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A study on moth (Lepidoptera: Heterocera) diversity in Barpeta district, Assam, India

Maniza Choudhury[1], Mofidul Islam[2*], Parthankar Choudhury[1]
[1]Department of Ecology and Environmental Science, Assam University, Silchar, Assam, India
[2] Department of Zoology, PDUAM- Behali, Biswanath, Assam, India

Abstract
A study was conducted to assess the diversity of macro moth fauna, specifically the families Arctiidae, Geometridae, and Sphingidae, in the Barpeta district of Assam, India. This research provides a comprehensive exploration of moth diversity in the Barpeta district, uncovering 53 species within the Arctiidae family, 46 species in the Geometridae family, and 4 species in the Sphingidae family. The families are distributed across various sites in the district, revealing variations in moth diversity indices. A total of 1320 moth specimens were collected, with family Arctiidae dominating at 61.21%, followed by Geometridae at 37.05%, and Sphingidae at 1.74%. The study includes detailed checklists, with 45 species identified to the species level in Arctiidae, 39 in Geometridae, and 3 in Sphingidae. Sub-families within each family are distinct, showcasing the diversity of Arctiidae (6 sub-families), Geometridae (4 sub-families), and Sphingidae (2 sub-families). The dominance of Arctiidae is further emphasized by the highest number of specimens (808), while Geometridae follows with 489 specimens, and Sphingidae exhibits a minimum count of 23 specimens. This study contributes valuable insights into the intricate world of moth diversity, paving the way for further research and conservation efforts in the region.

Keywords: Diversity, macro moth, Arctiidae, Geometridae, Sphingidae, Barpeta, Assam, India

Introduction

Insects, comprising over half of documented animal species (Wilson, 1992) [33], face population fluctuations due to forest fires and related factors, leading to rapid decline amid environmental degradation. Highly sensitive to their immediate environment, these species serve as crucial indicators of ecosystem "health." The diverse butterfly and moth populations offer a valuable means of monitoring forest ecosystem health. More than half of Earth's animal biodiversity is attributed to insects, highlighting their ecological importance globally. However, the assessment and quantification of these vital creatures are globally limited, as recent work by Shashank *et al*. in 2022 [31] indicates. The faunal assemblage, particularly focusing on Lepidoptera, serves as a central group for evaluating anthropogenic impacts on various ecosystems (Parikh *et al*. in 2021) [26].

Lepidoptera, one of the largest insect orders with 160,000 species, includes butterflies (18,000) and moths (142,000), with over 75% being nocturnal moths (Kawahara *et al*., 2018) [20]. India's reported 12,000 moth species by Subhalaxmi (2018) raises accuracy concerns, emphasizing the need for a comprehensive list. Despite extensive pre-independent documentation, there is a recognized need for a systematic taxonomic effort with modern surveys to update global moth status. Extensive documentation of the Indian moth fauna occurred primarily during the pre-independent period by notable researchers such as Hampson (1892 [16], 1894 [17], 1895 [18], 1896 [19]), Fletcher (1920 [10], 1932 [11], 1933 [12]), Moore (1882, 1884), and Bell and Scott (1937) [4]. However, there is a recognized need for a systematic taxonomic exercise accompanied by modern surveys to update the global status and distribution of moths.

Moths, often overlooked nocturnal creatures (Kehimkar, 2002) [22], play vital roles in conservation (Arandhara, 2018) [1] and pollination (MacGregor *et al*., 2015) [24]. They contribute as agricultural pests (Sharma, 2011) [30] and essential food sources for various organisms, including humans. Moths also serve as valuable model organisms in scientific research (Roe and Just, 2009) [28], prompting a re-evaluation of their ecological importance.

This faunal group, susceptible to light traps, is a compelling subject for ecological studies (Choi, 2008) [6]. Moth research in many districts of Assam lacks comprehensive studies, emphasizing the need for robust investigations and surveys (Chandra & Sambath, 2013) [5]. The present study on diversity of moths belonging to three families (Arctiidae, Geometridae and Sphingidae) in Barpeta district of Brahmaputra valley of Assam aims to provide baseline data for future long-term studies, filling the knowledge void on moth dynamics in the district.

Materials and Methods

Study area: The study was carried out in Barpeta district of Assam. The district is in Lower Brahmaputra valley with the total geographical area of the district is about 2243.96 Sq. KM. (https://barpeta.assam.gov.in). It lies between latitude 26'5" North - 26'49" North and longitude 90'39" East - 91'17" East. Surveying moths was conducted at 16 selected sites in Barpeta district, including Baghbor, Kalgachia, Khorichala, Mandia, Sorbhog, Howly, Barpeta Road, Jania, Bhawanipur, Patacharkuchi, Rehabari, Pathsala, Bahari, Sarthebari, Nagaon, and Chenga (refer to Map-1).

Collection of moths: The survey occurred biweekly between 19:00 and 23:00 hrs, spanning from January 2014 to December 2015. Nocturnal moths were collected by using UV light of 15-watt bulb and kept the moths in a plastic jar, sprinkled with ethyl acetate. For diurnal moths' collection insect net was used. These traps were set up at different sites in the study areas continuously for 45 sampling nights and days. Moths, caught in the traps were brought to the laboratory and were identified with the help of available literature based upon measurement of wing span and spreading characteristics of the wing (Hampson, 1894) [17].

Sampling method of moth species: This is a suitable method for surveying moth in a wide range of habitats. A modification of the line transects count was used to determine species richness and abundance of selected group of moths in different habitats in study areas under both the districts. Sampling count in each transact was repeated in most cases to see if any additional information is available or not.

Data Analysis: Indices of diversity, species richness and evenness of moth communities were assessed for each habitat type and calculated by using Shanon-Wiener diversity index (1949), Margalef's index (1958) [25] and evenness index (Pielou, 1966) [27].

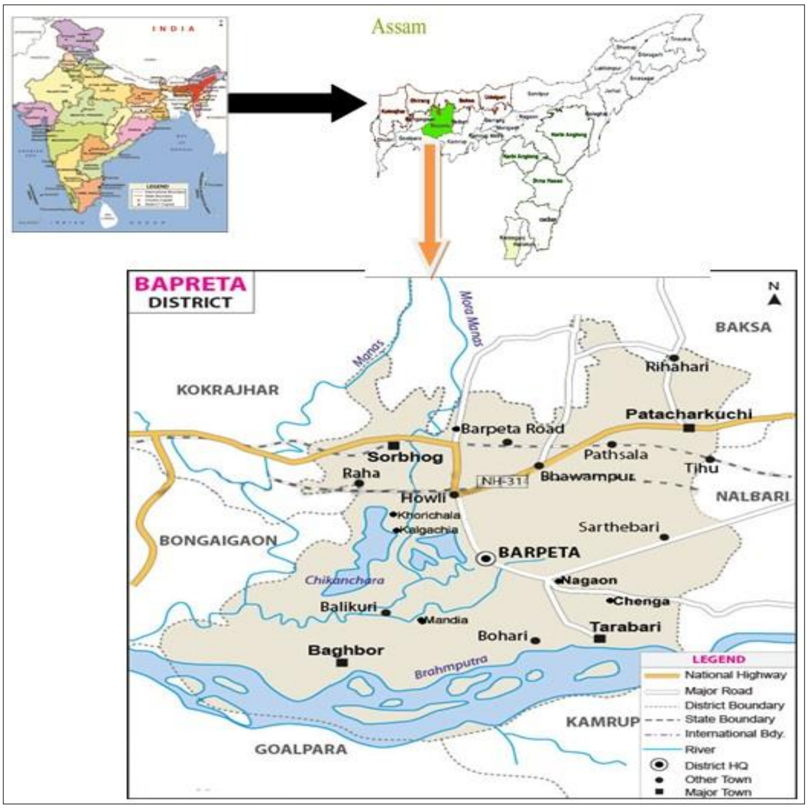

Fig 1: Map showing study sites in Barpeta District, Assam.

Results

The study unveils the presence of 53 species within the Arctiidae family, spanning 38 genera and 6 subfamilies. Additionally, the Geometridae family comprises 46 species distributed across 32 genera and 6 subfamilies, while the Sphingidae family includes 4 species from 4 genera and 2 subfamilies in Barpeta district (refer to Table-1). All three families (Arctiidae, Geometridae, and Sphingidae) are observed across all selected sites in the district. Notably, the moth diversity indices vary across different sites in the district.

Throughout the study, 1320 moth specimens were collected from three selected families (Arctiidae, Geometridae, and Sphingidae) in Barpeta district. The checklist of the moth fauna for these families in Barpeta is detailed in Table-1. Out of the 53 collected species, 45 were identified to the species level, 7 to the genus level, and one to the sub-family Level within the Arctiidae family. For the Geometridae family, among the 46 collected species, 39 were identified to the species level, 6 to the genus level, and one to the sub-family level. In the Sphingidae family, out of the 4 collected species, 3 were identified to the species level, and one to the subfamily level.

The families exhibited distinct sub-families, with Arctiidae having 6 sub-families (Arctiinae, Lymantriinae, Lithosiinae, Erebinae, Aganainae, and Hadeninae), Geometridae having 4 sub-families (Geometrinae, Ennominae, Larentiinae, and Sterrhinae), and Sphingidae having 2 sub-families (Sphinginae and Macroglossinae). The Arctiidae family dominated with 61.21% of the total recorded species, followed by the Geometridae family with 37.05%. Among the three families, the least dominant was Sphingidae, representing 1.74% in the district (refer to Fig: 2).

Table 1: List of species of three moth families (Arctiidae, Geometridae and Sphingidae) in Barpeta district.

Arctiidae		Geometridae		Sphingidae	
sub-family	Species	Sub-family	Species	Sub-family	Species
Arctiinae	*Aemilia pagana*	Geometrinae	*Dyspteris abortivaria*	Sphinginae	*Theretra latreillii*
	Agylla ramelana (Moore, 1865)		*Agathia hilarata* (Guenee, 1858		unidentified
	Amerila astrea Drury, 1773		*Agathia laetata* Fabricius, 1794		*Acherontia lachesis* Fabricius, 1798
	Creatonotos gangis Linnaeus, 1763		*Celenna festivaria*	Macroglossinae	*Hippotion rafflesii*

	Creatonotus transiens (Walker, 1855)		*Comostola pyrrhogona* Walker, 1866
	Eugoa bipunctata		*Comostola subtiliaria* Bremer, 1864
	Halysidota tesselaris		*Eumelea sp.*
	Hypercompe sp.		*Omphisa anastomosalis*
	Idalus citrine		*Pelagodes falsaria*
	Lygniodes sp.		*Pelagodes quadraria* Guenée, 1857
	Mangina argus Kollar, 1844		*Pingasa ruginaria* Guenée, 1857
	Mangina astrea Drury, 1773		*Abraxas amiculatata*
	Nepita conferta Walker 1854	Ennominae	*Abraxas (Abraxas) conferta* Swinhoe, 1893
	Nyctemera adversata (Schaller, 1788)		*Abraxas illuminata*
	Nyctemera arctata (Walker, 1764)		*Alcis arisema* Prout, 1934
	Olepa ricini Fabricius, 1775		*Amraica recursaria* Walker, 1860
	Platyja umbrina		*Chiasmia cymatodes* Wehrli, 1932
	Rajendra vittata Moore, 1879		*Chiasmia eleonora* Hubner, 1818
	Syntomoides conifis		*Chiasmia fidoniata* Guenée, 1858
	Syntomoides imaon Cramer, 1779		*Chiasmia nora* Walker, 1861
	Utetheisa lotrix Cramer, 1777		*Chorodna sp.*
Lymantriinae	*Arctornis sp.*		*Cleora sp.*
	Euproctis sp.		*Gastrinodes bitaeniaria*
	Numenes silleti		*Hyperythra lutea* Stoll, 1781
	Nygminii sp.1		*Hypomecis punctinalis*
	Nygminii sp.2		*Hyposidra talaca* Walker, 1860
	Perina nuda Fabricius, 1787		*Istrugia disputaria* Guenée, 1858
Lithosiinae	*Barsine defeta*		*Lomographa sp.*
	Barsine multistriata		*Medasina sp.*
	Barsine orientalis		*Plutodes costatus* (Butler, 1886)
	Chrysorabdia bivitta (Walker, 1856) (		*synchlora aerate*
	Cyana bellissima		*Tanaoctenia haliaria*
	Cyana interigratiotis		*Zamarada excisa* Hampson 1891
	Cyana signa (Walker, 1854)		*Zeheba aureata* Moore, 1887
	Cyana sp.		unidentified
	Eilema lurideola		*Chloroclystis filata*
	Lyclene sp.	Larentiinae	*Pasiphila rectangulata* Linnaeus, 1758
	Perina nuda		*Problepsis apollinaria*
	Prabhasa distorta	Sterrhinae	*Problepsis deliaria* Guenée, 1858
	Unidentifid		*Problepsis vulgaris*
Erebinae	*Arcte polygrapha* Kollar, 1844		*Scopula floslactata*
	Bastilla sp.		*Scopula pulchellata* Fabricius, 1794
	Catocala patala		*Scopula* sp.
	Dysgonia stuposa		*Timandra amaturaria*
	Erebus ephesperis Hubner, 1827		*Timandra punctinervis*
	Mocis frugalis Fabricius, 1775		*Traminda mundissima* Walker, 1861
	Mocis undata Fabricius, 1775		
	Nepita conferta Walker 1854		
Aganainae	*Asota caricae* Fabricius, 1775		
	Asota ficus Fabricius, 1775		
	Asota producta Butler, 1875		
	*Asota serica*Fabricius, 1775		
	Asota sp.		
Hadeninae	*Actinotia intermediata* (Bremer, 1861)		

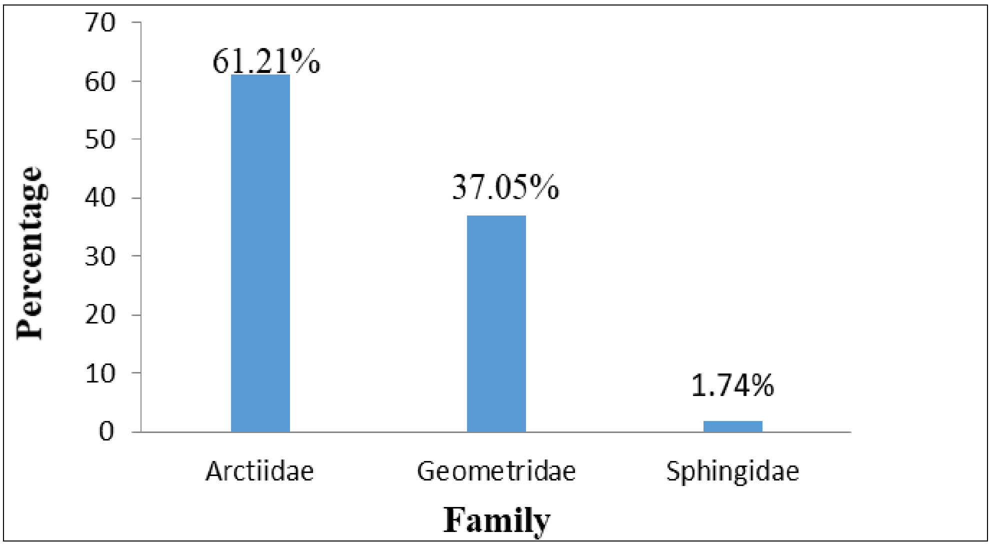

Fig 2: Family wise distribution of the moths fauna in Barpeta district.

The highest number of moth specimens (808) belonged to family Arctiidae, followed by the Geometridae family with a total of 489 moth specimens while family Sphingidae shows minimum no., with a total number of 23 moth specimens. Table 2, represents the diversity indices of the three families.

Table 2: Diversity indices of three moth families in Barpeta district.

Diversity indices	Family		
	Arctidae	**Geometrideae**	**Sphingidae**
Taxa_S	53	46	4
Individuals	808	489	23
Dominance_D	0.03367	0.03447	0.2665
Simpson_1-D	0.9663	0.9655	0.7335
Shannon_H	3.687	3.524	1.354
Evenness_e^H/S	0.753	0.754	0.968
Margalef	7.767	7.106	0.9568

The Analysis of Variance (ANOVA) was done to see if there exists any variation among the families in Barpeta district. The Calculation revealed that the calculated value of $t_{(0.05)}$ is 14.86, at $t_{(0.01)}$ is20.02 and at $t_{(0.001)}$ is 26.54. In all the cases the calculated value was higher than the table value [2.042 at ($t_{0.05}$), 2.750 at ($t_{0.01}$) and 3.646 at ($t_{0.001}$) respectively]. So, it can be inferred that there exists significant variation in population among the three families (i.e., Arctiidae, Geometridae and Sphingidae) in Barpeta district.

Discussion

This study aimed to assess the diversity of macro moth fauna, specifically the families Arctiidae, Geometridae, and Sphingidae, in the Barpeta district of the Brahmaputra valley in Northern Assam, India. Historical records by Cotes and Swinhoe (1889) [7] and Hampson (1892-1896) reported a vast number of moth species in India, with a focus on western Maharashtra. Arunachal Pradesh documented 105 species of the family Arctiidae in northeastern India (Kirti *et al*., 2005) [23]. Tawang district in Arunachal Pradesh revealed over 250 morpho-species of moths across diverse families (Chandra and Sambath, 2013) [5]. In Barpeta district, Geometridae dominated with 48% of recorded species, followed by Erebidae (26%) and Sphingidae (2%). Ghosh (2003) [15] reported 525 geometrid moth species in Sikkim and noted 460 and 260 species in Meghalaya and West Bengal, respectively. Despite Barpeta having a highly diverse moth fauna, there are fewer geometrid species compared to Meghalaya and West Bengal.

Vegetation plays a crucial role as a variable influencing moth population dynamic, providing shelter and food. Observations by Young (1997) [34] and Fox (1983) [14] support this correlation. The lower recorded numbers of moths in the Sphingidae family in both study areas might be attributed to limited food plant availability or insufficient attraction to the low-intensity light used during surveys. Biodiversity indices in Peshawar correlate with rich vegetation, demonstrating the critical role of vegetation in sustaining insect fauna (Aslam, 2009) [2].

Floral diversity significantly influences the composition and diversity of macro-moths, as larvae often exhibit specificity to host plants. The larvae, with various feeding habits, contribute to the overall diversity. Areas with diverse vegetation harbour more moth fauna, reflecting the importance of preserving natural resources for insect biodiversity (Beck *et al*., 2002 [3]; Fiedler and Schulze, 2004) [9]. Residents, lacking environmental education, tend to underestimate the contributions of moths to the environment and human well-being. Bridging this knowledge gap requires active collaboration involving farmers, local communities, researchers, and policymakers, as emphasized by Deb *et al*. (2015) [8] and Fox *et al*. (2021) [13] in biodiversity conservation. The study unveils the rich diversity of moths in the under-studied and scarcely documented Barpeta area, emphasizing the need for long-term surveys to explore and discover new species. The absence of conservation status highlights the urgency of enlisting moth species in the Wildlife (Protection) Act, 1972, to ensure their protection and conservation.

In conclusion, this research not only enhances our understanding of the underexplored Barpeta area but also underscores the necessity for a holistic conservation approach. Integrating scientific research, public awareness, and legal frameworks is crucial for the sustained protection of moth species in the region.

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Conflict of Interest Statement
The authors affirm that there is no conflict of interest associated with this research.

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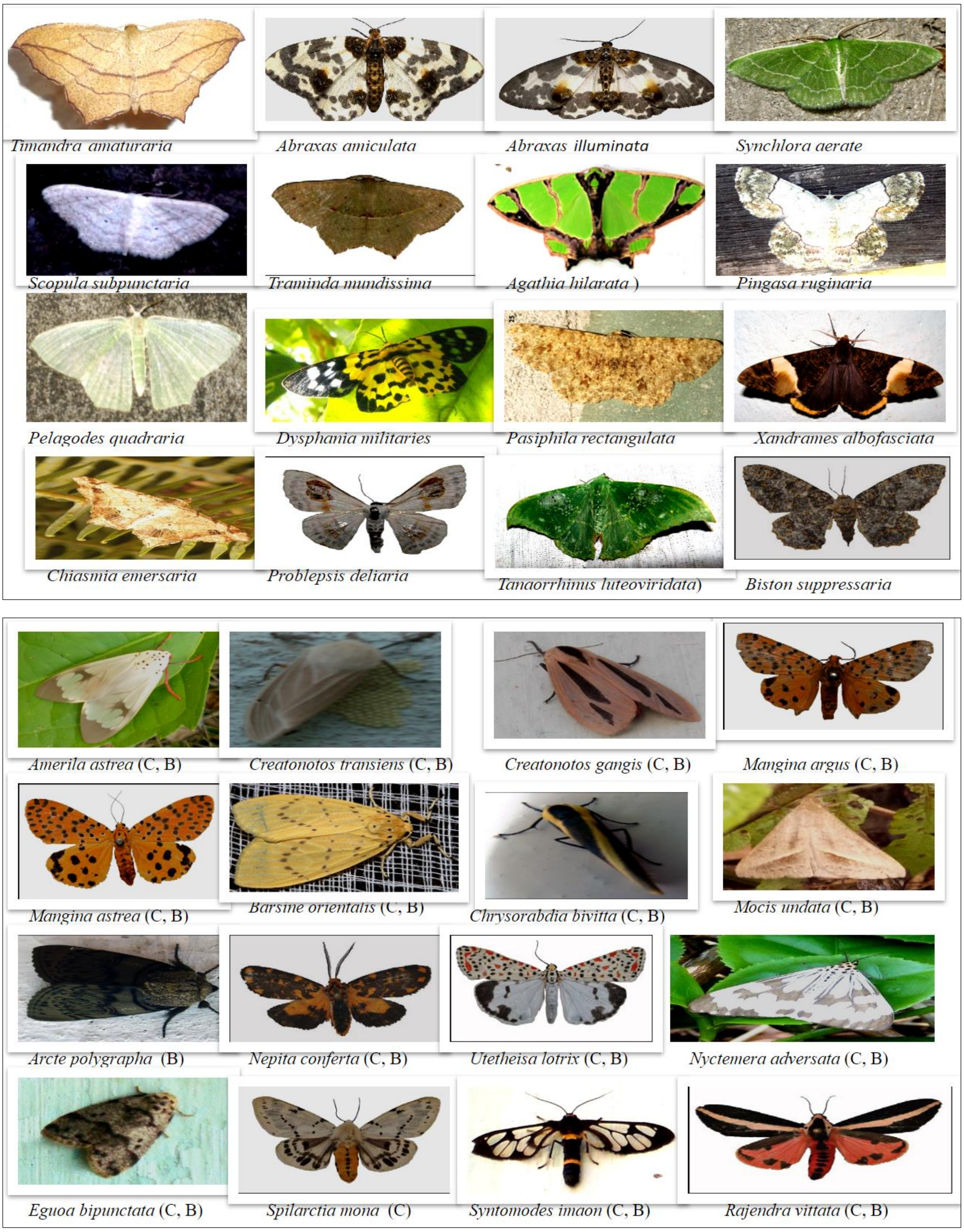

Fig 2: Photographs of some Moths during the survey

References

1. Arandhara S. Butterflies and locality predict the occurrence of larger day-flying moths in Dehing Patkai landscape, Assam. International Journal of Zoology Studies, 2018:3(2):314-321. ISSN: 2455-7269.
2. Aslam M. Diversity, Species richness and Evenness of moth fauna of Peshawar. Pak. Entomo, 2009, 31(2).
3. Beck J, Schulze CH, Linsenmair KE, Fiedler K. From forest to farmland: diversity of geometrid moths along

two habitat gradients on Borneo. Journal of Tropical Ecology, 2002, 17:33-51.
4. Bell TRD, Scott FB. The Fauna of British India: Including Burma and Ceylon. Moths: Sphingidae Vol. V. Taylor and Francis Ltd. London, 1937, 537.
5. Chandra K, Sambath S. Moth diversity of Tawang District, Arunachal Pradesh, India. Journal of Threatened Taxa,2013:5(1):3565-3570. ISSN: 0974-7907 (Online) 0974-7893 (Print). https://doi.org/10.11609/JoTT.o2718.966.
6. Choi SW. Diversity and composition of larger moths in three different forest types of Southern Korea. Ecological Research,2008:23(3):503-509. https://doi.org/10.1007/s11284-007-0406-8.
7. Cotes EC, Swinhoe CC. A Catalogue of Moths of India. *Part I-VI*: Sphinges, Bombyces, Noctues, Pseudo-Deltoids and Deltoids, Geometrites, Pyrales, Crambites, Tortrices and Addenda, Calcutta, 1889, 812pp.
8. Deb M, Nautiyal S, Sláma P, Bhattacharjee PC, Roychoudhury S. Butterfly of Assam University Campus in Silchar: Can Academic Institutions Contribute to Conservation of Species Diversity in Northeastern Region of India? Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,2015:63(82):731-739.
9. Fiedler K, Schulze CH. Forest modification affects diversity (but not dynamics) of speciose tropical pyraloid moth communities. Biotropica,2004:36:615-627.
10. Fletcher TB. Life histories of Indian insects: Microlepidoptera. Memoirs of the Department of Agriculture in India, Entomological Series,1920:6(1):77-79.
11. Fletcher TB. Life-histories of Indian Microlepidoptera (second series) Alucitidae (Pterophoridae), Tortricina and Gelechiadae. New Delhi: Imperial Council of Agricultural Research,1932:2:1-58.
12. Fletcher TB. Life-histories of Indian Microlepidoptera (second series) Cosmopterygidae to Neopseustidae. New Delhi: Imperial Council of Agricultural Research, 1933, 1-85.
13. Fox R, Dennis EB, Harrower CA, Blumgart D, Bell JR, Cook P, *et al.* The State of Britain’s Larger Moths 2021. Butterfly Conservation, Rothamsted Research and UK Centre for Ecology & Hydrology, Wareham, Dorset, UK, 2021, 44. Available from: https://nora.nerc.ac.uk/id/eprint/530375/.
14. Fox JF. Post-fire succession of small manunaland bird communities. In R W. Wein and D. A. MacLean (eds.). The Role of Fin in Northeen Circumpolar Ecosystems. SCOPE, John Wiky and Sons Ltd., 1983, 155-180.
15. Ghosh SK. Insecta: Lepidoptera: Heterocera: Geometridae, State fauna series-9, fauna of Sikkim (Part-4). Zoological Survey of India, 2003, 217-342.
16. Hampson GF. The Fauna of British India, Including Ceylon and Burma. Moths. Taylor and Francis Ltd. London,1892:1:527.
17. Hampson GF. The Fauna of British India, Including Ceylon and Burma. Moths. Taylor and Francis Ltd. London,1894:2:609.
18. Hampson GF. The Fauna of British India, Including Ceylon and Burma. Moths. Taylor and Francis Ltd. London,1895:3:546.
19. Hampson GF. The Fauna of British India, Including Ceylon and Burma. Moths. Taylor and Francis Ltd. London,1896:4:594.
20. Kawahara AY, Plotkin D, Hamilton CA, Gough H, Laurent RS, Owens HL, *et al*. Diel behavior in moths and butterflies: A synthesis of data illuminates the evolution of temporal activity. Organisms Diversity & Evolution,2019:18:13-27. https://doi.org/10.1007/s13127-017-0350-6.
21. Kawaharaa AY, Plotkina D, Espeland M, Meusemann K, Toussainta EFA, Donath A, *et al*. Phylogenomics reveals the evolutionary timing and pattern of butterflies and moths. In Futuyma, D. (ed) The Proceedings of the National Academy of Sciences,2019:116(45):22657-22663. https://doi.org/10.1073/pnas.1907847116.
22. Kehimkar I. Moths of India. Edition, 2002. ISBN 8174800271.
23. Kirti JS, Sodhi JS, Gill NS. Inventory of Arctiidae of North-Eastern India (Arctiidae: Lepidoptera). Journal of Entomological Research,2005:29(3):243-249.
24. Macgregor CJ, Pocock MJ, Fox R, Evans DM. Pollination by nocturnal Lepidoptera, and the effects of light pollution: a review. Ecological entomology,2015:40(3):187-198. https://doi.org/10.1111/een.12174.
25. Margalef R. Temporal succession and spatial heterogeneity in phytoplankton. In: Perspectives in Marine biology, Buzzati-Traverso (ed.), Univ. Calif. Press, Berkeley, 1958, 323-347.
26. Parikh G, Rawatani D, Khatri N. Insects as an indicator for environmental pollution. Environmental Claims Journal,2021:33(2):161-181.
27. Pielou EC. The measurement of diversity in different types of biological collections. J.Theoret. Biol.,1966:13:131-144.
28. Roe BE, Just DR. Internal and External Validity in Economics Research: Tradeoffs between Experiments, Field Experiments, Natural Experiments and Field Data. American Journal of Agricultural Economics,2009:91(5):1266-1271. https://doi.org/10.1111/j.1467-8276.2009.01295.x.
29. Shannon CE, Wiener W. The mathematical theory of communication. Urbana, University of Illinois Press, 1949, 177.
30. Sharma G. Studies on lepidopterous insects associated with vegetables in Aravali Range, Rajasthan, India. Biological Forum: An International Journal,2011:3(1):21-26.
31. Shashank PR, Naveena NL, Rajgopal NN, Elliott TA, Sreedevi K, Sunil S, *et al*. DNA barcoding of insects from India: Current status and future perspectives. Molecular Biology Reports,2022:49(11):10617-10626. https://doi.org/10.1007/s11033-022-07628-2.
32. Shubhalaxmi V. Field Guide to Indian Moths Ed. (VI+461), Birdwing Publisher, India, 2018, 1.
33. Wilson EO. Fluctuations in abundance of tropical insects. Amer. Nat.,1992:112: 1017-1045.
34. Young M. The natural history of moths. Poyser, London, 1997, 271.