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A checklist of moths in Bilaspur district, Himachal Pradesh, in the western Himalayan foothills, India

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ABSTRACT: In the first ever enumeration of moth diversity of Bilaspur district, Himachal Pradesh, India, located mostly in the Shivalik range, 82 species/morphospecies were reported, at least 22 of which are new records for Himachal Pradesh, and five are new records for Western Himalayas. In addition to a list of moths for the district supplemented with photographs, identification keys for similar species, larval host plants for species, and a near exhaustive dataset of distribution of the species/genera within and outside India are also provided.

KEY WORDS: Heterocera, Shivalik range, morphotaxonomy, distribution, surveys, morphospecies

INTRODUCTION

Moths are used for individual conservation management as well as indicators of environmental and vegetation changes (Dey *et al.*, 2015). For conservation of such assemblages, species diversity analysis is significantly important. Moth diversity and allied studies have been conducted across the Himalayan ranges. For example, in the Eastern Himalayas, there has been a study which enumerated settling moths in sites within the Eastern Himalayas (Sikkim, North Bengal and Arunachal Pradesh), recording 140 species (Singh *et al.*, 2022). In the Central Himalayas (Nepal), diversity of moths have been enumerated over the years from 1992-2000 (Haruta, 1992, 1993, 1994, 1995, 1998, 2000). Moth diversity studies in the Western Himalayas seem to be higher compared to the other parts. Certain regions of Western Himalayas have been explored starting from Cotes and Swinhoe (1887) in 'A catalogue of moths of India' and Hampson in 'Fauna of British India: Moths. Vol I' (1892).

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In the state of Uttarakhand, there have been a number of studies such as the one in Nanda Devi Biosphere Reserve, spread across the districts of Chamoli, Pithoragarh and Bageshwar in Garhwal Himalayas (Dey *et al.*, 2017). Due to extensive studies, a checklist for the whole of Jammu and Kashmir is available (Dar *et al.*, 2020). Some studies were done in landscapes that straddle between two main administrative units, such as in the Tons Valley in the high-altitude region shared between the states of Himachal Pradesh and Uttarakhand (Bhardwaj *et al.*, 2012). Some studies spanned all three main administrative units in the W. Himalayas such as the study of diversity of Lymantriidae family (tussock moths) (Kaleka, 2012). While there have been several studies on moth diversity across the Himalayas, several parts remain completely unexplored, especially at the finer level biodiversity preservation efforts are geared towards (by the forest departments), such as at the district level. Some among them are the districts falling under the Shivalik range in Himachal Pradesh. One in particular with no moth studies till date is Bilaspur district. While a recent study has thoroughly documented moths across the Shivalik range, it was largely restricted to Uttarakhand (Singh and Lekhendra, 2023), and did not cover Bilaspur district. The aim of the current study is to document moth biodiversity of this district, in the Lower Himalaya biogeographical zone.

MATERIALS AND METHODS

The study area is Bilaspur district, which is largely located in the Lower Himalaya biogeographical zone (in the biogeographical province of 2B: West Himalaya), with a minor part in the Middle Himalaya (in the 2A: North-West Himalaya province), in the state of Himachal Pradesh (Rodgers and Panwar, 1988; Chauhan *et al.*, 2020). Most of the district is part of the Shivalik range of the Himalayas (Yadav *et al.*, 2015). The elevation varies quite considerably between ~300 m asl to ~1800 m asl, resulting in a wide range of habitats and climatic conditions.

As part of surveys for the project 'High resolution spatial mapping of bird phenology as an indicator of ecosystem health in relation to climate change in Himalaya', two circular plots each of 25 m radius within 34 stratified random hexagons (with sides of approx. 500 m) were intensively studied, with at least two survey efforts each (except one hexagon), separated temporally by 26-120 days. Within each such circular plot, 1 to 3.5 hours of intensive sampling of invertebrates were carried out using methods of visual encounter surveys and temporarily flushing the ground litter using boots or sticks. All invertebrates sighted were noted down and photographed for identification and/or documentation. Since all moths were unidentifiable at that time, they were repeatedly photographed in every plot. Moths were also photographed opportunistically when sighted along the route to survey plots or at the basecamps in Bilaspur town. Since the surveys were diurnal, most of the moth species inventoried are diurnal. However, several nocturnal or crepuscular species were also recorded in the basecamps. The sampling was done from 16th March 2020 to 1st November 2021. Moths were identified through morphotaxonomy with the help of the following resources: i) Citizen science websites like Moths of India (Sondhi *et al.*, 2024), iNaturalist (iNaturalist, 2024) and India Biodiversity Portal (Vattakaven *et al.*, 2016), ii) books like Fauna of British India: Moths Vol I-IV (Hampson, 1892, 1894, 1895, 1896) and Moths of Borneo (Holloway, 2024).

RESULTS AND DISCUSSION

A total of 78 moth species/morphospecies were recorded during our study (Plates 1-7). An additional four species were found from the citizen science platform iNaturalist, which were not recorded during our study (Kohli, 2021a, 2021b, 2021c; Mujumdar, 2023). These 82 species in Bilaspur district belong to nine super families and 12 families (including 45 identified to species level, 25 to genus level, and 12 to higher taxonomic levels). The checklist contains the details of the species, along with known larval host plants and identification keys for species which have morphologically similar counterparts. The larval host plants are the ones recorded in India, gathered from available publications (from Robinson *et al.*, 2010 unless specified) and all may not be found in Bilaspur

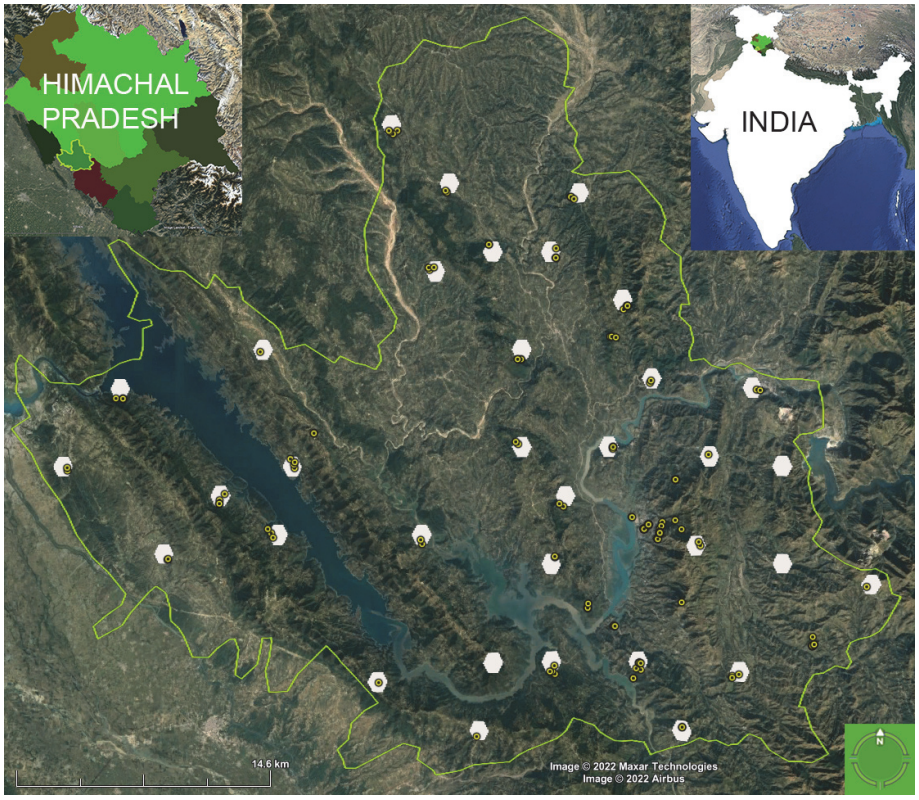


Fig.1 Study area of Bilaspur district. Hexagons represent the stratified random sampling cells and the circles represent the locations in which moths were observed

district (and only for moths identified to the species level). Distribution of the species around the world as well as within India has been given in the supplementary dataset (Zenodo: https://doi.org/10.5281/zenodo.13248751).

Superfamily Bombycoidea; Family Sphingidae; Subfamily Macroglossinae; Tribe Hemarini

1. *Cephonodes hylas* (Linnaeus, 1771): The dark pink band on the dorsal side of the abdomen has two prominent thick black bands on either side (which is faint and thin in a similar species *C. picus*). **Host plants**: *Xylia xylocarpa* (Roxb.) W.Theob. (Fabaceae), *Tectona grandis* L.f. (Lamiaceae), *Catunaregam spinosa* Thunb., Tirveng., *Gardenia* J.Ellis sp., *Haldina cordifolia* (Roxb.) Ridsdale, *Hymenodictyon obovatum* Wall., *Hymenodictyon orixense* (Roxb.) Mabb., *Mitragyna diversifolia* (Wall. ex G.Don) Havil., *Mitragyna parvifolia* (Roxb.) Korth, (Rubiaceae)

Superfamily Choreutoidea; Subfamily Brenthiinae; Family Choreutidae; Tribe Choreutini

2. *Brenthia* Clemens, 1860 sp.

Superfamily Gelechioidea

3. *Morphospecies A*

Superfamily Geometroidea; Family Geometridae; Subfamily Desmobathrinae; Tribe Eumeleini

4. *Eumelea* cf. *rosalia* (Stoll, [1781]): Prominent, continuous crimson bands on both dorsal and ventral sides, which is discontinuous in similar species *E. ludovicata*. **Host plant**: *Mallotus* Lour. sp. (Euphorbiaceae)

Subfamily Ennominae; Tribe Abraxini

5. *Abraxas* Leach, 1815 sp.

1. *Cephonodes hylas*, 2. *Brenthia* sp., 3. *Hyposada hydrocampata*, 4. *Morphospecies A*, 5. *Eumelea cf. rosalia*, 6. *Hyperythra lutea*, 7. *Chiasmia* sp., 8. *Chiasmia eleonara*, 9. *Chiasmia* cf. *fidoniata*, 10. *Chiasmia perfusaria*, 11. *Isturgia* sp., 12. *Morphospecies B*

Tribe Caberini

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

Host plants: *Ziziphus oenoplia* (L.) Mill., *Gouania leptostachya* DC. (Rhamnaceae)

Tribe Macariini

7. *Chiasmia* Hübner, 1823 sp.

8. *Chiasmia eleonora* (Cramer, [1780]): Unlike *C. eleonora*, *C. nora* is suffused with black, especially beyond the medial band of both wings. In *C. nora*, forewing has a black speck at end of cell, and the black patches in the hindwing beyond the band are more numerous, with a white patch on the outer area below vein 4 (Hampson, 1895).

9. *Chiasmia* cf. *fidoniata* Guenée, 1858

10. *Chiasmia perfusaria* (Walker, 1866)

11. *Isturgia* Hübner, 1823 sp.: As per morphology, current distribution, and species listed under the genus in India, *I. disputaria* is the only option, but requires more taxonomic studies before this species can be confirmed, as it's an African species, and may not occur in India.

12. *Morphospecies B*

Subfamily Geometrinae

13. *Agathia* Guenée, 1858 sp.

Subfamily Sterrhinae; Tribe Cosymbiini

14. *Traminda mundissima* (Walker, 1861)

Host plants: *Senegalia catechu* (L.f.) P.J.H.Hurter & Mabb., *Vachellia nilotica* (L.) P.J.H.Hurter & Mabb. (Fabaceae)

Tribe Cyllopodini

15. *Rhodostrophia stigmatica* Butler, 1889: Similar to *R. vibicaria* but description given in Butler (Ed.) (1889) matches more with *R. stigmatica*. Although the discocellular spots don't look black as described, it looks darker than the red for *R. vibicaria*. The spot also looks more oblong for *R. vibicaria* as shown in Rennwald (Ed.) (2019). The second line in this individual looks narrower than *R. vibicaria*.

Tribe Rhodometrini

16. *Rhodometra sacraria* (Linnaeus, 1767)

Host plant: *Rumex vesicarius* L. (Polygonaceae)

Tribe Scopulini

17. *Problepsis vulgaris* Butler, 1889

18. *Scopula* Schrank, 1802 sp.: There could be two species of *Scopula* amongst the photographed *Scopula* spp. given the morphological variations. But we are considering only one species due to lack of clarity (note that the morphospecies *Scopula* sp. 17 and sp. 18 in Plate 2 could be the same).

Family Uraniidae; Subfamily Epipleminae

19. *Orudiza protheclaria* Walker, 1861

Host plants: *Bajanella sp., Oroxylum indicum* Vent. (Bignoniaceae) (Smetacek & Smetacek, 2011)

Superfamily Lasiocampoidea; Family Lasiocampidae; Subfamily Lasiocampinae; Tribe Pinarini

20. *Lebeda nobilis* ssp. *nobilis* Walker, 1855: Only one similar species in India - *Lebeda trifascia* Walker, 1855, which has nearly parallel lines on the dorsal region, compared to the curved and spreading lines in *L. nobilis*. **Host plants**: *Casuarina equisetifolia* L. (Casuarinaceae), *Cupressus* L. (Cupressaceae), *Pteridium aquilinum (L.) Kuhn* (Dennstaedtiaceae), *Quercus* L. sp. (Fagaceae), *Myrica rubra* Siebold & Zucc. (Myricaceae), *Pinus kesiya* Royle ex Gordon (Pinaceae), *Thysanolaena latifolia* (Roxb. ex Hornem.) Honda (Poaceae), *Rubus* L. sp. (Rosaceae), *Camellia* L. (Theaceae).

Superfamily Noctuoidea; Family Erebidae

21. *Morphospecies C* (Caterpillar): Individuals with two pairs of functional abdominal prolegs and anal claspers belongs with a high degree of certainty, to the family Erebidae. In contrast, individuals in the

family Geometridae only have one pair of functional abdominal prolegs.

22. *Morphospecies D*

Subfamily Aganainae

23. *Asota plaginota* (Butler, 1875)

Host plants: Millets sp. (Poaceae) (Kalaisekar *et al.*, 2016)

Subfamily Anobinae; Tribe Anobini

24. *Anoba* Walker, 1858 sp.

25. *Plecoptera* Burmeister, 1839 sp.

Subfamily Arctiinae; Tribe Lithosiini

26. *Siccia* Walker, 1854 (= *Aemene* Walker, 1854) sp.

27. *Cyana* cf. *chrysopeleia* N.Singh, Volynkin, Kirti & Datta, 2020

28. *Morphospecies E* (Caterpillar)

29. *Morphospecies F*: *Wittia sororcula* (Hufnagel, 1766) or Lithosiini-genera sp. or *Eilema* sp. Or *Katha* sp. Morphological characters are similar in all genera, except for variations in coloration which would not provide the correct identification.

Subtribe Nudariina

30. *Miltochrista* cf. *undulata* (Swinhoe, 1903)

Tribe Arctiini; Subtribe Spilosomina

31. *Morphospecies G* (Caterpillar)

Subfamily Boletobiinae; Tribe Aventiini

32. *Cerynea punctilinealis* Walker, 1865: two black spots on costa, which is single in similar species *C. ustula*.

33. *Hyposada hydrocampata* (Guenée, 1857): *Hyposada hydrocampata* has large black dots on the forewings unlike *Phalacra* spp..

Tribe Eublemmini

34. *Eublemma cochylioides* (Guenée, 1852)

Host plants: *Vigna unguiculata* (L.) Walp. (Fabaceae); *Lactuca sativa* L., *Elephantopus scaber* L. (Asteraceae)

Tribe Phytometrini

35. *Rhesala* Walker, 1858 sp.

Subfamily Calpinae

36. *Fodina pallula* Guenée, 1852

Host plant: *Vallaris solanacea* (Apocynaceae)

Tribe Calpini

37. *Oraesia emarginata* (Fabricius, 1794): Both adult and caterpillar stages of *Oraesia* were recorded during the study. The fore wing pattern (transverse dark brown bands with pale white striations) are as described in literature, but the hindwing pattern is necessary confirm the species. However, *Oraesia argyrosigna* is the only other similar species found nearby, and they are darker.

Subfamily Erebinae

38. *Morphospecies H* (Caterpillar)

Either in the tribe Ophiusini or Poaphilini

Tribe Acantholipini

39. *Acantholipes trajecta* (Walker, 1865): Hind wings have a dark brown patch, above which a discontinuous band is present, which is absent in similar-looking *A. circumdata*.

Tribe Poaphilini

40. *Dysgonia torrida* (Guenée, 1852): Compared to the similar-looking *D. algira* whose middle band on the forewing is grey and has angular lines (especially the inner line) on the narrowest part, *D. torrida* has a middle band that is clear to white and has rounded lines on the narrowest part (Demerges and Grandmaire, 2014).

Tribe Erebini

41. *Erebus hieroglyphica* (Drury, 1773)

Tribe Hypopyrini

42. *Hypopyra* Guenee, 1852 sp. or *Spirama*

Guenée, 1852 sp.: While the individual looks like *Hypopyra*, individuals of the genus *Spirama* sometimes only have part of the spiral present like the discal stigma in *Hypopyra*.

Tribe Euclidiini

43. *Mocis frugalis* (Fabricius, 1775)

Host plants: *Cyperus rotundus* L. (Cyperaceae); *Vigna radiata* (L.) R. Wilczek (Fabaceae); *Sorghum bicolor* (L.) Moench, *Oryza sativa* L., *Megathyrsus maximus* (Jacq.) B.K.Simon & S.W.L.Jacobs, *Saccharum officinarum* L. (Poaceae); Zingiberaceae sp.

44. *Mocis undata* (Fabricius, 1775)

Host plants: *Phaseolus* Hennig, 1932 (Chlorophyceae); *Shorea robusta* Roth (Dipterocarpaceae); H*evea brasiliensis* (Willd. ex A.Juss.) Müll.Arg. (Euphorbiaceae); *Butea monosperma* (Lam.) Taub., *Cajanus cajan* (L.) Millsp., *Dalbergia latifolia* Roxb., *Glycine max* (L.) Merr., *Indigofera* L., *Ougeinia oojeinensis* (Roxb.) Hochr., *Rhynchosia minima* (L.) DC., *Vigna mungo* (L.) Hepper, *Vigna trilobata* (L.) Verdc., *Vigna unguiculata* (L.) Walp. (Fabaceae); *Gossypium* L. (Malvaceae); *Solanum tuberosum* L. (Solanaceae)

Subfamily Herminiinae

45. *Herminia undulata* (Moore, 1882): Submarginal line have a white lining unlike other *Herminia* spp. occuring in Asia, such as the *Herminia kurukoi*. The rest of features matches the description by Moore (1879).

46. *Hydrillodes* Guenée, 1854 sp.

Subfamily Hypeninae

47. *Rhynchina* Guenée, 1854 sp.

48. *Dichromia sagitta* (Fabricius, 1775)

Host plants: *Stephanotis volubilis* (L.fil.) S.Reuss, Liede & Meve, *Tylophora asthmatica* (L.fil.) Wight & Arn., *Vincetoxicum indicum* (Burm.fil.) Mabb., *Vincetoxicum lindleyi* A.Kidyoo, (Apocynaceae) (Gole & Das, 2011; National Bureau of Agriculturally Important Insects, 2013), Asclepiadaceae sp. (Swafvan & Sureshan, 2022)

Subfamily Lymantriinae; Tribe Nygmiini

49. *Morphospecies I*

Subfamily Rivulinae

50. *Bocula* Guenée, 1852 sp.

51. *Rivula* Guenée [1845] sp.: *Rivula basalis* or *R. simulatrix*: This individual is likely *Rivula basalis* but these two species can only be confidently be separated by features in their hind-wing and abdomen, which is not visible in the image taken.

Subfamily Tinoliinae

52. *Calesia haemorrhoa* Guenée, 1852: The wing pattern is similar to *C. fuscicorpus*, but *C. dasypterus* has a distinct reddish abdomen. Females of *C. dasyptera* look similar but have prominent white dots on the forewing. The frons and palpi is orangish (clearly contrasting the reddish abdomen) in *C. haemorrhoa*, instead of bright red like individuals of *C. dasyptera*. *C. haemorrhoa* show 3 prominent squiggly dark lines over the greyish-black or greyish-brown dorsal side, whereas the females of *C. dasyptera* has only one prominent dark line running through the mid-dorsal portion of all the wings, like a necklace. **Host plants**: *Barleria cristata* L., *Justicia adhatoda* L., *Justicia wynaadensis* (Nees) B.Heyne, *Eranthemum purpurascens* Wight ex Nees (Acanthaceae)

Family Noctuidae; Subfamily Agaristinae

53. *Episteme* Hübner, 1820 sp.

Subfamily Condicinae; Tribe Condicini

54. *Condica* Walker, 1856 sp.: Proportionately bigger and bulkier thorax compared to the similar-looking *Amyna* spp.

Subfamily Eriopinae

55. *Callopistria* Hübner, [1821] sp.

Subfamily Eustrotiinae

56. *Amyna* Guenée, 1852 sp.

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

Host plant: *Oryza sativa* L. (Poaceae)

Subfamily Heliothinae

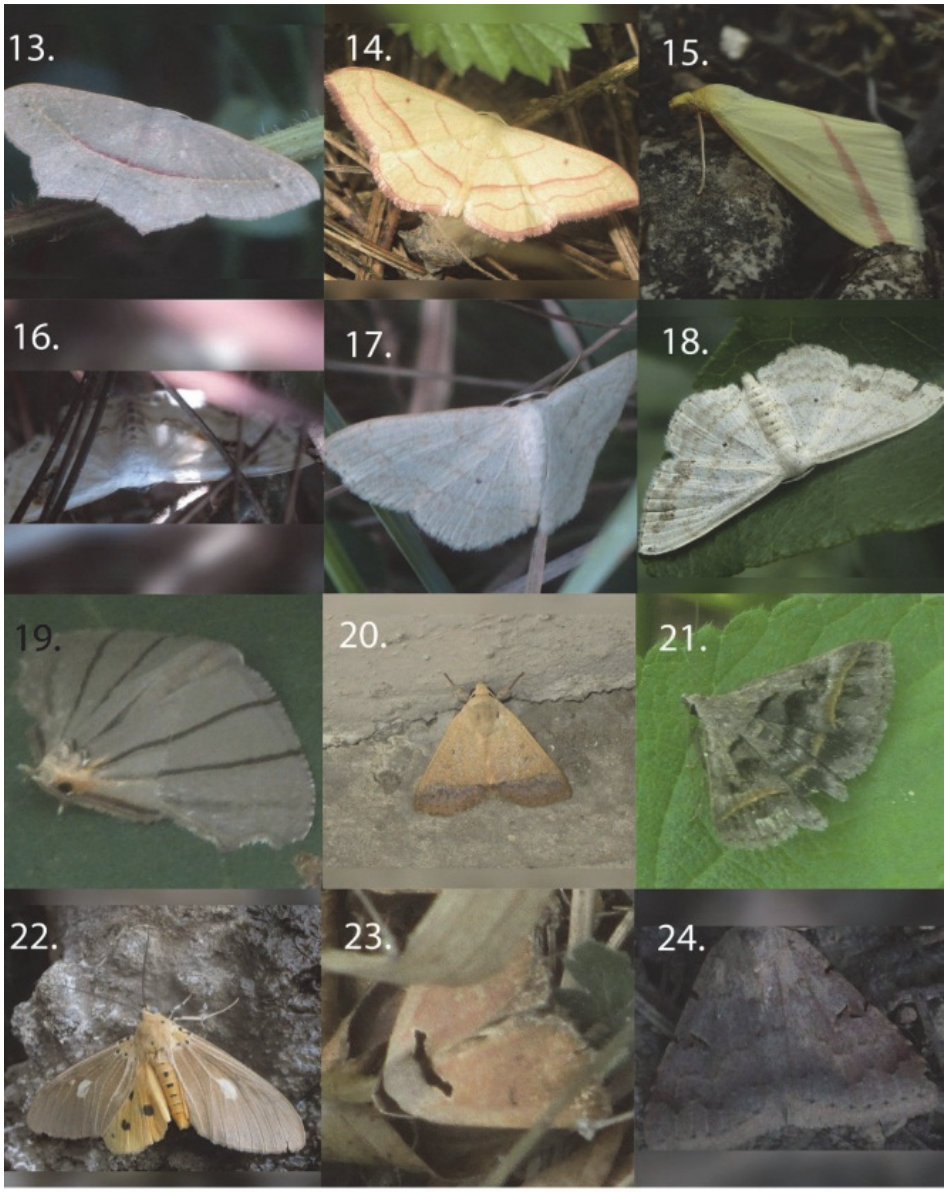
58. *Helicoverpa armigera* Hübner, [1809]

Host plants: *Allium cepa* L. (Amaryllidaceae); *Cannabis sativa* L. (Cannabaceae), *Dianthus caryophyllus* L. (Caryophyllaceae); *Ricinus communis* L. (Euphorbiaceae); *Carthamus tinctorius* L., *Guizotia abyssinica* (L.fil.) Cass., *Lipschitziella heteromalla* (D.Don) Kasana & A.K.Pandey, *Zinnia violacea* Cav. (Compositae); *Avena sativa* L., *Cenchrus americanus* (L.) Morrone, *Oryza sativa* L., *Sorghum bicolor* (L.) Moench (Poaceae), *Albizia procera* (Roxb.) Benth., *Arachis hypogaea* L., *Cajanus cajan* (L.) Millsp., *Crotalaria juncea* L., *Dalbergia sissoo* Roxb. ex DC., *Medicago sativa* L., *Pisum sativum* L., *Senegalia catechu* (L.f.) P.J.H.Hurter & Mabb. (Fabaceae); *Linum usitatissimum* L. (Linaceae); *Abelmoschus esculentus* (L.) Moench, *Alcea rosea* L., *Gossypium hirsutum* L., *Hibiscus mutabilis* L. (Malvaceae); *Platanus orientalis* L. (Platanaceae); *Citrus* × *sinensis* (L.) Osbeck (Rutaceae); *Populus ilicifolia* (Engl.) Rouleau, *Salix tetrasperma* Roxb. (Salicaceae); *Antirrhinum majus* L. (Plantaginaceae); *Datura stramonium* L., *Hyoscyamus niger* L., *Solanum lycopersicum* L., *Solanum tuberosum* L. (Solanaceae)

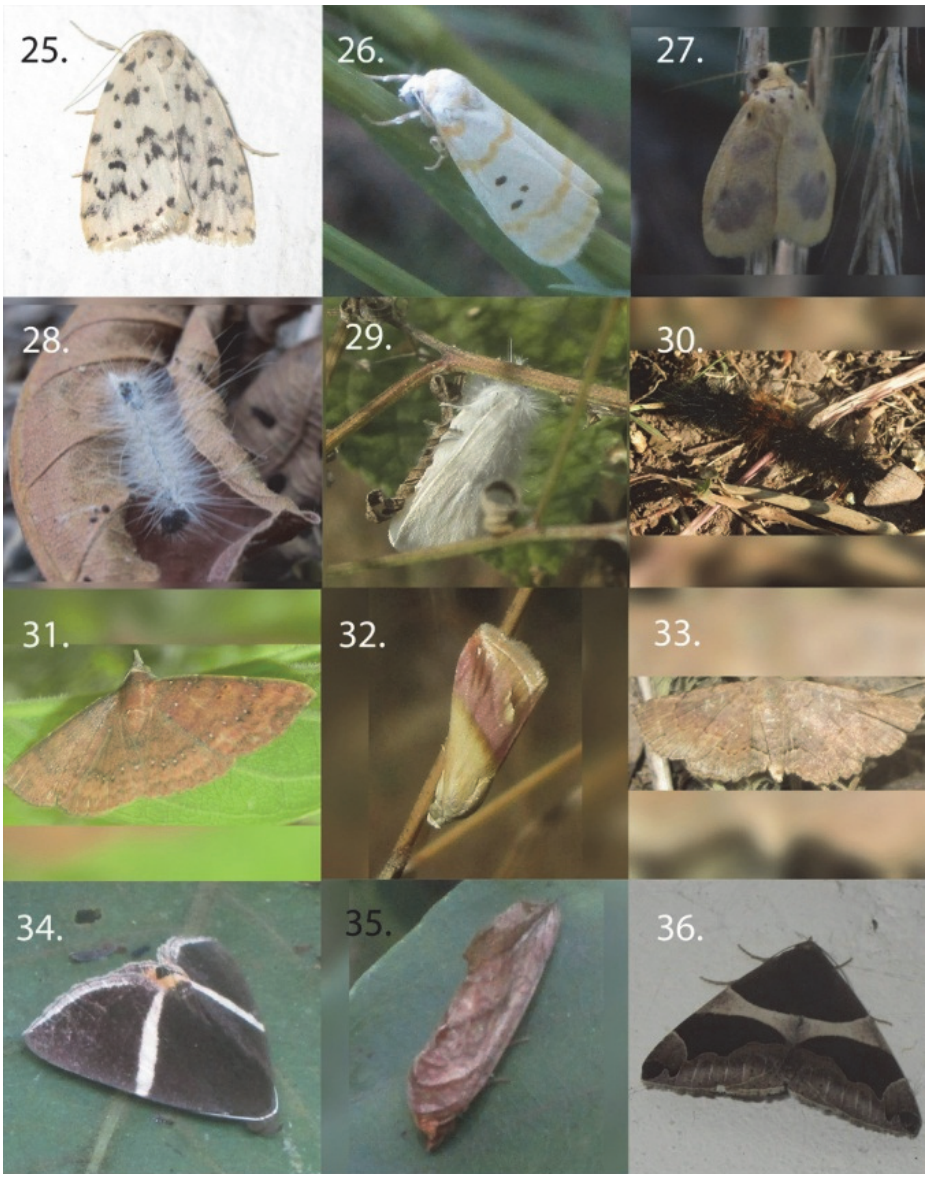
Subfamily Noctuinae; Tribe Prodeniini

59. *Spodoptera litura* (Fabricius, 1775)

Host plants: *Beta vulgaris* L., *Chenopodium album* L., *Spinacia oleracea* L. (Amaranthaceae); *Allium cepa* L. (Amaryllidaceae); *Mangifera indica* L. (Anacardiaceae); *Annona squamosa* L. (Annonaceae); *Apium graveolens* L. (Apiaceae); *Carissa carandas* L. (Apocynaceae); *Typhonium trilobatum* (L.) Schott, *Colocasia* Schott sp. (Araceae); *Cordia macleodii* Hook.fil. & Thomson (Boraginaceae); *Brassica oleracea* L., *Raphanus raphanistrum ssp. sativus* (L.) Domin (Brassicaceae); *Carica papaya* L. (Caricaceae); *Casuarina equisetifolia* L. (Casuarinaceae); *Terminalia corrugata* (Ducke) Gere & Boatwr. (Combretaceae); *Carthamus tinctorius* L., *Chrysanthemum* L. sp., *Guizotia abyssinica* (L.fil.) Cass., *Helianthus annuus* L., *Lactuca sativa* L. (Compositae); *Ipomoea batatas* (L.) Lam. (Convolvulaceae); *Citrullus lanatus* (Thunb.) Matsum. & Nakai, *Momordica dioica* Roxb. ex Willd. (Cucurbitaceae); *Diospyros montana* Roxb. (Ebenaceae); *Ricinus communis* L. (Euphorbiaceae); *Senna obtusifolia* (L.) H.S.Irwin & Barneby, *Acacia nilotica Vachellia nilotica* (L.) P.J.H.Hurter & Mabb., *Arachis hypogaea* L., *Cajanus cajan* (L.) Millsp., *Clitoria ternatea* L., *Glycine max* (L.) Merr., *Lathyrus sativus* L., *Phaseolus vulgaris* L., *Pisum sativum* L., *Sesbania grandiflora* (L.) Poir., *Trigonella foenum-graecum* L., *Vigna mungo* (L.) Hepper (Fabaceae); *Tectona grandis* L.f. (Lamiaceae); *Abelmoschus esculentus* (L.) Moench, *Corchorus capsularis* L., *Corchorus olitorius* L., *Hibiscus* L. sp. (Malvaceae); *Ficus carica* L., *Ficus religiosa* L., *Morus alba* L., *Morus nigra* L. (Moraceae); *Moringa* Adans. sp. (Moringaceae); *Musa acuminata* Colla (Musaceae); *Syzygium malaccense* (L.) Merr. & L.M.Perry, *Psidium guajava* L. (Myrtaceae); *Argemone mexicana* L., *Papaver somniferum* L. (Papaveraceae); *Sorghum bicolor* (L.) Moench, *Oryza sativa* L., *Saccharum officinarum* L., *Triticum aestivum* L., *Zea mays* L. (Poaceae); *Malus domestica* (Suckow) Borkh, *Malus sylvestris* Mill, *Prunus domestica* L. (Rosaceae); *Catunaregam spinosa* Thunb., Tirveng., *Tamilnadia uliginosa* (Retz.) Tirveng. & Sastre (Rubiaceae); *Citrus grandis* (L.) Osbeck (Rutaceae); *Capsicum annuum* L., *Cestrum nocturnum* L., *Solanum lycopersicum* L., *Nicandra physalodes* (L.) Gaertn., *Nicotiana tabacum* L., *Solanum violaceum* Ortega, *Solanum torvum* Sw., *Solanum tuberosum* L. (Solanaceae); *Camellia sinensis* (L.) Kuntze (Theaceae); *Lantana camara* L. (Verbenaceae); *Vitis vinifera* L. (Vitaceae)



13. *Traminda mundissima*, 14. *Rhodostrophia stigmatica*, 15. *Rhodometra sacraria*, 16. *Problepsis vugaris*, 17. *Scopula* sp., 18. *Scopula* sp., 19. *Orudiza protheclaria*, 20. *Bocula* sp., 21. *Acantholipes trajecta*, 22. *Asota plaginota*, 23. *Anoba* sp., 24. *Plecoptera* sp.



25. *Siccia (= Aemene)* sp., 26. *Cyana* cf. *chrysopeleia*, 27. *Miltochrista* cf. *undulata*, 28. *Morphospecies E*, 29. *Morphospecies I*, 30. *Morphospecies G*, 31. *Cerynea punctilinealis*, 32. *Eublemma cochylioides*, 33. *Rhesala* sp., 34. *Fodina pallula*, 35. *Oraesia emarginata*, 36. *Dysgonia torrida*

Subfamily Plusiinae; Tribe Argyrogrammatini

60. *Chrysodeixis* Hübner, [1821] sp.

61. *Thysanoplusia intermixta* (Warren, 1913): *T. intermixta* looks similar but the sub-costal forewing stigmata (the orbicular stigmata) is bilobed and grotesquely oblique, whereas in *T. orichalcea*, it is usually circular and sometimes squarish. The green area extends slightly less towards the base (i.e. towards the head region) in *T. intermixta* and is basally more blunt and rounded compared to the sharper stop of the green patch in *T. orichalcea*. But the size and length of the greenish-golden area is highly variable, and therefore the position of the orbicular stigmata is also quite variable, but usually lies right below the greenish-golden finger in the center in case of *T. orichalcea*, and lies under the semi-circular arch of the greenish-golden area in *T. intermixta.* Colour varies based on the freshness of the scales, angle of incidence of light, and other factors. So, the key based on colour i.e. forewings in *T. orichalcea* has a distinctive pale lustrous green area, whereas in *T. intermixta*, it is of somewhat yellower tone, is not very reliable. Another key which may be reliable is that *T. intermixta* has a more distinct irregular submarginal. **Host plants**: *Lactuca sativa* L. (Asteraceae), Apiaceae sp., Fabaceae sp., Rosaceae sp., Lamiaceae sp., Linaceae sp., (Hashiyama *et al.*, 2011; Kalawate *et al.*, 2023)

Family Nolidae; Subfamily Eariadinae

62. *Earias cupreoviridis* (Walker, 1862)

Host plants: *Corchorus* L., *Grewia tiliifolia* Vahl, *Hibiscus* L. sp., *Kydia calycina* Roxb., *Sida cordifolia* L., *Sida rhombifolia* L. (Malvaceae); *Oryza sativa* L. (Poaceae)

Subfamily Nolinae

63. *Nola* sp. (*Nola internella-analis* complex): The photograph could be of an individual of any of the following four species, all of which have a similar fascia and are found in India: *Nola analis* (Wileman & West, 1928), *Nola internella* (Walker, 1864), *Nola pascua* (Swinhoe, 1885), *Nola quadrimaculata* Heylaerts, 1892 (Anonymous, 2023).

Superfamily Pyraloidea; Family Crambidae; Subfamily Crambinae; Tribe Crambini

64. *Morphospecies J*

Subfamily Musotiminae

65. *Morphospecies K*

Subfamily Pyraustinae

66. *Ecpyrrhorrhoe* Hübner, 1825 sp. (previously the genus *Paliga* Moore, 1886)

Subfamily Spilomelinae

67. *Nausinoe perspectata* (Fabricius, 1775)

Host plants: *Jasminum sambac* (L.) Aiton (Oleaceae); *Nyctanthes arbor-tristis* L. (Verbenaceae)

68. *Nausinoe geometralis* (Guenée, 1854)

Host plants: *Chrysojasminum humile* (L.) Banfi, *Jasminum auriculatum* Vahl, *Jasminum flexile* Vahl, *Jasminum grandiflorum* L., *Jasminum multiflorum* (Burm. f.) Andrews, *Jasminum sambac* (L.) Aiton (Oleaceae)

Tribe Herpetogrammatini

69. *Herpetogramma* Lederer, 1863

Tribe Hymeniini

70. *Spoladea recurvalis* (Fabricius, 1775)

Host plants: *Trianthema portulacastrum* L. (Aizoceae); *Achyranthes aspera* L., *Amaranthus* L., *Beta vulgaris* L., *Celosia argentea* L., *Chenopodium album* L., *Gomphrena* L. (Amaranthaceae); *Vigna radiata* (L.) R. Wilczek (Fabaceae); *Plectranthus* L'Hér. (Lamiaceae)

Tribe Margaroniini

71. *Conogethes* Meyrick, 1884 sp.

72. *Omiodes diemenalis* (Guenée, 1854)

Host plants: *Cajanus cajan* (L.) Millsp., *Chamaecrista absus* (L.) H.S.Irwin & Barneby, *Derris elliptica* (Wall.) Benth., *Dendrolobium*

triangulare (Retz.) Schindl., *Glycine max* (L.) Merr.*, Flemingia chappar* Buch.-Ham. ex Benth., *Flemingia paniculata* Wall. ex Benth., *Ougeinia oojeinensis* (Roxb.) Hochr., *Vigna mungo* (L.) Hepper (Fabaceae)

73. *Glyphodes bicolor* (Swainson, 1821)

Host plants: *Alstonia scholaris* (L.) R.Br.*, Carissa carandas* L. (Apocynaceae); *Ougeinia oojeinensis* (Roxb.) Hochr. (Fabaceae); *Tectona grandis* L.f. (Lamiaceae); *Artocarpus integer* Merr., *Ficus benghalensis* L. (Moraceae)

Tribe Nomophilini

74. *Nomophila noctuella* (Denis & Schiffermüller, 1775)

Host plants: *Moricandia arvensis* (L.) DC. (Brassicaceae); *Glycine max* (L.) Merr., *Melilotus officinalis* (L.) Lam., *Medicago sativa* L. (Fabaceae); *Tectona grandis* L.f. (Lamiaceae); *Cenchrus americanus* (L.) Morrone, *Poa pratensis* L., *Trifolium pratense* L., *Trifolium repens* L., *Zea mays* L. (Poaceae); *Polygonum aviculare* L. (Polygonaceae); *Portulaca oleracea* L. (Portulacaceae); *Potentilla canadensis* L. (Rosaceae)

Tribe Spilomelini

75. *Cnaphalocrocis* (syn *Marasmia*) cf. *poeyalis* (Boisduval, 1833)

Host plant: *Oryza sativa* L. (Poaceae)

76. *Cnaphalocrocis medinalis* (Guenée, 1854) (syn. *rutilalis* (Walker, [1859])

77. *Cnaphalocrocis trebiusalis* (Walker, 1859)

Family Pyralidae; Subfamily Pyralinae; Tribe Pyralini

78. *Pyralis pictalis* (Curtis, 1834)

Host plants: *Millettia auriculata* Baker (Fabaceae); *Phoebe lanceolata* (Nees) Nees (Lauraceae); *Populus alba* L. (Salicaceae)

Superfamil Tortricoidea; Family Tortricidae

79. *Morphospecies L*

Superfamily Zygaenoidea; Family Zygaenidae; Subfamily Zygaeninae

80. *Praezygaena caschmirensis* (Kollar, 1844)

Subfamily Chalcosiinae

81. *Eterusia* Hope, 1841 sp. (Caterpillar)

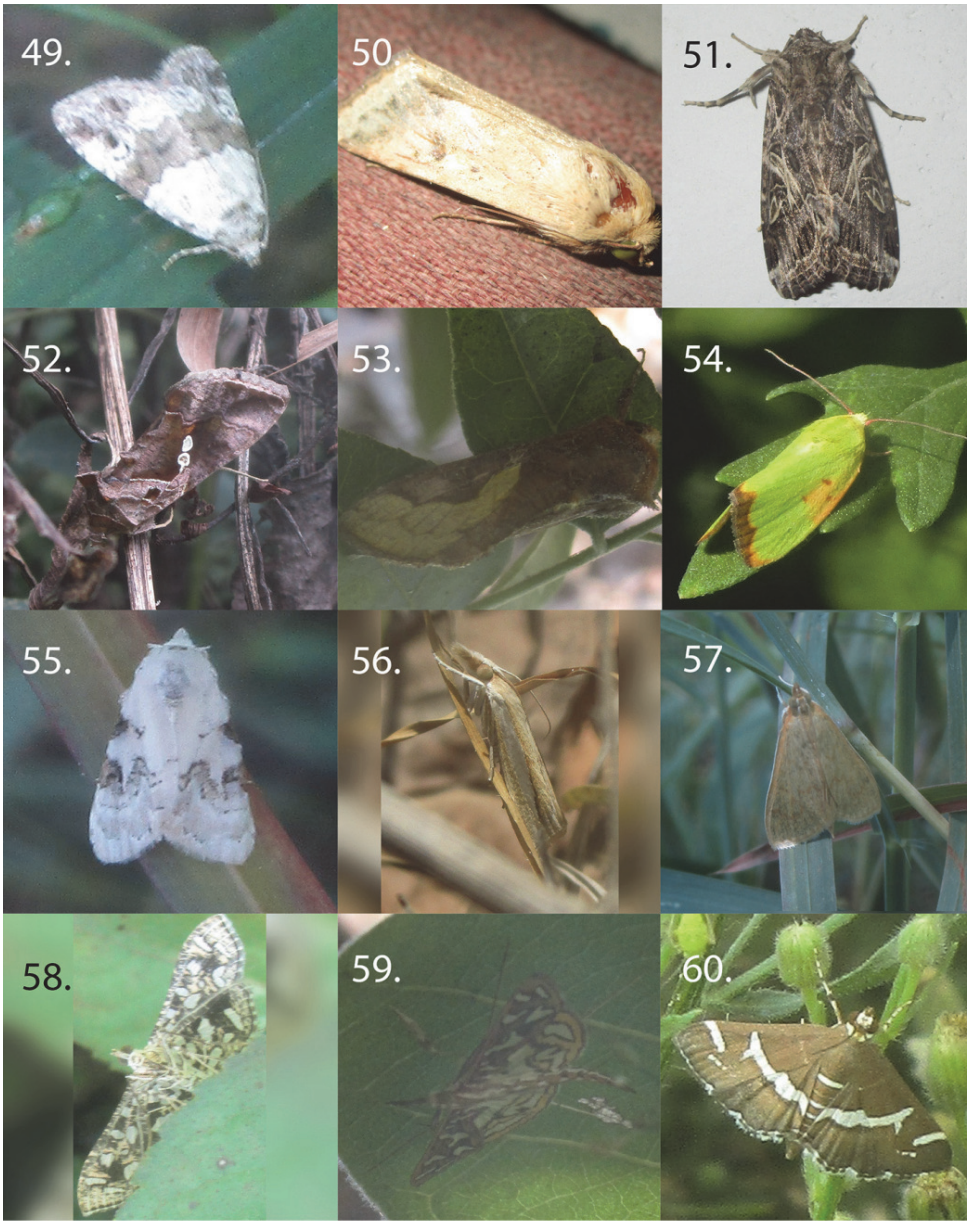
82. *Trypanophora* Kollar, 1844 sp. (Caterpillar)

In this study, at least 82 species were recorded, all of which are new records for Bilaspur district, at least 22 of which are new records for Himachal Pradesh (see supplementary dataset), and at least five of which are new records for the Western Himalayas. Note that 'at least' is used here for a couple of reasons: i) since some records are at state-level resolution with the states having Himalayan and non-Himalayan geography ii) since the identification were not possible to species level for several individuals. The new additions to the Western Himalayas are *Anoba* sp., *Brenthia* sp., *Eublemma cochylioides*, *Herminia undulata,* and *Hyposada hydrocampata*. Some of the unidentified species from this study could be new species to science, altogether. This shows the significance of our study, even though it was not a targeted study to inventorize moths, revealing that even vertebrate-targeted studies can also help in insect biodiversity assessment.

While butterfly diversity was found to be not be indicative of moth diversity at local scales in Colorado, USA (Ricketts *et al.*, 2002), moth and butterfly diversity and abundance was found to be strongly correlated in a study conducted in the Tons Valley, Western Himalayas (Bhardwaj *et al.*, 2012), which is ~150 Km from Bilaspur district (geodesic distance, from the centers of the sites). Given that Tons Valley is quite close to Bilaspur district, it may not be erroneous to assume that this correlation exists in the latter too. This can help us extrapolate or estimate the number of moth species in Bilaspur district.

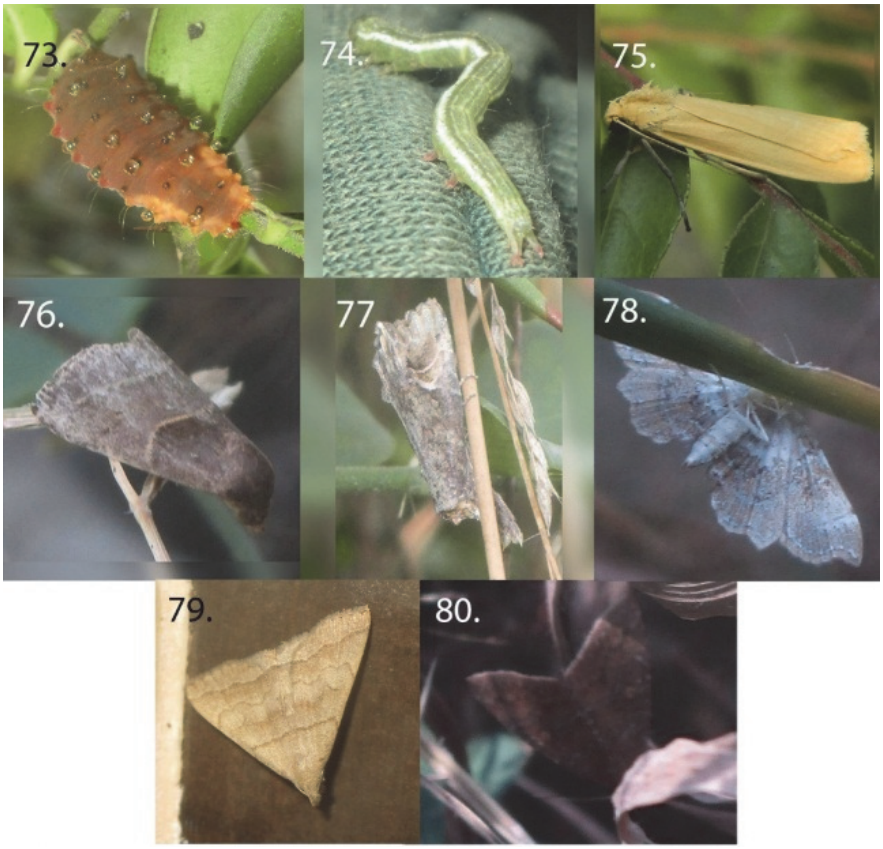
The total number of butterflies species recorded in the study of Lepidoptera in the Tons Valley was

37. *Erebus hieroglyphica*, 38. *Hypopyra or Spirama* sp., 39. *Mocis frugalis*, 40. *Mocis undata*, 41. *Morphospecies H*, 42. *Hydrillodes* sp., 43. *Rhynchina* sp., 44. *Dichromia sagitta*, 45. *Calesia haemorrhoa*, 46. *Condica* sp., 47. *Episteme* sp., 48. *Callopistria* sp.



49. *Maliattha signifera*, 50. *Helicoverpa armigera*, 51. *Spodoptera litura*, 52. *Chrysodeixis* sp., 53. *Thysanoplusia intermixta*, 54. *Earias cupreoviridis*, 55. *Nola* sp., 56. *Morphospecies J*, 57. *Ecpyrrhorrhoe* sp., 58. *Nausinoe geometralis*, 59. *Nausinoe perspectata*, 60. *Spoladea recurvalis*

61. *Conogethes* sp., 62. *Omiodes diemenalis*, 63. *Herpetogramma* sp., 64. *Glyphodes bicolor*, 65. *Nomophila noctuella*, 66. *Cnaphalocrocis* cf. *poeyalis*, 67. *Cnaphalocrocis medinalis*, 68. *Cnaphalocrocis trebiusalis*, 69. *Pyralis pictalis*, 70. *Morphospecies L*, 71. *Praezygaena caschmirensis*, 72. *Eterusia* sp.



73. *Trypanophora* sp., 74. *Morphospecies C*, 75. *Morphospecies F*, 76. *Rivul*a sp., 77. *Morphospecies D*, 78. *Morphospecies K*, 79. *Herminia undulata*, 80. *Amyna* sp.

156 (with an estimate of 163-166), while the moth diversity in terms of morphospecies was 784 (estimate: 873-891), which indicates a ratio of ~5 (range: 5.03-5.37) moth species for every butterfly species. We have recorded close to a 100 species of butterflies in Bilaspur district during the same study period, which is most likely close to the true diversity of butterflies in the district (unpublished data). Applying the same ratio for the number of moth species in Bilaspur district, we get a total of 503-537 species of moths, which means an inventory completeness of 14.1-15.1 per cent. This estimate needs to be taken with a pinch of caution since the elevational range of Bilaspur district (low to mid elevation) is different from that of Tons Valley (mid to high elevation), although there is some overlap between habitat types. This study has shone a light on how poorly studied, many parts of the ecologically sensitive biographical zone of Himalayas are. Studies like this help establish baseline data for further ecological studies.

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