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Drivers regulating species composition of the larger nocturnal moths in Tinsukia district, Assam

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Abstract
Species composition of larger moths was studied in Tinsukia district, Assam. Tests were performed to investigate the influence of habitat types, elevational gradient and bioclimatic variables on abundance of the moth community. Data on 120 moth species (1598 individuals) were recorded from 45 sites, a subset of 6 habitat types during 2013 to 2015. Individual-based rarefaction curve showed that the moths recorded from forested habitats were more diverse than those from the semi-natural, disturbed and agricultural habitat as expected. Habitat type, categories of elevation, and relative humidity differed the accumulation of the moth individuals, while a significant difference was not observed between temperature and sampled month. Simple linear regression suggested that elevation contributed most to the species composition. Moths should be considered for further investigation with more intensive sampling, as this study represented a small portion of the community. It was revealed that modest shift in environmental parameters and habitat complexes marked a substantial variation in response to their occurrence, thus, further research on assigning more responsive moths as indicator species may serve as a conservation tool for the entire community as well as indicators of habitat quality.

Keywords: Tinsukia, Assam, drivers, species

Introduction

The study area, Tinsukia district occupies the extreme north-east and upper corner of the state Assam. The district covers an area about 3790 sq. km(s), extending from 27.23° to 27.95° N latitude and 95. 22° to 95.98° E longitude. Characterised by a diversity of environmental conditions, the district is situated at an elevational gradient ranging from 80m on the flood-prone banks of the river Brahmaputra to highlands adjoining the Patkai foothills crossing above 400 m. The temperature ranges from 8°C in the coldest month to 39°C in summer. About 40.42% of the district comes under forested area. The forests of Tinsukia is exceptionally heterogenous, tropical evergreen and semi-evergreen forests with varying proportions of deciduous trees are characteristic of the district. Compared to the other districts, Tinsukia is one among those distinctly urbanized, growing with economy, industry and petroleum resources. However, agriculture is dominant with 34.96% of the land utilized for cultivation. Paddy, sugarcane and other vegetables are cultivated along with a large number of commercial tea gardens occupying almost every corner of the district. In these past recent decades, human agglomeration, industrial effluence, monoculture cultivation and deforestation activity in the forested habitats are creating a percipient influence, as a result of which the rich biodiversity history of the district is on decline [1, 2, 3].

Among the insect groups, lepidoptera is diverse and taxonomically complex and contain agilely identifiable species as well [4]. Like the other holometabolous insects, they tend to have entirely different entities, i.e. adults as fluid feeding and larvae as chewing. Thus, specialised in utilizing separate resources in their life stages that must overlap in a site forming a potential habitat for them [5]. Occupying numerous ecosystems, lepidoptera play role as habitat indicators, pollinators, herbivores, and prey for other organisms [6, 7, 8].

Butterflies have been long considered as a key group for ecological research as potential indicators for ecosystem health, recently larger moths (more commonly known as macro-moths) are implemented in conservation and management as they have an advantage over other insects due to ease in sampling, large number of species and more accumulation of individuals [9, 10, 11].

A scanty of information on moths exist in the district, scattered inventories in form of species lists on butterfly and a few moth groups are reported from some areas [12, 13, 14].

Extensive studies related to species composition, ecology and distribution for both butterflies and moths are lacking.

This present study aims at observing and estimating the species composition of larger moths, evaluating the habitats they occur and to reveal the factors that influence their composition, three questions were mainly addressed:

1. How many larger moth species occur and what species or family represent the majority?
2. Do the habitat types and environmental categories show similarity in species composition?
3. What factors influence the abundance of larger moths?

Materials and Methods

Study area

Sampling was conducted selecting 45 sites of the district, comprising six major habitat types and relief, particularly elevation ranging from 117m to 442m. The study was conducted during 2013 to 2016. (1) Tropical evergreen forest, confined to south eastern side of the district is composed of dense *Dipterocarpus trees along with Mesua, Shorea and Vatica* formation, relatively higher elevation in these forests induce rainfall and holds moisture promoting better vegetation growth, modest deforestation and human activity is seen in these forest; (2) Degraded evergreen forest, confined to some parts of east and south-eastern side of the study area, covered by sparse formation of Dipterocarpus trees; the lowland semi evergreen forests of northern part, situated close proximity to the banks of Brahmaputra shows formation of *Shorea, Pterospermum and Kayea,* lacking Dipterocarp trees, these forests are increasingly being degraded by human logging and mass deforestation is evident in the buffers as well as in the interiors; (3) Semi-natural rural land occupied by human settlements that share forest edge with scattered forest trees, ornamental plants and agriculture lands, (4) Paddy cultivation land, spreading over vast extent of open land covering more than 35 sq. km(s) (5) Extensive tea cultivation land and; (6) Disturbed urban land agglomerated by human settlements, ornamental vegetation, with oil drilling, open caste coal mining and few other industrial operations. Map of the study area shown in Figure 1. Habitat types including sampling site locations given in Table 1.

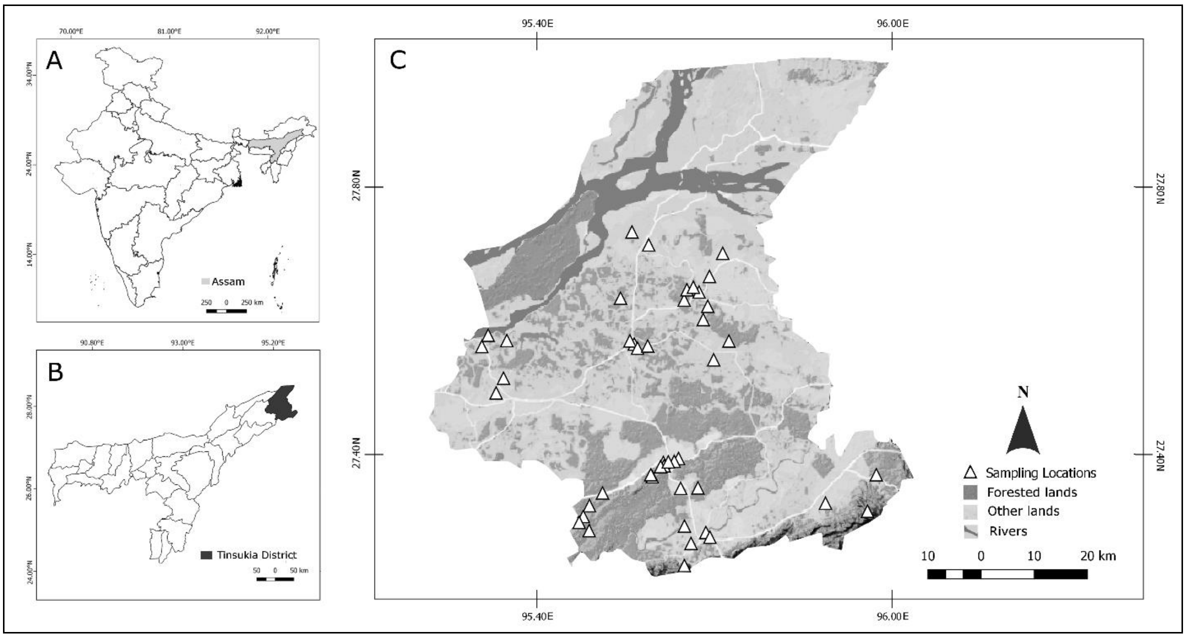

Fig 1: Study area map showing A. India, B. Assam and C. Tinsukia district. Triangle mark represent sampling locations

Table 1: Habitats of the study area, administrative units and sampling sites

Habitat type	Site name
Degraded evergreen forest	Digboi: Digboi college campus, Digboi graveyard, Digboi reserve west block; Kakopather: Kako block, Hatigorh gaon; Philobari: Rangpur, Doom Dooma reserve.
Disturbed urban land	Digboi: Digboi town; Doom Dooma: 8 No., 8 No. 2, Doom Dooma town; Margherita: Kumarpaty field; Ledo: Ledo town; Tinsukia: Tinsukia town
Paddy cultivation land	Kakopather: Kachari Maithong, Lazum pathar;
Semi-natural rural	Tinsukia rural: Guijan village; Jagun: Lalpahar; Kakopather: Upor Ubon, 2 No Tezi pathar; Philobari: Kumsang TE, Borgaon Talup: Dhadum gaon, Laphangkula gaon;
Tea cultivation land	Digboi: Golai tea, Powai tea; Doom Dooma: Badlabheta T.E, Daisajan T. E; Margherita: Dehing tea estate, 112/109 Nala grant
Tropical evergreen forest	Digboi: Balijan oil rig, Balijan; Jagun: Parbatipur N.C, Famang N.C; Margherita: Makum forest block; Saraipung: Saraipung forest

Environmental variables

The elevation of the study sites measured by an in a GPS device (embedded altimeter) was categorized into (1) 120-139 m (low elevation); (2) 140-159 m (moderate elevation) and; (3) 160 m to above 400 m (high elevation).

The bioclimatic variables, temperature and relative humidity were measured using digital hygrometer classified as (1) 11-18°C (low temperature); (2) 19-23°C (moderate temperature); (3) 24-28°C (high temperature) and (1) 60-69% (low humidity); (2) 70-79% (moderate relative humidity); (3) 80-89% (high relative humidity).

Sampling Procedure

Sampling was carried out subdividing the entire study sites into broad habitat types, to ensure regular sampling on each habitat type, minimum 2 replicate sites representative of the habitat were selected evenly, spaced within 500m. Light trapping carried out with a white sheet (6x4 feet) attached into two vertical poles (6 feet height). Centred to the sheet, 160w mercury vapour bulb connected to 240v mains was used wherever accessible or else a portable 9w actinic-UV tube powered by a 12v battery used for remote areas where the mains were inaccessible. The sampling event started from 17:00 hours to 04:00 hours and lights were visited within an interval of 2-3 hours to ensure species accumulated do not escape. The sampling site coordinates, elevation and habitat type were noted. Once the moths gather into the sheet, identification and count on moths against each species were recorded.

Data analysis

Prior to analyses, the sampling records were split into two datasets, (a) “species dataset” containing species abundance data for 120 moth species used as response variables. (b) “environmental dataset” containing data on environmental variables for the sampled sites.

Analyses of species composition were performed in R (3.2.4) [15] and Estimate S [16]. To assess the adequacy of the sampling effort, individual-based species accumulation curve (SAC) was computed, these rarefaction curves graphically represent the species richness on average pooled species individuals for each of the sampled habitats. Estimates on total moth richness of the study area were computed by non-parametric estimators (Chao 1, Chao 2, Jack-knife 1, Jack-knife 2) [17] and compared with the observed richness. Rank-abundance curve (RAC) was performed to analyse patterns of species abundance, where the most abundant to the least abundant species are ranked in a graphical plot. Variance in moth abundance between the habitat types, moth families and categories of environmental variables were checked by calculating mean moth abundance and performing Kruskal-Wallis Test, a non-parametric alternative to analysis of variance (ANOVA) that allow comparison of continuous variables for three or more groups. Differences in species composition between the habitats were measured by Bray-Curtis ecological distance [18]. Based on the created distance matrix, the sites and habitats with similar species compositions were grouped as clusters by hierarchal clustering method.

To look for the potential environmental variables influencing the larger moths, Biodiversity R [19] package was employed in R for simple linear regression analyses on mean moth abundance against each predictor variable.

Results

Species composition

Abundance data on 1598 individuals, representing 120 species from 10 families were recorded. Species richness estimates on 500 randomizations on the species dataset showed significant differences from the observed data, with the exception of Chao 1 estimator, that produced an estimate of 121 species, did not differ significantly from the observed species richness, however, Chao 2 indicated presence of 177 species revealing 57 additional species that were not recorded, Jack-knife 1, Jack-knife 2 produced 134 and 142 species estimates. Individual-based rarefaction curves across the habitat types showed none of the habitats reach asymptote or inventory completeness, tropical evergreen forest and degraded evergreen forest showed higher accumulation of species, while, paddy cultivation land showed the least accumulation Rarefaction curve given in Figure 2.

The plot on Rank abundance curve indicated *Ercheia cyllaria*, ranked first in the plot having the largest total abundance (48) and that *Maxates sp.* was ranked last since this species showed the lowest abundance (4). The rank-abundance curve for the species dataset is given in Figure 3.

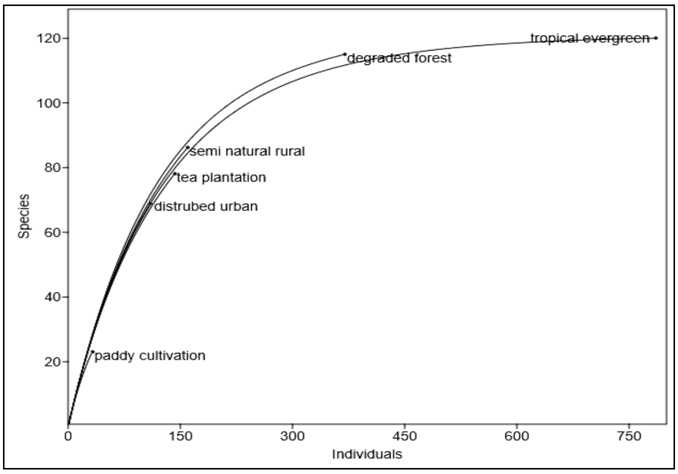

Fig 2: Individual-based rarefaction curve across different habitat types.

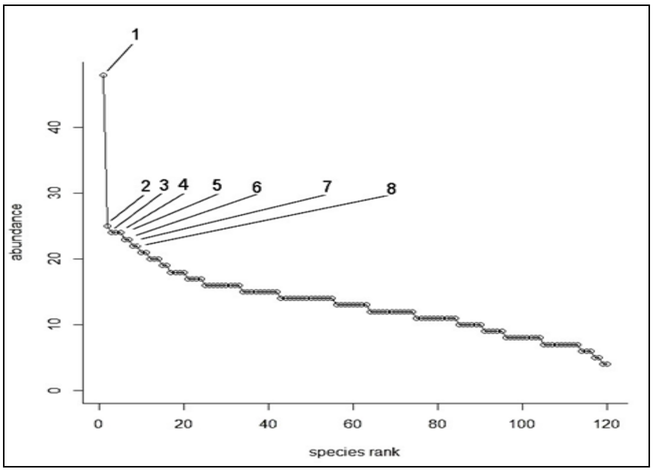

Fig 3: Rank-abundance curve for the species dataset. Species rank (1) *Ercheia cyllaria* Cramer, 1779; (2) *Numenes siletti* Walker, 1855; (3) *Argina astrea* Drury, 1773; (4) *Bastilla crameri* Moore, 1885; (5) *Hyposidra talaca* Walker, 1860; (6) *Syntomoides imaon* Cramer, 1779; (7) *Trigonodes hyppasia* Cramer, 1779; (8) *Mocis frugalis* Fabricius, 1775

Compraision between habitat types and environmental categories

Kruskal Wallis test showed significant difference in counts of species among the habitat types $H= 34.194, df =5, p=2.18 \times 10^{-6}$; moth families $H=31.154, df = 9, p= 0.00027$; categories of elevation $H=23.019, df =2, p= 1.1 \times 10^{-5}$; and relative humidity $H=18.787, df =2, p=8.3 \times 10^{-5}$. Significant difference was not observed for temperature $H=0.884, df =2, P=0.643$; and sampled months $H=3.852, df =9, p=0.921$. Results tabulated in Table 2.

Distance matrix measured by the Bray Curtis ecological distance calculated the similarity between habitats 5 and 6 as 0.392 which is the highest among the others, whereas the lowest similarity observed as 0.924 for habitats 2 and 5. The distance matrix is shown in table 3.

Cluster analysis grouped the tropical evergreen and degraded evergreen forests into single cluster, followed by joining clusters of semi natural rural, tea cultivation and disturbed urban land. Paddy cultivation land formed a distinct group.

Hierarchical clustering performed for the habitat versus species abundance data using the calculated distance matrix clustered the 6 habitats into a hierarchical sequence of 10 steps. At the first step, the 5th and 6th habitat were joined that had the smallest value of all the pairwise distances, the second step joined 1st and 3rd habitat, then 4th habitat was merged into the cluster formed by 1st and 3rd. Similarly, 2nd habitat having the least similarity of all the pairwise distances were joined at the last step. The habitat similarity cluster is represented by a dendrogram tree in Figure 4.

Table 2: Variation in moth mean abundances among the attributes, *Here, H= test statistic, df=degrees of freedom and p= probability value to determine significant difference (p<0.05*).*

Attributes	p=	df	H
Habitats (n=6)	$2.18 \times 10^{-6*}$	5	34.194
Elevation, m (n=3)	$1.1 \times 10\text{-}5^{*}$	2	23.019
Temperature, °C (n=3)	0.643	2	0.884
Relative humidity, % (n=3)	$8.3 \times 10^{-5*}$	2	18.787
Moth families (n=10)	0.0002^{*}	9	31.154
Months sampled(n=10)	0.921	9	3.852

Table 3: Distance matrix of the habitat types (1) disturbed urban land; (2) paddy cultivation land; (3) semi-natural rural; (4) tea plantation land; (5) tropical evergreen forest (6) degraded evergreen forest

Habitat	1	2	3	4	5
2	0.818				
3	0.459	0.749			
4	0.597	0.828	0.568		
5	0.757	0.924	0.669	0.700	
6	0.596	0.870	0.515	0.515	0.392

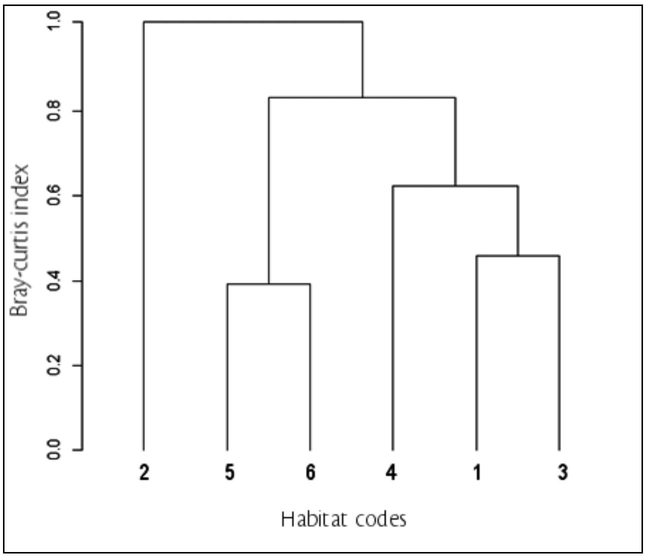

Fig 4: Dendrogram of clusters formed by the habitat types: (1) disturbed urban land; (2) paddy cultivation land; (3) semi-natural rural; (4) tea plantation land; (5) tropical evergreen forest (6) degraded evergreen forest

Drivers of species composition

Simple linear regression analysis on mean moth abundance against the continuous environmental variables showed, elevation (F 1, 43 = 17.57, p = 0.0001, Adjusted R^2=0.273) alone explaining 27.3% of the variability, however the coefficient of determination was not very significant to affirm a linear relationship; temperature (F 1, 43 =0.007799, p =0.564, Adjusted R^2=-0.01527) and humidity (F 1, 43 = 2.73, p =0.1056, Adjusted R^2=0.03788) did not show significant influence on mean moth abundance, shown in Table 4.

Table 4: Linear regression analysis summary for the variables, * indicate significance (p<0.05)

Variables	F statistic	p-value	df	Adj. R^2	Slope ± SE	Intercept
Elevation	17.571	0.001*	43	0.2736	0.002 ± 0.001	-0.065
Temperature	0.007	0.564	43	0.0152	-0.002 ± 0.004	0.262
Humidity	2.732	0.105	43	0.0378	0.005 ± 0.003	-0.184

Discussion

Natural habitats have been increasingly altered for human use and a greater extent of earth's biodiversity is on threat [20, 21, 22]. This phenomenon is frequently cited as the cause of decline for Lepidoptera as well as most other taxa all over the world [23, 24]. At present there is perpetual gap in knowledge of moths and most other insects, in such state, species inventories and baseline ecological research must be prioritised and prominence of these studies can be possibly taken forward towards conservation of the species by better understanding on the needs of the community. The present study is a preliminary understanding of the moth community, its associated environmental parameters and habitat regimes from the study area. Species composition and distribution of insect based on habitat regimes and environmental gradients have been studied intensively, such studies reveal the undisturbed habitats to be more suitable than the disturbed ones [25, 26, 27]. The results of this study contradicted what was expected, indicating significantly higher species richness and abundance in the forested habitats. It is also hypothesized that forests provide abundant food, cover and other necessary resources for the organisms. Thus, they have more niches and rich species diversity [28, 29]. The most heterogenous tropical evergreen forest represented 24% species richness, and higher abundance also averted the occurrence of any singleton species. Degraded forest habitat did not show any significant difference from the tropical evergreen in terms of mean moth abundance, here, 23% of the species richness occurred and the mean proportion of singletons was marked by 0.20 species, this type of habitat once furnished by the characteristics of an evergreen forest, but, at present, increasing modification have degraded them by numerous source of disturbance and depletion of natural resources. Semi natural rural land that retain a few properties of natural habitat, showed significantly higher mean proportion of singletons as 17.58 species and 18% of the species richness. A probable reason that account for such observation might be because of moderate species richness and relatively lower abundance due to diverse lands use patterns. Firstly, the locations at a proximity of forest edge attracted some proportion of the forest species, that are possibly sampled. Secondly, agricultural lands resulted accumulation of pest moths, further, in these sites silk yielding species are occasionally reared, few may get attracted to lights adding the richness, however, the individual counts did not increase. Tea cultivation land covering vast areas of homogenous tea plantation accumulated moths that are associated with tea, constituting 16% of the species. Disturbed urban lands, with mass agglomeration of human settlements lack the properties of a natural habitat, ornamental plants, herbs and shrublands dominate the vegetation grounds.

14% of the species were representative of this habitat, mean proportion of singletons was moderate resulting 6.6 species. 5% of the species were observed in paddy cultivation land, in this habitat type, species from two micro-moth families; Crambidae and Pyralidae (not included in this study) were in high numbers. Some distant flying tourist moth as well as those that feed on herbs and grasses in their larval stage and yet to disperse or those species that visit the weed flowers may have accumulated, these possibilities increased the mean proportion of singletons to 27.4 species, highest among the other habitats.

Species composition of the moth families revealed Erebidae to be the most speciose as expected as this family is remarkable more diverse in tropics [30] and in this study 41 % of species richness(S), 49% of the total abundance (A) were represented by Erebidae; followed by Geometridae 22%(S), 20 % (A); and Sphingidae 7% (S), 14 %(A), the other families represented relatively lower proportions. Abundance of each species according to the occurred habitat type is presented in Table 5.

Measuring species richness of hyper-diverse taxa such as the lepidoptera is beyond time, cost and sampling effort [9, 31]. Evidently, in this study too all the species were not sampled at either site, thus, none of the rarefaction curves reached an asymptote of all the habitats. The species richness estimates as well as the individual-based rarefaction curve revealed that the moth survey or sampling effort was not adequate, thus, more intensive sampling has to be done in order to represent species richness of the study area and also for each habitat type.

Previous studies on influence of environmental factors upon insects, showed that the patterns of warmer weather conditions can accelerate physiology leading rapid production of generations [31, 32]. Studies also state that this may elevate species distributions to higher elevational ranges [33, 34]. The influence of elevation on tropical moth communities display two patterns; (1) decreasing diversity along increasing elevation gradients and (2) increasing species richness and abundance up to a moderate elevation peak, where, as elevations levels go higher from the peak, reduce diversity showing a unimodal distribution [9, 35, 36].

In this study, the lowest sampling site was situated at 117m, followed by sites reaching up to 206m, at the highest, sites were on 348m and 442m. Abundance was considered for evaluating the influence of elevation, the results followed the second pattern as the counts on individuals increased as elevation gradient reached up to 442 m. However, a significant linear relationship was not obtained as sampling sites were missing on elevations between 206 m to 348 m.

Previous investigation on effects of temperature and relative humidity on moths showed higher accumulation of moths with increasing temperature and relative humidity [37, 38]. The results of this study showed no significant influence of temperature and humidity on mean abundance of the moth community.

Conclusion

This observed trend of decreasing richness and increasing singletons from more heterogenous natural to homogenous urban and agricultural habitats is likely to be the result of reduction of vegetation attributes due to the change of natural vegetation to human settlements and monoculture cultivation of commercial plants. It was also observed that moths from the agricultural habitats such as tea and paddy land are mostly associated with major cultivated plants and occurrence of some polyphagous moth species.

This study may form a basis for understanding the ecology of overlooked moth community in the study area, strengthening the importance of continued scientific surveys and for conservation of species as well as the habitats concerned. There is a need of establishing indicator assemblages of moth community in these habitats and beyond the study area. Habitat suitability studies on moth species are necessary at present and for that intensive studies on adult and larval stages are essential.

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Table 5: List of moths sampled and their abundance in the habitats, DUL: disturbed urban land; PCL: Paddy cultivation land; SNR: Semi-natural rural; TPL: tea plantation land; TEF: tropical evergreen forest and; DEF: degraded evergreen forest

Moth Species	DUL	PCL	SNR	TCL	TEF	DEF
Family: Lasiocampidae						
Trabala vishnou Lefebvre, 1827	1	0	2	1	9	1
Trabala ganesha Roepke, 1951	0	1	4	0	6	6
Odonestis bheroba Moore, 1858	2	0	4	0	7	2
Euthrix laeta Walker, 1855	1	0	3	2	5	3
Family: Saturnidae						
Antheraea frithi Moore, 1859	0	0	1	0	4	2
Antheraea assamensis Helfer, 1837	0	1	2	1	5	5
Cricula trifenestrata Helfer, 1837	3	0	3	1	3	4
Antheraea helferi	1	1	2	2	3	2
Family: Sphingidae						
Acherontia styx Westwood 1847	1	0	3	0	8	3
Acherontia lachesis Fabricius, 1798	0	0	2	1	2	5
Psilogramma discistriga Walker, 1856	1	1	0	0	6	3
Argius convolvuli Linnaeus, 1758	0	0	1	1	11	3

Clanis titan Rothschild and Jordan, 1903	2	0	0	1	2	2
Ambulyx substrigilis Westwood 1848	4	1	1	1	5	5
Marumba spectabilis Butler 1875	3	0	1	0	3	1
Marumba dyras Walker, 1856	1	0	2	0	3	1
Callambulyx rubricosa Walker 1856	0	0	2	0	3	1
Angonyx testacea Walker, 1856	2	0	2	2	6	4
Enpinanga assamensis Walker 1856	2	0	1	0	3	1
Theretra nessus Drury, 1773	1	0	3	2	4	1
Theretra silhetensis Walker, 1856	0	0	1	0	7	1
Pergesa acteus Cramer, 1777	1	2	1	0	1	0
Eupanacra mydon Walker, 1856	0	0	0	0	7	1
Eupanacra busiris Walker,1856	3	0	4	1	6	1
Acosmeryx shervillii Boisduval, 1875	0	1	0	1	5	1
Acosmeryx anceus Stoll, 1781	2	0	0	0	7	2
Elibia dolichus Westwood 1847	0	2	4	1	3	2
Daphnis nerii Linnaeus, 1758	2	0	0	0	2	4
Cephonodes hylas Linnaeus 1771	1	0	1	1	7	1
Family: Erebidae						
Artena dotata Fabricius, 1794	0	0	1	0	3	3
Thyas coronata Fabricius, 1775	0	0	0	0	2	3
Ophiusa triphaenoides Walker, 1858	0	0	1	1	3	2
Achaea janata Linnaeus, 1758	0	0	1	0	7	5
Buzara onelia Guenée, 1852	0	0	0	2	6	6
Bastilla crameri Moore, 1885	3	0	6	0	11	3
Bastilla acuta Moore, 1883	1	0	0	2	8	5
Pindara illibata Fabricius, 1775	1	0	3	0	6	4
Grammodes geometrica Fabricius, 1775	0	0	0	2	7	4
Chalciope mygdon Cramer, 1777	0	0	1	2	7	8
Trigonodes hyppasia Cramer, 1779	0	4	4	1	6	5
Mocis frugalis Fabricius, 1775	0	0	2	3	8	3
Ercheia cyllaria Cramer, 1779	1	0	2	0	38	7
Serrodes campana Guenee, 1852	2	0	0	2	7	1
Hulodes caranea Cramer, 1780	0	0	0	2	10	3
Hypopyra ossigera Guenee, 1852	0	0	1	5	5	3
Sympis rufibasis Guenee, 1852	2	0	2	0	7	5
Erebus ephesperis Hubner, 1827	1	0	1	2	6	5
Erebus macrops Linnaeus, 1768	0	0	0	3	6	3
Calyptra minuticornis Guenée, 1852	1	1	1	2	9	5
Eudocima materna Linnaeus, 1767	1	0	1	0	7	5
Eudocima salaminia Cramer, 1777	0	1	0	0	6	6
Phyllodes eyndhovii Vollenhoven, 1858	2	0	0	1	3	3
Hamodes propitia Guerin-Meneville, 1831	1	0	0	1	5	3
Anoba sp. 1	1	0	1	0	7	2
Episparis experimens Walker, 1862	1	1	1	1	7	6
Lopharthrum comprimens Walker, 1858	0	0	2	0	5	1
Lycimna polymesata Walker, 1860	2	0	1	0	4	5
Saroba pustulifera Walker, 1865	0	0	0	1	2	4
Cyana sp. 1	1	0	0	4	5	3
Cyana coccinea Moore, 1878	1	0	1	3	1	3
Calliteara grotei Moore, 1859	1	0	1	0	8	5
Amata passalis Fabricius, 1781	0	1	2	1	7	3
Areas galactina Hoeven, 1840	0	0	0	1	7	7
Argina astrea Drury, 1773	4	0	5	1	8	6
Amerila astreus Drury, 1773	2	0	2	0	11	5
Nyctemera adversata Schaller, 1788	0	0	1	1	10	4
Asota caricae Fabricius, 1775	0	0	1	0	8	6
Asota helicona	2	2	2	2	9	5
Aglaomorpha plagiata Walker, 1855	2	0	0	3	8	3
Oeonistis altica Linnaeus, 1768	1	0	2	2	8	1
Macrobrochis gigas Walker, 1854	0	0	2	2	12	2
Syntomoides imaon Cramer, 1779	1	0	1	1	10	8
Rectipalpula billeti Joannis, 1900	1	1	2	2	14	4
Anticarsia irrorata Fabricius, 1781	3	0	0	1	10	3
Numenes siletti Walker, 1855	0	0	1	1	17	6
Cyclodes omma van der Hoeven, 1840	0	0	1	3	12	2
Enispa elataria Walker, 1861	0	1	3	0	17	3
Anomis flava Fabricius 1775	2	0	1	2	14	3
Family: Geometridae						
Fascellina chromataria Walker, 1860	1	0	0	3	12	3

Plutodes flavescens Butler, 1880	2	0	1	1	8	4
Thinopteryx crocoptera Kollar, 1844	1	0	1	2	5	1
Hyposidra talaca Walker, 1860	2	0	2	5	7	7
Biston bengaliaria Guenée, 1857	1	0	0	6	7	6
Biston suppressaria Guenée, 1858	0	0	1	4	4	3
Chorodna metaphaeria Walker, 1862	1	1	1	0	12	1
Krananda semihyalina Moore, 1868	1	0	1	3	4	4
Celerena divisa Walker, 1862	3	0	3	1	4	1
Chorodna sp. 1	0	0	0	1	2	3
Tanaorhinus viridiluteatus Walker, 1861	0	0	0	0	2	2
Agathia diversiformis Warren, 1894	0	0	2	1	4	2
Eucyclodes gavissima Walker, 1861	3	0	2	0	2	3
Maxates sp.1	0	0	0	2	1	1
Berta chrysolineata Walker, 1863	1	0	1	1	4	1
Aporandria specularia Guenée, 1857	1	0	2	2	7	2
Traminda aventiaria Guenée, 1857	1	0	1	0	6	4
Problepsis vulgaris Butler, 1889	0	0	1	1	6	0
Zythos avellanea Prout, 1932	1	0	1	1	8	0
Hyperythra lutea Stoll, 1781	2	2	1	3	13	0
Chiasmia nora Walker, 1861	0	0	1	0	8	1
Ecliptopera rectilinea Warren, 1894	0	0	0	3	6	3
Lomographa inamata Walker, 1860	0	0	0	0	5	3
Lophophleps triangularis Hampson, 1895	1	0	2	1	7	3
Antitrygodes divisaria Walker, 1861	1	0	0	5	8	4
Sarcinodes aequilinearia Walker 1860	0	0	1	1	6	3
Family: Uranidae						
Lyssa zampa Butler, 1869	0	1	2	0	4	3
Acropteris grammearia Geyer, 1832	1	0	4	1	4	3
Urapteroides astheniata Guenée, 1857	0	0	0	0	4	4
Orudiza protheclaria Walker, 1861	1	1	3	0	6	2
Family: Drepanidae						
Tridrepana flava Moore, 1879	0	0	1	1	3	2
Teldenia vestigiata Butler, 1880	0	0	2	4	4	3
Callidrepana patrana Moore, 1866	1	0	0	1	2	2
Cyclidia substigmaria Hübner, 1831	0	1	0	2	3	5
Canucha specularis Moore, 1879	2	0	4	0	6	2
Thyatira batis Linnaeus, 1758	1	0	1	1	8	1
Family: Nolidae						
Titulcia confictella Walker, 1864	0	0	0	1	5	1
Carea angulata Fabricius, 1793	0	2	1	1	2	3
Family: Cossidae						
Xyleutes mineus Cramer, 1777	1	0	3	1	5	2
Xyleutes persona le Guillou, 1841	0	0	2	1	5	3
Family: Bombycidae						
Mustilia sp. 1	1	0	5	2	3	1
Trilocha varians Walker, 1855	5	0	2	1	4	3

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