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Macro Moth (Lepidoptera: Heterocera) Diversity in the Southern Assam Region: A Study in Cachar District, India

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Abstract: This study assessed macro moth diversity in the Cachar district, Assam, India, focusing on Arctiidae, Geometridae, and Sphingidae families. It identified 56 Geometridae, 55 Arctiidae, and 6 Sphingidae species, showcasing variations in diversity indices across sites. Among 1599 specimens, Geometridae constituted 50.78%, Arctiidae 47.4%, and Sphingidae 1.74%. The checklists include 55 species, with 41 at the species level, 10 at the genus level, one at the sub-family level, and three at the family level in Arctiidae. In Geometridae, 50 of the 56 species were identified to the species level, and 7 to the genus level. Sphingidae had four species identified to the species level and two to the subfamily level. Geometridae dominated with 812 specimens, followed by Arctiidae (758) and Sphingidae (29). This study offers valuable insights into moth diversity, laying the foundation for further research and conservation efforts in the region.

Keywords: Diversity, Macro moth, Arctiidae, Geometridae, Sphingidae, Lepidoptera, Heterocera

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Introduction

Insects, constituting over half of the documented animal species (Wilson, 1992), experience population fluctuations influenced by forest fires and related factors, resulting in rapid declines amidst environmental degradation. Due to their heightened sensitivity to their surroundings, these species serve as crucial indicators of ecosystem health. The diverse populations of butterflies and moths offer valuable insights for monitoring the well-being of forest ecosystems. Insects significantly contribute to Earth's animal biodiversity, with more than half of documented species attributed to them, underscoring their global ecological importance. However, the assessment and quantification of these vital creatures face global limitations, as highlighted by recent research by Shashank *et al*. (2022). The faunal assemblage, particularly focusing on Lepidoptera, emerges as a central group for evaluating anthropogenic impacts on various ecosystems (Parikh *et al*., 2021). Lepidoptera, one of the largest insect orders with 160,000 species, encompasses butterflies (18,000) and moths (142,000), with over 75% being nocturnal moths (Kawahara *et al*., 2018). Despite India reporting 12,000 moth species (Subhalaxmi, 2018), accuracy concerns arise, underscoring the need for a comprehensive list. Despite extensive pre-independent documentation, there is a recognized need for a systematic taxonomic effort using modern surveys to update the global moth status.

Extensive documentation of the Indian moth fauna primarily occurred during the pre-independent period by notable researchers such as Hampson (1892, 1894, 1895, 1896), Fletcher (1920, 1932, 1933), Moore (1882, 1884), and Bell and Scott (1937). However, there is a recognized need for a systematic taxonomic effort, coupled with modern surveys, to update the global status and distribution of moths. Moths, often overlooked as nocturnal creatures (Kehimkar, 2002), play crucial roles in conservation (Arandhara, 2018) and pollination (MacGregor *et al*., 2015). They contribute as agricultural pests (Sharma, 2011) and serve as essential food sources for various organisms, including humans. Additionally, moths serve as valuable model organisms in scientific research (Roe and Just, 2009), prompting an evaluation of their ecological importance. This faunal group, susceptible to light traps, is a compelling subject for ecological studies (Choi, 2008). Many districts of Assam lack comprehensive moth research, emphasizing the need for robust investigations and surveys (Chandra and Sambath, 2013). The present study on the diversity of moths belonging to three families (Arctiidae, Geometridae, and Sphingidae) in the Cachar district of the Barak valley of Assam aimed 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 survey was conducted in the Cachar district of Assam, situated within the Barak Valley in the Southern part of North East India. The district spans a total geographical area of about 3,786 square kilometers. Bounded by the N.C hills and Jaintia hills of Meghalaya to the North, Manipur state to the East, Mizoram to the South, and Hailakandi district of Assam and Bangladesh to the West (http://cachar.gov.in), the district lies between 24°22' N and 25°08' N latitude and 92°24' E and 93°15' E longitude. The survey of moths was conducted at 16 specific sites in Cachar district, including Loharbond, Borokhai, Taranathpur, Rosekandi, Dholai, Sonai, Dulabchera, Sonaimukh, Lakhipur, Udarbond, Rajabajar, Kumbhir, Dalu, Masimpur, Laisong, and Barkhola (Fig. 1).

Collection of Moths:

The survey, conducted biweekly from January 2014 to December 2015 between 19:00 and 23:00 h, involved the use of a 15-watt UV light bulb to collect nocturnal moths. The collected moths were placed in a plastic jar with ethyl acetate. For diurnal moths, an insect net was employed. These traps were set up continuously for 45 sampling nights and days across different sites in the study areas. Subsequently, moths caught in the traps were brought to the laboratory and identified using available literature, focusing on wing span and spreading characteristics (Hampson, 1894).

Sampling Method of Moth Species:

The study utilized a modified line transects count method to survey moths in diverse habitats. This approach was employed to determine the species richness and abundance of selected moth groups in various habitats across the study areas in both districts. Sampling counts in each transect were often repeated to explore additional information.

Data Analysis:

Indices of diversity, species richness, and evenness within moth communities for each

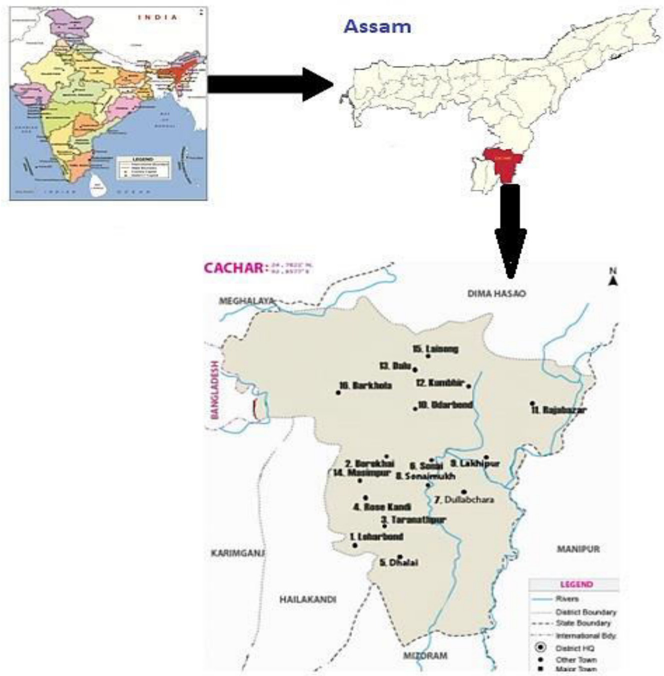

Fig. 1: Map showing study sites in Cachar district, Assam.

habitat type were assessed using the Shanon-Wiener diversity index (1949), Margalef's index (1958), and the evenness index (Pielou, 1966).

Results

The findings of the study reveal the presence of 55 species within the Arctiidae family, encompassing 42 genera and 6 subfamilies. Furthermore, the Geometridae family consists of 56 species distributed across 38 genera and 3 subfamilies, and the Sphingidae family includes 6 species from 6 genera and 2 subfamilies in the Cachar district (Table 1). All three families (Arctiidae, Geometridae, and Sphingidae) are observed across all selected sites in the district. Notably, the moth diversity indices exhibit variations across different sites in the district.

Throughout the study, a total of 1599 moth specimens were collected from three selected families (Arctiidae, Geometridae, and Sphingidae) in the Cachar district. The detailed checklist of the moth fauna for these families in Cachar is presented in Table 1. Among the 55 collected species, 41 were identified to the species level, 10 to the genus level, one to the sub-family level, and three to the family level within the Arctiidae family. In the Geometridae family, out of the 56 collected species, 50 were identified to the species level, and 7 to the genus level. Regarding the Sphingidae family, four out of the six collected species were identified to the species level, and two 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 3 sub-families (Geometrinae, Ennominae and Larentiinae), and Sphingidae having 2 sub-families (Sphinginae and Macroglossinae). The Geometridae family dominated with 50.78% of the total recorded species, followed by the Arctiidae family with 47.40%. Among the three families, the least dominant was Sphingidae, representing 1.81% in the district (Fig. 2).

The family Geometridae exhibited the highest number of moth specimens (812), followed by the Arctiidae family with a total of 758 moth specimens, while the Sphingidae family had the

Table 1: List of species of three moth families in Cachar district

Arctiidae		**Geometridae**		**Sphingidae**	
Sub-family	**Species**	**Sub-family**	**Species**	**Sub-family**	**Species**
Arctiinae	*Acronicta rumicis*	***Geometrinae***	*Agathia hilarata* (Guenee, 1858)	***Sphinginae***	*Acherontia lachesis* Fabricius, 1798
	Agylla ramelana (Moore, 1865)		*Agathia laetata* Fabricius, 1794		*Unidentified* 1
	Amerila astrea Drury, 1773		*Arichanna sp.*	***Macroglo ssinae***	*Rhagastis confusa*
	Creatonotos gangis		*Celenna festivaria*		*Theretra latreillii*
	Creatonotus transiens (Walker, 1855)		*Chlorissa gelida*		*Hippotion boerhavia*
	Eugoa bipunctata		*Comostola pyrrhogona* Walker, 1866		*Unidentified* 2
	Halysidota tesselaris		*Comostola subtiliaria* Bremer, 1864		
	Hypercompe sp.		*Dysphania militaries*		
	Idalus citrine		*Dyspteris abortivaria*		
	Lygniodes sp.		*Eumelea ludovieta*		
	Mangina argus (Kollar, 1844)		*Eumelea* sp.		
	Mangina astrea Drury, 1773		*Hypochrosis rufescens* (Butler, 1880)		
	Nepita conferta Walker 1854		*Maxates veninotata*		
	Nyctemera adversata (Schaller, 1788)		*Omphisa anastomosalis*		
	Nyctemera arctata (Walker, 1764)		*Pelagodes falsaria*		
	Olepa ricini Fabricius, 1775		*Pelagodes quadraria* Guenée, 1857		
	Rajendra vittata Moore, 1879		*Pingasa ruginaria* Guenée, 1857		
	Spilarctia mona Swinhoe, 1885		*Plutodes costatus* (Butler, 1886)		
	Spilosoma dalbergiae (Moore, 1888)	**Ennominae**	*Abraxas amiculata*		
	Syntomoides conifis		*Abraxas (Abraxas) conferta* Swinhoe, 1893		

	Syntomoides imaon Cramer, 1779		*Abraxas illuminata*
	Utetheisa lotrix Cramer, 1777		*Amraica recursaria* Walker, 1860
Lymantriinae	*Arctornis* sp.		*Biston suppressaria* Guenée, 1857
	Euproctis sp.		*Chiasmia cymatodes* Wehrli, 1932
	Hypoprepia fucosa		*Chiasmia eleonora* Hubner, 1818
	Numenes silleti		*Chiasmia emersaria*
	Nygminii sp.1		*Chiasmia fidoniata* Guenée, 1858
	Nygminii sp.2		*Chiasmia nora* Walker, 1861
	Perina nuda Fabricius, 1787		*Cleora* sp.
Lithosiinae	*Barsine defecta*		*Comibaena cassidara*
	Barsine multistriata		*Gastrinodes bitaeniaria*
	Barsine orientalis		*Hyperythra lutea* Stoll, 1781
	Chrysorabdia bivitta (Walker, 1856)		*Hypomecis punctinalis*
	Cyana bellissima		*Hyposidra talaca* Walker, 1860
	Cyana interigratiotis		*Lomographa* sp
	Cyana sp.		*Synchlora aerate*
	Eilema lurideola		*Tanaoctenia haliaria*
	Lyclene sp.		*Tanaorhinus luteoviridata* (Walker, 1861)
	Prabhasa distorta		*Zamarada excisa* Hampson 1891
Erebinae	*Bastilla* sp.		*Zeheba aureata* Moore, 1887
	Dysgonia stuposa	**Larentiinae**	*Chloroclystis filata*
	Erebus ephesperis Hubner, 1827		*Pasiphila rectangulata* Linnaeus, 1758
	Mocis frugalis Fabricius, 1775		*Xandrames albofasciata*

			Moore, 1867
	Mocis undata Fabricius, 1775		*Xandrames* sp.
Aganainae	*Asota caricae* Fabricius, 1775		*Problepsis apollinaria*
	Asota ficus Fabricius, 1775		*Problepsis deliaria* Guenée, 1858
	Asota producta Butler, 1875		*Problepsis vulgaris*
	Asota serica Fabricius, 1775		*Scopula floslactata*
	Asota sp.		*Scopula pulchellata* Fabricius, 1794
Hadeninae	*Actinotia intermediata* (Bremer, 1861)		*Scopula* sp.A
	Unidentified1		*Scopula subpunctaria* Herrich Schäffer 1847
	Unidentified 2		*Timandra amaturaria*
	Unidentified 3		*Traminda mundissima* Walker, 1861
			Scopula sp.B

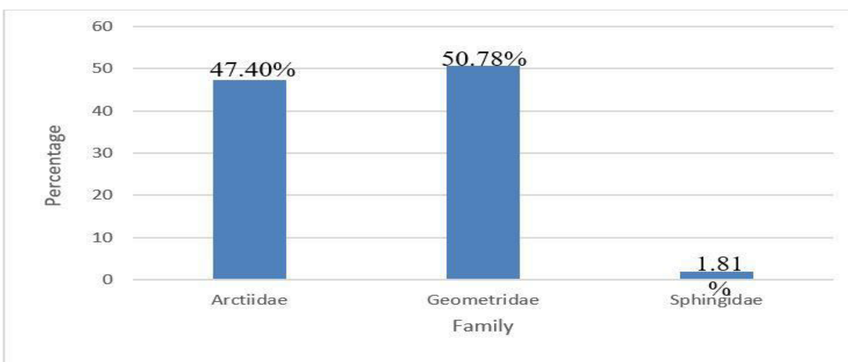

Fig. 2: Family wise distribution of the Moths fauna in Cachar district.

Table 2: Diversity indices of three moth families in Cachar district

Diversity indices	Family		
	Arctidae	**Geometrideae**	**Sphingidae**
Taxa_S	55	56	6
Individuals	758	812	29
Dominance_D	0.02438	0.02724	0.2176
Simpson_1-D	0.9756	0.9728	0.7824
Shannon_H	3.841	3.749	1.645
Evenness_e^H/S	0.8466	0.7589	0.8639
Margalef	8.144	8.21	1.485

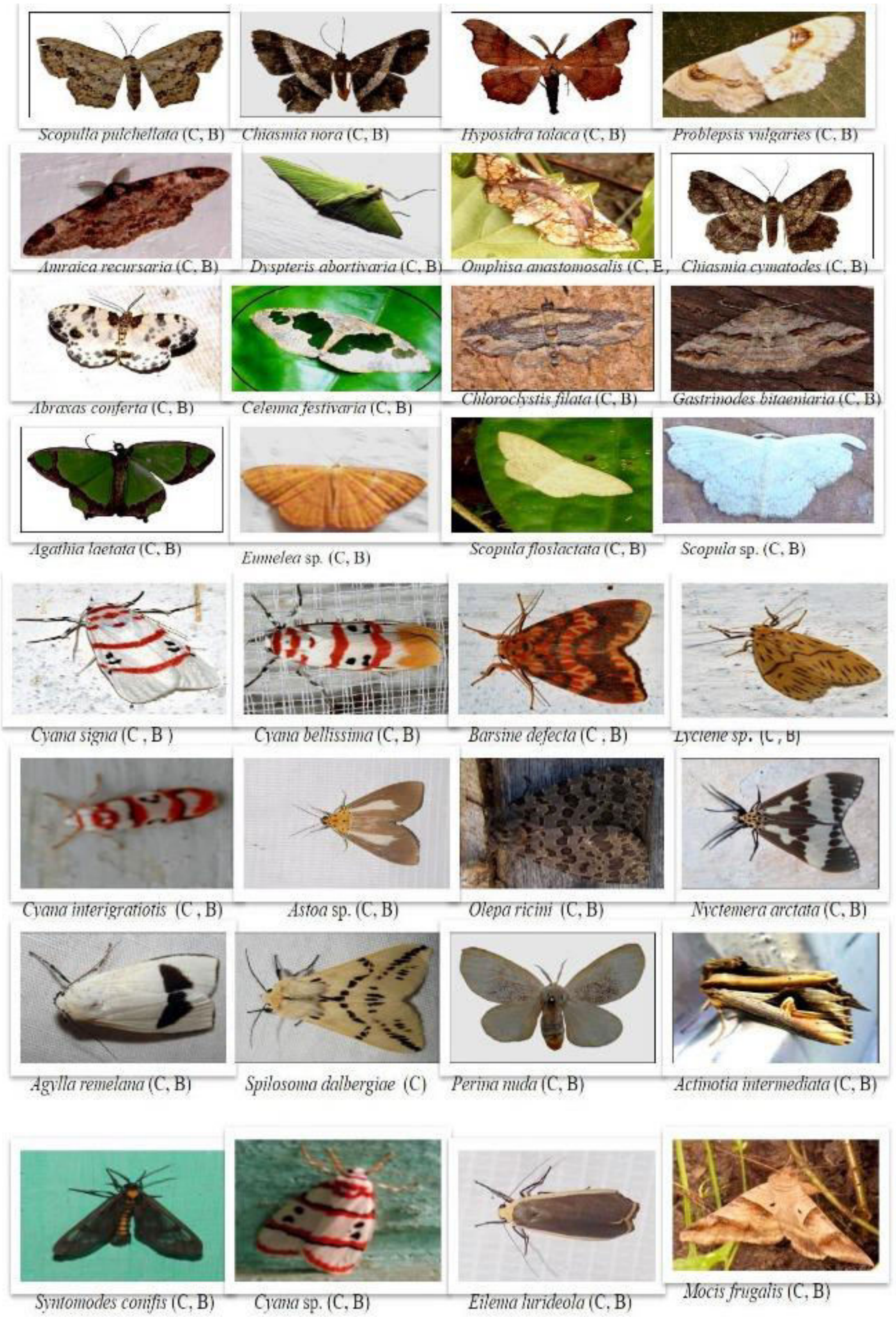

Fig. 3: Photographs of some Moths during the survey.

minimum count, totalling 29 moth specimens. Table 2 presents the diversity indices for the three families. Figure 3 depicts few during the study.

To assess the variation among the families in Cachar district, an Analysis of Variance (ANOVA) was conducted. The calculations indicated that the t-values at significance levels of 0.05, 0.01, and 0.001 were 5.819, 7.837, and 10.39, respectively. In all cases, the calculated values exceeded the critical values of 2.042 at t (0.05), 2.750 at t (0.01), and 3.646 at t (0.001). Therefore, it can be inferred that there is a significant variation in population among the three families (Arctiidae, Geometridae, and Sphingidae) in the Cachar district.

Discussion

This study sought to evaluate the diversity of macro moth fauna, focusing on the families Arctiidae, Geometridae, and Sphingidae, in the Cachar district of the Barak Valley in Southern Assam, India. Historical records by Cotes and Swinhoe (1889) and Hampson (1892-1896) highlighted a significant number of moth species in India, particularly in western Maharashtra. Arunachal Pradesh documented 105 species of the Arctiidae family in northeastern India (Kirti *et al*., 2005), and Tawang district in Arunachal Pradesh revealed over 250 morpho-species of moths across diverse families (Chandra and Sambath, 2013). In Cachar district, the Geometridae family dominated, constituting 50.78% of the total number of collected individuals, followed by the Arctiidae (47.40%) and Sphingidae (1.81%) families. Ghosh (2003) reported 525 geometrid moth species in Sikkim and noted 460 and 260 species in Meghalaya and West Bengal, respectively. Despite Cachar having a highly diverse moth fauna, there are fewer geometrid species compared to Meghalaya and West Bengal.

Vegetation plays a pivotal role as a variable influencing the dynamic of moth populations, providing both shelter and food. Supporting this correlation, observations by Young (1997) and Fox (1983) highlight the crucial role of vegetation. The lower recorded numbers of moths in the Sphingidae family in the study area may be attributed to limited availability of food plants or insufficient attraction to the low-intensity light used during surveys. Biodiversity indices in Peshawar show a correlation with rich vegetation, emphasizing its critical role in sustaining insect fauna (Aslam, 2009). 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 overall diversity. Areas with diverse vegetation harbor more moth fauna, underscoring the importance of preserving natural resources for insect biodiversity (Beck *et al*., 2002; Fiedler and Schulze, 2004). Unfortunately, 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) and Fox *et al*. (2021) for biodiversity conservation. The study unveils the rich diversity of moths in the under-studied and scarcely documented Cachar 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.

Conclusion

In conclusion this research not only enhances our understanding of the underexplored Cachar 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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