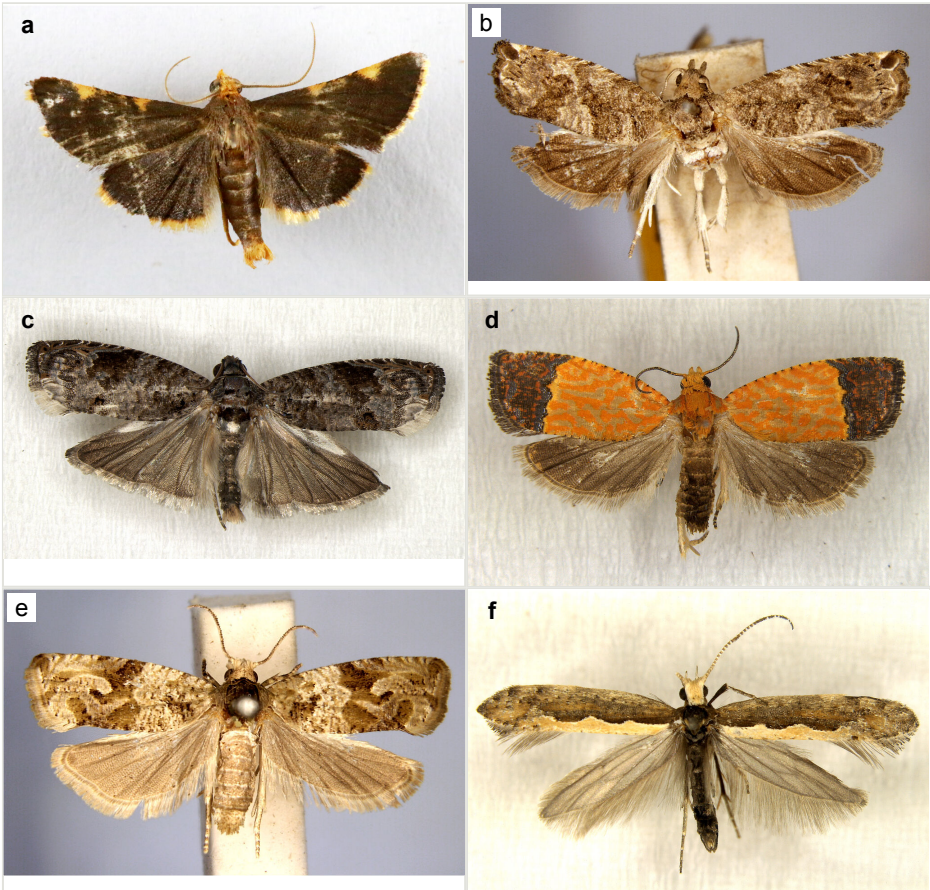


Figure 32.

Adults:

a: *Hypsopygia mauritialis* [doi](#)b: *Acanthoclitia balanoptycha* [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 balanoptycha* (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 sphenograpt* 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

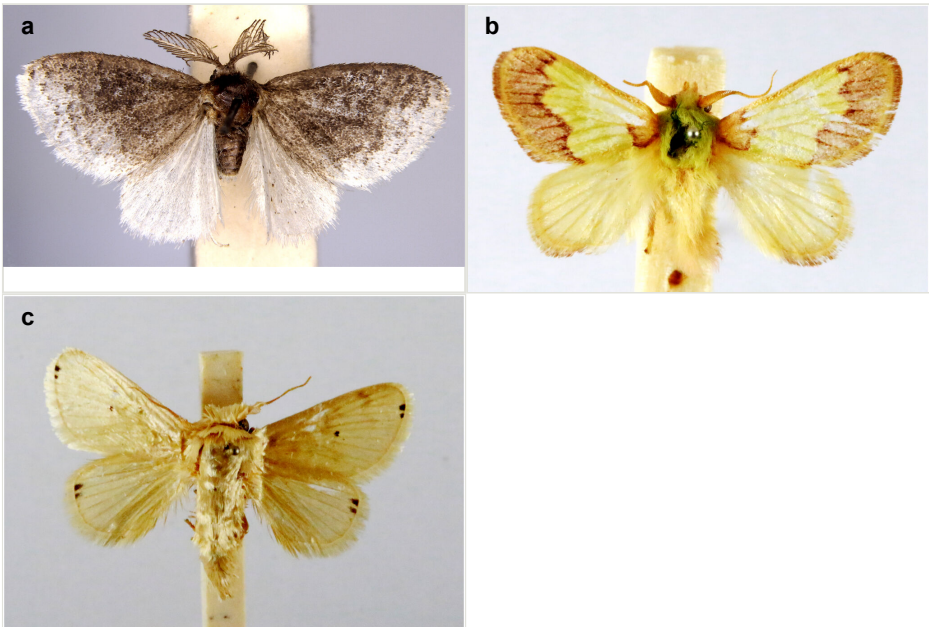


Figure 33.

Adults:

a: *Fulgoraecia melanoleuca* [doi](#)b: *Aergina hilaris* [doi](#)c: *Altha nivea* [doi](#)***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 Cossioidea, 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
Gelechioidea	15	Blastobasidae	1
		Coleophoridae	1
		Cosmopterigidae	2
		Elachistidae	3
		Gelechiidae	5
		Oecophoridae	1
		Scythrididae	1
		Stathmopodidae	1
Geometroidea	37	Geometridae	36
		Uraniidae	1
Gracillarioidea	5	Gracillariidae	5
Lasiocampoidea	7	Lasiocampidae	7
Hyblaeoidea	1	Hyblaeidae	1
Noctuoidea	164	Erebidae	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 (Macrolepidoptera 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.

References

- Arora G (2000) Studies on some Indian Pyralid species of Economic Importance, Part I. Crambinae, Schoenobiinae, Nymphulinae, Phycitinae and Galleriinae (Lepidoptera: Pyralidae). ZOOLOGICAL SURVEY OF INDIA. Occasional Paper No. 181: i-vii, 1-169. URL: <http://faunaofindia.nic.in/PDFVolumes/occpapers/181/index.pdf>
- Barlow HS (1982) An introduction to the moths of South East Asia. Malayan Nature Society, Kuala Lumpur.
- Bell TRD, Scott FB (1937) The Fauna of British India, including Ceylon and Burma. Moths, Vol. 5, Sphingidae. London, Taylor and Francis
- Bhagat R (2020) Biodiversity and updated checklist of moth caterpillar-fauna (Lepidoptera), damaging host tree and plant species of Jammu, Kashmir and Ladakh (India). Indian Forester 146 (2): 173-180.
- Biswas J, Dookia S, Faisal M (2017) Butterflies of Delhi with new additions and an annotated checklist from Delhi, India. International Journal of Zoological Studies 2 (6): 4-10.
- Champion HG, Seth SK (1968) A revised survey of the forest types of India. Manager of Publications
- Chandra K (2007) Moth diversity of Madhya Pradesh and Chhattisgarh, India, and its conservation measures; pp. 49 - 61. In: Kendrick RC (Ed.). Proceedings of the first Southeast Asian Lepidoptera Conservation Symposium, Hong Kong
- Common IFB (1990) Moths of Australia. Brill <https://doi.org/10.1071/9780643101227>
- Dabadghao P, Shankarnarayan KA, others (1973) The grass cover of India. Indian Council of Agriculture Research, New Delhi
- Dakshini K (1968) Vegetation of Delhi State: Mehrauli region, 1. Analysis of pattern. 34. Proceedings of National Institute of Sciences of India.
- Dar MA, Akbar SA, Wachkoo AA, Ganai MA (2020) Moth (Lepidoptera) fauna of Jammu and Kashmir state. In: Dar G, Khuroo A (Eds) Biodiversity of the Himalaya: Jammu and Kashmir State. 1, 18. Springer, Singapore. [ISBN 978-981-32-9174-4]. https://doi.org/10.1007/978-981-32-9174-4_31
- Dennis EB, Brereton T, Morgan BJ, Fox R, Shortall CR, Prescott T, Foster S (2019) Trends and indicators for quantifying moth abundance and occupancy in Scotland. Journal of Insect Conservation 23 (2): 369-380. <https://doi.org/10.1007/s10841-019-00135-z>
- Dey P,, Joshi K, Uniyal VP (2018) Common moths of WII. Wildlife Institute of India, Dehradun, India, 75 pp.

- Donahue JP (1966) An annotated list of the butterflies of Delhi, India. *Journal of Bombay Natural History Society* 63 (2): 235-259.
- Fletcher T (1920) Life histories of Indian insects: Microlepidoptera. *Memoirs of the Department of Agriculture in India*, Entomological Series 6: 77-79.
- Fletcher T (1932) Life-histories of Indian Microlepidoptera (second series) Alucitidae (Pterophoridae), Tortricina and Gelechiidae. New Delhi : Imperial Council of Agricultural Research 1-58.
- Fletcher T (1933) Life-histories of Indian Microlepidoptera (Second series) Cosmopterygidae to Neopseustidae. New Delhi : Imperial Council of Agricultural Research 1-85.
- Forest Survey of India (2019) State of forest report 2019. Ministry of Environment, Forest & Climate Change Government of India. URL: <https://fsi.nic.in/isfr-volume-ii?pgID=isfr-volume-ii>
- Fox R, Parsons M, Chapman J, Woiwod I, Warren M, Brooks D (2013) The state of Britain's larger moths 2013. *Butterfly Conservation and Rothamsted Research*, Wareham, Dorset, UK.
- Franzén M, Johannesson M (2007) Predicting extinction risk of butterflies and moths (Macrolepidoptera) from distribution patterns and species characteristics. *Journal of Insect Conservation* 11 (4): 367-390. <https://doi.org/10.1007/s10841-006-9053-6>
- Ghosh S, Varshney R (1997) Lepidoptera: Heterocera. In: Director, Zoological Survey of India, Kolkata (Ed.) *Zoological Survey of India, State Fauna Series 6: Fauna of Delhi*.
- Groenendijk D, Ellis W (2011) The state of the Dutch larger moth fauna. *Journal of Insect Conservation* 15 (1): 95-101. <https://doi.org/10.1007/s10841-010-9326-y>
- Gupta S (1994) Checklist of Indian Pyraustinae (Lepidoptera: Pyralidae). *Memoirs of the Entomological Society of India*. 14:1-8.
- Gurule SA, Nikam SM (2013) The moths (Lepidoptera: Heterocera) of northern Maharashtra: a preliminary checklist. *Journal of Threatened Taxa* 5 (12): 4693-4713. <https://doi.org/10.11609/JoTT.o2555.4693-713>
- Hallmann CA, Zeegers T, van Klink R, Vermeulen R, van Wielink P, Spijkers H, van Deijk J, van Steenis W, Jongejans E (2020) Declining abundance of beetles, moths and caddisflies in the Netherlands. *Insect Conservation and Diversity* 13 (2): 127-139. <https://doi.org/10.1111/icad.12377>
- Hampson G (1891) Illustrations of typical specimens of Lepidoptera Heterocera in the collection of the British Museum, Part VIII-The Lepidoptera Heterocera of the Nilgiri District. London, Taylor & Francis
- Hampson G (1892) The Fauna of British India including Ceylon and Burma. Moths, Vol. 1, Saturniidae to Hypsiidae. London, Taylor & Francis <https://doi.org/10.5962/bhl.title.100745>
- Hampson GF (1894) The Fauna of British India including Ceylon and Burma. Moths, Vol. 2, Arctiidae, Agrastidae, Noctuidae. London, Taylor & Francis
- Hampson GF (1895) The Fauna of British India including Ceylon and Burma. Moths, Vol. 3, Noctuidae (cont.) to Geometridae. London, Taylor & Francis
- Hampson GF (1896) The Fauna of British India including Ceylon and Burma. Moths, Vol. 4. Pyralidae. London, Taylor & Francis
- Holloway J (1988) The Moths of Borneo. Part 6; Family Arctiidae: Subfamilies Arctiinae, Syntominiæ, Aganainæ (to Noctuidæ). Southdene Sdn. Bhd., Kuala Lumpur, Malaysia.

- Holloway J (1997) The moths of Borneo. Part 10. Geometridae: Sterrhinae, Larentiinae and addenda to other subfamilies. *Malayan Nature Journal (Malaysia)* 51: 1-242.
- Holloway J (2003) The moths of Borneo. Part 18. Family Nolidae. Southdene, Kuala Lumpur, Malaysia.
- Holloway J (2011) The moths of Borneo: Families Phaudidae, Himantopteridae and Zygaenidae; revised and annotated checklist. *Malayan Nature Journal* 63 (1/2).
- Holloway JD (1983) The moths of Borneo. Part 4. Family Notodontidae. *Malayan Nature Journal (Malaysia)* 37: 1-107.
- Holloway JD (1985) The moths of Borneo. Part 14. Family Noctuidae: subfamilies Euteliinae, Stictopterinae, Plusiinae, Pantheinae. *Malayan Nature Journal (Malaysia)* 38: 157-317.
- Holloway JD (1986) The moths of Borneo. Part I. Key to families; Families Cossidae, Metarbelidae, Ratardidae, Dudgeoneidae, Epipyropidae and Limacodidae. *Malayan Nature Journal (Malaysia)* 40 (1/2).
- Holloway JD (1987) Superfamily Bombycoidea: Families Lasiocampidae, Eupterotidae, Bombycidae, Brahmaeidae, Saturniidae, Sphingidae. Superfamily Bombycoidea: families Lasiocampidae, Eupterotidae, Bombycidae, Brahmaeidae, Saturniidae, Sphingidae (3).
- Holloway JD (1989) The moths of Borneo: family Noctuidae, triline subfamilies: Noctuinae, Heliothinae, Hadeninae, Acronictinae, Amphipyrynae, Agaristinae. *Malayan Nature Journal (Malaysia)* 42 (2-3): 57-228.
- Holloway JD (1993) The moths of Borneo (Part 11): Family Geometridae, subfamily Ennominae. *Malayan Nature Journal (Malaysia)* 47: 1-309.
- Holloway JD (1996) The moths of Borneo (Part 9): Family Geometridae, subfamilies Oenochrominae, Desmobaethrinae and Geometrinae. *Malayan Nature Journal* 49: 147-326.
- Holloway JD (1998) The moths of Borneo (Part 8): Castniidae, Callidulidae, Drepanidae, Uraniidae. *Malayan Nature Journal (Malaysia)* 52: 1-155.
- Holloway JD (1999) The moths of Borneo (Part 5): Family Lymantriidae. *Malayan Nature Journal (Malaysia)* 53: 1-188.
- Inoue H, Kennett R, Kitching IJ (1996) Moths of Thailand: Sphingidae. *Brothers of St Gabriel in Thailand, Bangkok*.
- Kendrick RC (2002) Moths (insecta: lepidoptera) of Hong Kong. University of Hong Kong, Hong Kong SAR. https://doi.org/10.5353/th_b3027883
- Kirti J, Singh N (2015) Arctiid moths of India. Vol. 1. Nature Books India, New Delhi
- Kirti J, Singh N (2016) Arctiid moths of India. Vol. 2. Nature Books India, New Delhi
- Kononenko V, Pinratana A (2005) Moths of Thailand, Volume 3. Noctuidae. Bangkok, Brothers of St Gabriel in Thailand
- Kononenko V, Pinratana A (2013) Moths of Thailand, Vol. 3, Part 2. Noctuoidea. An illustrated catalogue of Erebidae, Nolidae, Euteliidae, and Noctuidae (Insecta: Lepidoptera) in Thailand. Bangkok, Brothers of St Gabriel in Thailand
- Kumar R, Ramamurthy VV, Kumar N (2012) Biosystematics of major lepidopteran pests of vegetables. LAP Lambert Academic Publishing, 348 pp.
- MacGregor CJ, Pocock MJ, Fox R, Evans DM (2015) Pollination by nocturnal Lepidoptera, and the effects of light pollution: a review. *Ecological Entomology* 40 (3): 187-198. <https://doi.org/10.1111/een.12174>

- Maheshwari J (1963) The flora of Delhi. National Institute of science communication, Council of Scientific and Industrial Research, New Delhi
- Maheshwari S (1953) Vegetation of Delhi Ridge. Journal of Bombay Natural History Society 51: 439-465.
- Mallet J (2007) Taxonomy of Lepidoptera: the scale of the problem. The Lepidoptera Taxome Project.
- Mandal D, Bhattacharya D (1979) On the Pyraustinae (Lepidoptera: Pyralidae) from the Andaman, Nicobar and Great Nicobar islands, Indian ocean. Records of the Zoological Survey of India. 77: 293-342. URL: <http://faunaofindia.nic.in/PDFVolumes/records/077/01-04/0293-0342.pdf>
- Mathew G, Rahmathulla V (1995) Biodiversity in the Western Ghats-A study with reference to moths (Lepidoptera: Heterocera) in the silent valley National Park, India. Entomon 20: 25-34.
- Miller-Rushing A, Primack R, Bonney R (2012) The history of public participation in ecological research. Frontiers in Ecology and the Environment 10 (6): 285-290. <https://doi.org/10.1890/110278>
- Moore F (1880) The Lepidoptera of Ceylon Vol. 1. L. Reeve & Co <https://doi.org/10.5962/bhl.title.8801>
- Moore F (1882) The Lepidoptera of Ceylon Vol. 2. L. Reeve & Co
- Moore F (1884) The Lepidoptera of Ceylon Vol. 3. L. Reeve & Co
- MPD (2021) Master Plan for Delhi – 2021. Delhi: Delhi Development Authority. URL: https://dda.org.in/mpd_2021.aspx
- Nazneen (2019) Dragonflies & Damselflies in & around Delhi: A Field Guide. DK India & WWF India
- Paul M, Das SK, Singh R, Shashank P (2016) Moth (Lepidoptera: Heterocera) fauna of Delhi with notes on their role as potential agricultural pests. Journal of Entomology and Zoology Studies 4 (2): 435-438.
- Paul M, Das S, Singh R, Pathania P (2017) Study and updated checklist of moths (Lepidoptera: Heterocera) in selected areas of Delhi, India. International Journal of Current Research 9 (08): 56208-56214.
- Paul M (2021) Impact of urbanization on moth (Insecta: Lepidoptera: Heterocera) diversity across different urban landscapes of Delhi, India. *Acta Ecologica Sinica* 41 (3): 204-209. <https://doi.org/10.1016/j.chnaes.2021.01.008>
- Pocock MJ, Roy HE, Preston CD, Roy DB (2015) The Biological Records Centre: a pioneer of citizen science. Biological Journal of the Linnean Society 115 (3): 475-493. <https://doi.org/10.1111/bij.12548>
- Robinson GS, Tuck KR, Shaffer M (1994) Field guide to the smaller moths of South-East Asia. Natural History Museum
- Roe BE, Just DR (2009) Internal and external validity in economics research: Tradeoffs between experiments, field experiments, natural experiments, and field data. American Journal of Agricultural Economics 91 (5): 1266-1271. <https://doi.org/10.1111/j.1467-8276.2009.01295.x>
- Rose H (2002) An inventory of the moth fauna (Lepidoptera) of Jatinga, Assam, India. Zoos' Print Journal 17 (2): 707-721. <https://doi.org/10.11609/JoTT.ZPJ.17.2.707-21>
- Schintlmeister A, Pinratana A (2007) Moths of Thailand. Vol. 5. Notodontidae. Bangkok, Brothers of St Gabriel in Thailand

- Sharma S, Nahid S, Sharma M, Sannigrahi S, Anees MM, Sharma R, Shekhar R, Basu AS, Pilla F, Basu B, others (2020) A long-term and comprehensive assessment of urbanization-induced impacts on ecosystem services in the capital city of India. *City and Environment Interactions* 7.
- Shubhalaxmi V, Kendrick RC, Vaidya A, Kalagi N, Bhagwat A (2011) Inventory of moth fauna (Lepidoptera: Heterocera) of the northern western Ghats, Maharashtra, India. *Journal of the Bombay Natural History Society* 108 (3): 183-205.
- Singh N, Ahmad J, Joshi R (2017) Diversity of moths (Lepidoptera) with new faunistic records from North East Jharkhand, India. *Records of the Zoological Survey of India* 117 (4): 326-340. <https://doi.org/10.26515/rzsi/v117/i4/2017/121289>
- Sinha G (2014) An introduction to the Delhi Ridge. Department of Forest and Wildlife, Government of National Capital Territory of Delhi
- Smetacek P (2011) Review of Indian Lepidoptera collections and their significance in conservation. *ENVIS Bulletin: Arthropods and their conservation in India (Insects & Spiders)* 14 (1): 135-139.
- Sondhi S, Y. Sondhi, Roy P, Kunte K (2021) Moths of India. <https://www.mothsofindia.org/>. Accessed on: 2021-2-15.
- Sondhi Y, Sondhi S (2016) A partial checklist of moths (Lepidoptera) of Dehradun, Mussoorie and Devalsari in Garhwal, Uttarakhand, India. *Journal of Threatened Taxa* 8 (5): 8756-8776. <https://doi.org/10.11609/jott.2814.8.5.8756-8776>
- Sondhi Y, Sondhi S, Pathour SR, Kunte K (2018) Moth diversity (Lepidoptera: Heterocera) of Shendurney and Ponmudi in Agasthyamalai Biosphere Reserve, Kerala, India, with notes on new records. *Tropical Lepidoptera Research*.
- Van Nieuwerkerken EJ, Kaila L, Kitching IJ, Kristensen NP, Lees DC, Minet J, Mitter C, Mutanen M, Regier JC, Simonsen TJ, others (2011) Order Lepidoptera Linnaeus, 1758. In: Zhang Z-Q (Ed.) *Animal biodiversity: an outline of higher-level classification and survey of taxonomic richness*. *Zootaxa* 3148 (1): 212-221. <https://doi.org/10.11646/zootaxa.3148.1.41>
- Vaughan N (1997) The diets of British bats (Chiroptera). *Mammal Review* 27 (2): 77-94. <https://doi.org/10.1111/j.1365-2907.1997.tb00373.x>
- Wickramasinghe LP, Harris S, Jones G, Vaughan Jennings N (2004) Abundance and species richness of nocturnal insects on organic and conventional farms: effects of agricultural intensification on bat foraging. *Conservation Biology* 18 (5): 1283-1292. <https://doi.org/10.1111/j.1523-1739.2004.00152.x>
- Zagrobelny M, Dreon AL, Gomiero T, Marcazzan GL, Glaring MA, Møller BL, Paoletti MG (2009) Toxic moths: source of a truly safe delicacy. *Journal of Ethnobiology* 29 (1): 64-76. <https://doi.org/10.2993/0278-0771-29.1.64>
- Zolotuhin V, Pinratana A (2005) Moths of Thailand, Volume 4: Lasiocampidae. Bangkok, Brothers of St Gabriel in Thailand