‘Moth Diversity in Dhemaji District of Assam’

A
Project Report Submitted
to
Department of Zoology (PG)
Silapathar Science College,
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In partial fulfilment of the requirements for the degree of Masters of Science

By

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JULY, 2022

Dedicated to my family and teachers

DECLARATION

I **Jadumoni Bora** bearing Roll No. **202820024009**, Registration No. **451028220** dated: 07-12-2021, hereby declare that the subject matter of the dissertation entitled "**Moth Diversity in Dhemaji District of Assam**" is the record of work done by me. The dissertation is being submitted to Silapathar Science College for the degree of Master of Science in the Department of Zoology (PG) and not been submitted to any other institute for obtaining any degree.

Jadumoni Bora

Place: Silapathar Science College

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CERTIFICATE

Certified that the dissertation entitled **"Moth Diversity in Dhemaji District of Assam"** for the award of Master of Science degree (as final semester practical project) is the outcome of a bonafide research work. This work has not been submitted previously for the obtaining any other degree of this or any other institution. I recommended that the project work may be placed before the examiners for consideration of award of the degree.

Place: Silapathar Science College
Date: 23 -July, 2022

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CONTENTS

ABSTRACT

Moths are phytophagous, cosmopolitan, agricultural pests, night pollinators, chiefly nocturnal and potential bio-indicators. The current study reports on species diversity, species composition, abundance, and distributional pattern of moth fauna in few of the selected habitat sites in the Dhemaji district of Assam. During the survey period of March-June, 2022, opportunistic sightings were made along with light traps were installed in three different sites viz., agricultural area, urban area and home garden areas. Present study reported a total of 59 individual specimens of moths were encountered belonging to 30 species under 30 genera and 16 families. Out of 59 specimens of moths, Based on the number of species, the family Geometridae was most dominant with 06 species contributing to 20%, followed by Sphingidae with 05 species contributing to 16.7%, Crambidae with 04 species contributing to 13.3%,, Erebidae, Limacodidae and Saturniidae with 02 species contributing to 6.7%, and rest of the families were dominated with 02 species each contributing to 3.3%. In terms of Species richness and abundance *Lyssa zampa* was the most dominant species in terms of the number of individuals (05), followed by *Timandra comae* and *Cnaphalocrocis medinalis* with 04 individuals, *Elophila obliteralis, Acleris forsskaleana, Micropterix aureoviridella* and *Macroglossum sp.* with 03 individuals, and the least dominant with 09 and 12 individuals. The Spatial variation in species diversity indices across study site indicates species richness among the three studied sites to be very low at site-3 (urban area) (n=07), followed by both the site -1 (agricultural area) (n=12) and site-2 (home garden area) (n=12). Statistical analysis on species distribution and evenness across the three study site indicated an increasing dominance index of species; 0.1111 (site-1 agricultural area), 0.1157 (site-2 home garden area) and 0.1667 (site-3 urban area). Shannon Weiner diversity indices H' was higher at site-1 agricultural area with value of 2.2046 and least at site-3 urban area with value of 1.8637. The evenness *E* value calculated for the three sites indicates the site-3 urban area (0.9577) to be the highest as compared to the E value for the site-1 agricultural area (0.8872) and site-2 home garden area (0.8735). Among all the studied sites, the agricultural site showing higher diversity indices because of more abundant resources availability in terms of food, shelter and avoidance of predators as compared to the other sites like urban areas where they are under the influence of more predatory attacks.

Keywords: *Moths, diversity, urban, home garden, agricultural area, Assam*

While butterflies provide the deepest historical lens to examine the phenomenon of global insect decline, macro-lepidopteran moths arguably supply the next largest set of historical records. In Europe, moths have been the focus of collecting efforts for over 200 year (David, 2020) and systematic monitoring for many decades. Moths offer additional advantages over butterflies for assessing insect biodiversity change. Their ranks include a wide spectrum of herbivores, including tree, shrub, forbs, grass, fungus, lichen, and alga feeders, as well as detritivores.

Moths include rich assemblages tied to all terrestrial plant communities from sub-polar regions to the equator. Their species taxonomy is less problematic than that of most insect lineages, and, for some countries, there have been reliable identification guides for more than a century. The immature stages of Lepidoptera are among the best known of any insect order, and knowledge of their host associations and other life-history traits can contribute considerably to efforts to understand and predict demographic declines and implications for ecosystem functioning.

Moths represent a substantial component of the insect biomass available to insectivorous vertebrates, both as caterpillars and adults, and are an important dietary source for many animals, most notably bats and songbirds . They are the very fabricunder lying the species-rich radiations of parasitoids in the Chalcidoidea, Ichneumonoidea, and Tachinidae, which collectively make up much of the planet's metazoan species diversity and moths likely play a much-underestimated role as pollinators of angiosperms. Depletions of moths will have effects that will cascade, upward and downward, triggering further losses of interactions and species. Thus, there is ample reason to regard macro lepidopterans as a worthy focal group to study global biodiversity change, and one which has much to offer as a proxy for other insect lineages with more nascent taxonomy, poorly known ecologies, and sparser long-term bio-monitoring data. Because the order Lepidoptera comprises with Butterflies and Moths, which are the most common insects of the forest ecosystems and agricultural fields and are often termed as the biological indicators of the ecosystem.

Most of the biological researchers have used Lepidoptera as a model organism to assess the impact of human and pollution disturbance and management practices of the forest ecosystems (Willott, 1999). In recently scientists estimated to comprise of 1, 74, 250 species, in 126 families and 46 super families in worldwide. In India it is estimated that approximately 12,000 species of moths belongs to 41 families are recorded (Chandra, 2007). Lepidoptera (moths and butterflies) highly depending up on the local vegetation pattern. Climate factor like temperature, humidity, rainfall, wind speed, wind direction also a very important to survival of the species, and also food requirement.

Moths being a prominent element of terrestrial ecosystems, they function as pollinators of flowers, herbivores of crops and wild plants and prey for numerous species of rodents, birds, and bats. These polyphyletic groups of insects represent more than 90% of all lepidopterans of the earth and a large number of moth species are still waiting to be discovered and named, mostly from the tropical regions of the world (Heppner, 2008). These ecto-thermic animals occupy a wide range of habitats around the world and are sensitive to environmental pressures.

Therefore, monitoring the changes in the patterns of moth distribution and abundance in an area can be used as potent ecological indicators for the conservation of biodiversity (David et al., 1986). Several factors can be attributed to the worldwide decline in moth population including habitat loss, degradation and fragmentation, agricultural intensification, changes in woodland management, urbanization, chemical pollution, artificial light at night and climate.

Moths come in all shapes and sizes and some don't even look like moths at all. The clearing moths for instance, look like wasps to stops predators from attacking than ,many moths have fantastic camouflages to help then hide from predators ,the hook tips, for example look just like dry leaves .others are brightly coloured like the tiger moths and hawk moths.

The present study was conducted in the Dhemaji district of Assam to address the diversity and abundance of Moths in different habitat structures. As, in the state of Assam there are very less research work has been conducted so far especially from the selected district. Thus, understanding the importance of Moths we I have worked on below mentioned objectives in my present project work:

1. ***To conduct survey to understand the diversity of moths in three selected sites of Dhemaji district of Assam, India.***
2. ***To understand the differences in the species distribution pattern of moths between the three study sites.***

Lepidoptera (Moths and Butterflies) are one of the highly plant-dependent groups of insects and form a rich component of fauna. Lepidoptera, play a central role in all terrestrial ecosystems. They are important herbivores, pollinators, and serve as food and hosts for multiple other organisms at higher trophic levels (Summerville et al., 2004). The better-known groups of Lepidoptera (butterflies in particular) have often been advocated as useful indicators of environmental change (Hill et al., 1995). Moths are among the scores of large taxonomic groups that are little studied. More than 90% of the known Lepidoptera species are moths and the majority of them are nocturnal (Scoble, 1992). Compared to the other mega diverse insect groups, the larger moths of Borneo, in particular, are taxonomically well known and relatively easy to identify (Holloway, 1985).

The Lepidoptera (butterflies and moths) are one order of class Insecta for which quantifying the regional species pool and locating data on species natural history may be straightforward tasks (Robinson et. al., 2002). The moth diversity in tall grass prairies are more than butterfly species and moth may be the suitable taxa for answering general questions about the exchange of species between regional and actual species pools within restored prairies. In this case, restoration ecologists may desire to determine whether the frequency of site occupancy is related with some traits like diet specialization, regional abundance, or body size. Specific hypotheses may be derived from existing macro ecological theory, which suggests that smaller, more generalist species tend to be the most widely distributed (Brown, 1995; Blackburn and Gaston, 2003).

The moth fauna of the family Arctiidae of Arunachal Pradesh was studied by Arora and Chaudhury (1982). With more than 21,000 described species, Geometridae is one of the three most species-rich moth families. Their taxonomy is relatively advanced (Scoble, 1999), and the adults can easily be attracted with blacklight tubes. They have been described as a suitable group in which to study about the environmental effects of forest because of their weak flight ability and the high habitat fidelity (Thomas, 2002). Since, Geometridae is one of the largest families of Lepidoptera, geometrid moths are generally well known to react sensitively to environmental change, which has rendered them a frequently used focal group to address a wide range of ecological questions (Holloway, 1985; Willott, 1999)

In Assam, there are various research studies have been carried out on diversity and distribution of moth species. A field work conducted by Rose (2002), prepared an inventory of 81 species of the moth fauna under Lepidoptera of Jatinga, Assam. Arandhara and Tariang, (2018), Arandhara, et al., 2017) have observed species composition of larger moth in Tinsukia district under the influence of habitat types, elevational gradient and bioclimatic variables on abundance of moth community. Another research work done by Chandra and Sambath (2013) in Tawang districts of Arunachal Pradesh during the year 2009 using light trapping method. Hazarika, et. al. (2009) conducted species diversity surveys on lepidopterans in and around Jorhat district of Assam.

Several other studies have illustrated the importance of assembly history in ecological communities (Chase, 2003) with some studies suggesting that the initial fauna to colonize a site may cause local communities to diverge in species composition when the regional species pool is sufficiently diverse (Fukami, 2004). Ultimately, species traits may interact with local and regional habitat characteristics, such as plant community composition, to influence species re-colonization of restored habitats (Waltz and Covington, 2004; Summerville et al., 2004). The monitoring of community structures of moths could provide a detailed map of the parts of the forest ecosystem. They also show sensitivity towards environmental changes because of their habitat preference and this makes them a suitable biological indicator group in biodiversity assessment and documentation. Since, they are highly sensitive to changes in the environment; this group of insects is easily affected by relatively minor perturbations in the habitat. Therefore they have been considered as indicators of environmental quality. Moths appear to be at least as well suitable as butterflies for assessing environmental impacts (Holloway, 1985).

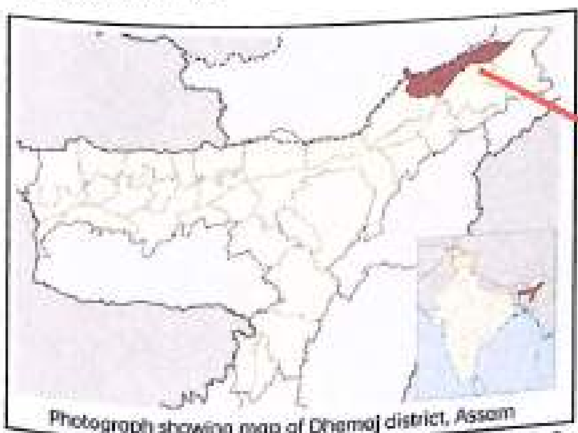
Through the above extensive reviews of available literature from the state of Assam it can be infer that very few studies were conducted to assess the spider diversity in the Dhemaji district of Assam. So, the proposed study was carried out with an objective to document the spider diversity of Dhemaji district Assam.

Survey area:

Dhemaji district is situated in upper Assam of India, The study was carried out during the period of March to June, 2022 in local village in Dhemaji town, near agricultural field, in urban area- in my home garden, balcony outdoor indoor. The Dhemaji district have climatic condition with the maximum day time temperature during the summer varies between 35°C to 45°C and during the winter season it ranges between 10°C to 20°C and the minimum number of rainfall is received in the day time in may month.

Geography:

Dhemaji district is located between 94°12'18" E - 95°41'32" E longitudes and 27°05'27" N 27°57'16" N latitudes in Assam. Below map shows the location of the Dhemaji District in Assam, India. It occupies a total area of 3,237 sq.km and is located in the remote eastern most part of Assam in Northeastern region of India. It shares it boundaries with the hills of Arunachal Pradesh on the North and eastern region and Lakhimpur district on the west and river Brahmaputra on the south. The district emerges from the foot hills of Arunachal Pradesh and stretches to the river Brahmaputra with Subansiri one side and the river Siang on the other. The river Brahmaputra flows from east to west in the southern part of the district. The geographical location of the district has enhanced the entire area as a hot spot of biodiversity. The district has enormous terrestrial as well as aquatic heterogeneity including forest grasslands, rivers, wet lands which provide unique habitats for many wild flora and fauna.



Map shows the location of the Dhemaji District in Assam, India.

Study sites: For the present study three different types of habitat types were selected to conduct the survey. These sites were from agricultural area, home garden area and urban area. Below are the brief details of the selected three sites in the Dhemaji district of Assam:

Site-1 (Agricultural area) – These sites is mostly dominated with herbs, shrubs and agricultural plantations with lots of prominent water bodies around the agricultural fields. These fields were moderately disturbed by the farming practices.

Site-1 (Agricultural area)

Site - 2 (Home garden area) – These sites is mostly the backyard area of house, which generally have mixed cultivation of plantation and are less disturbed as well.

Site - 2 (Home garden area) with light trapping set up.

Site-3 (Urban area)- These sites were mostly the indoor and outdoor areas in the town area, roads, etc. These areas were highly disturbed due the human activities and are highly susceptible to moths.

Site-3 (Urban area) with light trapping set up.

Methods:

Moths being nocturnal in nature needs special forms of survey methods. Sometimes, they area also attracted to the lights and can be easily captured and recorded. Thus, we had used the opportunistic method through light trapping and frequent opportunistic visits to light sources of several places and streets of the local campus at night. Most of the moths were recorded from the light traps created by mounting a high power (23-Watt) LED lamp in front of a white house wall or using white cloths, located at different areas in the study site. In additionally, a large number of moths were also documented from the agricultural area and street light towers equipped with high power LED lamps.

The moth photographs were identified based on physical features with the help of available literatures including Hampson (1891), Bell and Scott (1937). The classification system used in the present study was adapted from the work of van Nieukerken et al., (2011). In addition, a number of web resources including **www.jpmoths.org**, Moths of India- **http://www.mothsofindia.org/**, **https://www.flickr.com/groups/mothsofindia/** and iNaturalist- **https://www.inaturalist.org** were used for the purpose of identification. None of the species was captured or killed during the entire period of the study.

Data analysis:

The collected data on aquatic insects were analysed using Microsoft excel and other diversity indices formulas which are as follows:

Shannon Wiener diversity index (1963)

To calculate the diversity of aquatic insect. Shannon index (H') as a measure of species richness and abundance was applied. Shannon index is derived using the following equation:

$$H = -\sum_{i=1}^{S} pi * (ln\, pi)$$

Where;

H = Shannon Wiener index for species diversity,

S = Number of species,

Pi = Proportion of total sample belonging to the ith species, and

ln = Natural log

In addition, Simpson's index (D) and the Evenness index (E) are evaluated as a measure of species dominance and evenness, respectively (Magurran, 1988).

Simpson's index (D)

$$D = \sum_{i=1}^{S} (pi)^2$$

Where;

D = Simpson's Index of species diversity

pi = proportion of total sample belonging to the i^{th} species As biodiversity increases, Simpson's Index decreases.

Evenness index (E)

$$E = H/H(max) = \sum (pi(ln pi)/ln S$$

where **Hmax** is the natural logarithm of the total number of species

Species composition:

During the present investigation, 59 individual specimens of moths were encountered belonging to 30 species under 30 genera and 16 families. The number of individuals of different species of moths are presented in Table 1. Out of 59 specimens of moths, 11 (20%) of each specimens belong to the family Geometridae, followed by Crambidae 10 (18%), Sphingidae, 09 (15%) specimens to Uraniidae, 05 (9%) of each specimens to Erebidae, Tortricidae, Limacodidae, Micropetrigidae and Seometridae. 03 (5%) of each specimens belongs to the Saturniidae and Zygaenidae and rest 02 (4%) of each specimens belongs to the family Brahmaeidae, Cossidae, Lasiocampidae and Noctuidae (Figure 1).

Based on the number of species, the family Geometridae was most dominant with 06 species contributing to 20%, followed by Sphingidae with 05 species contributing to 16.7%, Crambidae with 04 species contributing to 13.3%, Erebidae, Limacodidae and Saturniidae with 02 species contributing to 6.7%, and rest of the families were dominated with 02 species each contributing to 3.3%, (Figure 2).

According to some studies the family Geometridae is one of the largest families of Lepidoptera and are generally well known to react sensitively to environmental change (Holloway, 1985, Willott, 1999) and sometimes the adults can easily be attracted with blacklight tubes (Scoble, 1999). This might be the reason why we have trapped and encountered the family Geometridae to be the highest.

Also, the differences in reports of various types of species might be due to the difference in plant community composition among the selected study sites. As, studies on plant community composition and its importance on influence of species diversity and its re-colonization has been emphasized by Waltz and Covington (2004) and Summerville et al., (2004).

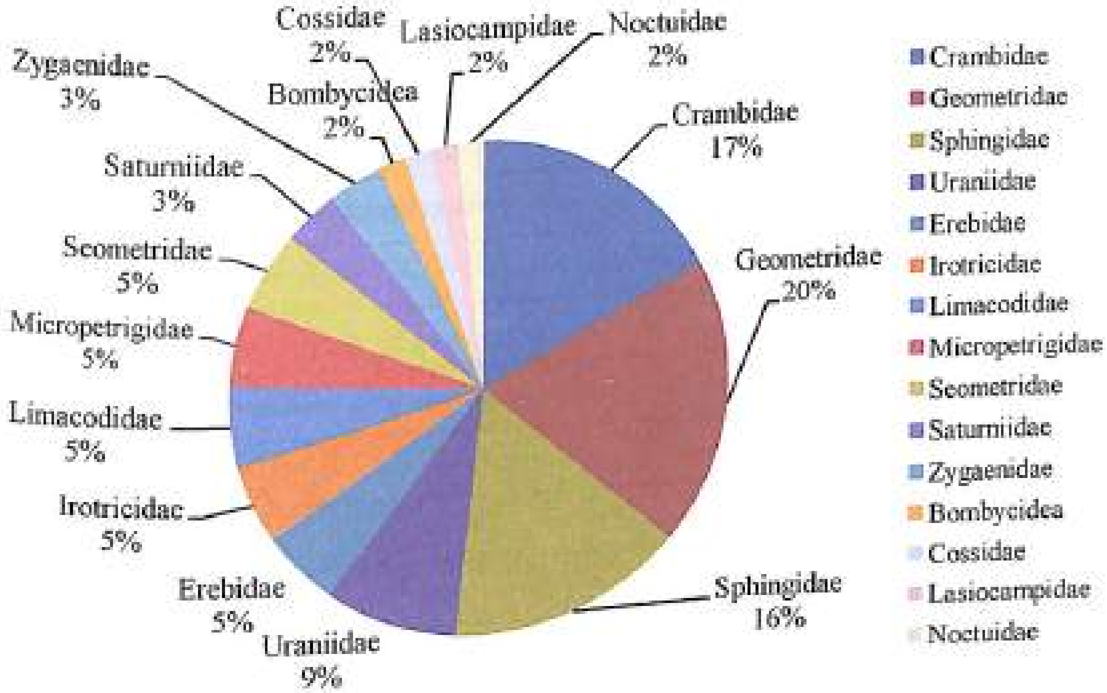


Figure 1. Species richness of moth fauna with reference to their Families from present study.

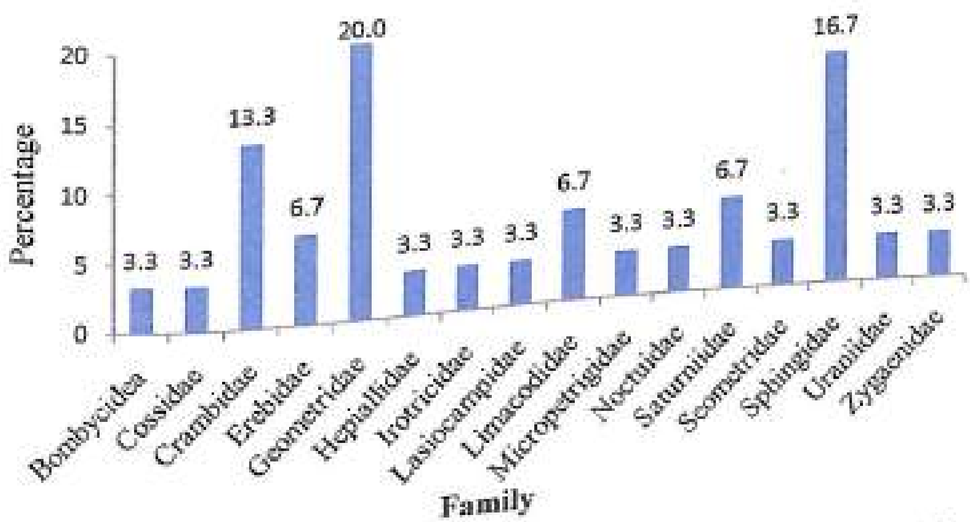


Figure 2. Percentage contribution of different families of moths encountered from present study

Species richness and abundance:

Lyssa zampa was the most dominant species in terms of the number of individuals (05), followed by *Timandra comae* and *Cnaphalocrocis medinalis* with 04 individuals, *Elophila obliteralis, Acleris forsskaleana, Micropterix aureoviridella* and *Macroglossum sp.* with 03 individuals, and the least dominant with 09 and 12 individuals was shown by other species as shown in table 1.

Spatial variation in species diversity indices across study site:

Present result indicates species richness among the three studied sites to be very low at site-3 (urban area) (n=07), followed by both the site -1 (agricultural area) (n=12) and site-2 (home garden area) (n=12) (Table 1 and 2).

Statistical analysis on species distribution and evenness across the three study site indicated an increasing dominance index of species; 0.1111 (site-1 agricultural area), 0.1157 (site-2 home garden area) and 0.1667 (site-3 urban area) (Table 2).

Shannon Weiner diversity indices H' was higher at site-1 agricultural area with value of 2.2046 and least at site-3 urban area with value of 1.8637 (Table 2).

The evenness *E* value calculated for the three sites indicates the site-3 urban area (0.9577) to be the highest as compared to the E value for the site-1 agricultural area (0.8872) and site-2 home garden area (0.8735) (Table 2).

The spatial variation reported among the three studies site is due to the difference in the habitat and plant community structures. Waltz and Covington (2004) had reported the importance and influence of these similar parameters influencing the species diversity and distribution. Thus, the same has been seen here in this present study as well among the studied sites.

Among all the studied sites, the agricultural site showing higher diversity indices because of more abundant resources availability in terms of food, shelter and avoidance of predators as compared to the other sites like urban areas where they are under the influence of more predatory attacks.

Table 1. Distribution of various species encountered under different families across three study sites

Sl. No.	Species	Family	Total no. of individuals	Site-wise distribution of species*		
				Site-1	Site-2	Site-3
1	*Brahmaea hearseyi* (Swinhoe, 1892)	Brahmaeidae	1	+	-	-
2	*Cossula magnifica* (Strecker, 1876)	Cossidae	1	+	-	-
3	*Cnaphalocrocis medinalis* (Gunee, 1854)	Crambidae	4	-	+	-
4	*Elophila sp.*	Crambidae	3	-	-	+
5	*Maruca sp.*	Crambidae	2	-	-	+
6	*Herpetogramma fluctuosalis* (Lederer, 1863)	Crambidae	1	-	+	-
7	*Spilosoma virginica* (Fabricius, 1798)	Erebidae	2	-	+	-
8	*Macrobrochis gigas* (Walker, 1854)	Erebidae	1	-	+	-
9	*Geometra lycaenaria* (Kolar, 1848)	Geometridae	2	+	-	-
10	*Ourapteryx* (Duponchel, 1845)	Geometridae	1	+	-	-
11	*Pelagodes antiquadraria* (Holloway, 1996)	Geometridae	2	-	+	-
12	*Eumelea aurantiata* (Warren, 1896)	Geometridae	1	-	+	-
13	*Timandra comae* (Anton Schmidt, 1931)	Geometridae	4	-	+	-
14	*Pingasa ruginaria* (Guenee, 1858)	Geometridae	1	-	-	+
15	*Acleris forsskaleana* (Linnaeus, 1758)	Tortricidae	3	-	+	-
16	*Philudoria potatoria* (Harris, 1841)	Lasiocampidae	1	+	-	-
17	*Miresa semicalida* (Walker, 1855)	Limacodidae	2	+	-	-
18	*Parasa darma* (Moore, 1860)	Limacodidae	1	-	-	+
19	*Micropterix aureoviridella* (Higher, 1898)	Micropetrigidae	3	+	-	-
20	*Amphipoea oculea* (Latreille, 1809)	Noctuidae	1	-	-	+
21	*Antheraea sp.*	Saturniidae	1	-	+	-
22	*Loepa katinka* (Westwood, 1848)	Saturniidae	2	+	-	-
23	*Heraclia terminates* (Hubner, 1820)	Geometridae	3	+	-	-
24	*Enpinanga assamensis* (Baker, 1904)	Sphingidae	1	-	+	-
25	*Daphnis nerii* (Linnaeus, 1758)	Sphingidae	2	-	-	+
26	*Theretra silhetensis* (Walker, 1856)	Sphingidae	2	+	-	-
27	*Clanis titan* (Rothschild & Jordan, 1903)	Sphingidae	1	-	+	-
28	*Macroglossum sp.* (Scopoli, 1777)	Sphingidae	3	+	+	+
29	*Lyssa zampa* (Butler, 1869)	Uraniidae	5	+	-	-
30	*Cyclosia papilionaris* (Drury, 1773)	Zygaenidae	2	-	-	+
	Total		59	12	12	08

*Site-1 (Agricultural area); Site -2 (Homegarden area); Site-3 (Urban area)

Table 2. Species diversity indices across three study sites in Dhemaji District of Assam.					
Study site	**Species richness**	**Number of individuals**	**Shannon's diversity index (H')**	**Pielou Evenness index -E**	**Simpson's index (D)**
Site- 1 (Agricultural area)	12	24	2.2046	0.8872	0.1111
Site-2 (Home-garden area)	12	22	2.1706	0.8735	0.1157
Site-3 (urban area)	7	12	1.8637	0.9577	0.1667

Dominant species:

During the present study it has been reported that among all the three study sites there were few of the species showed highest dominance in their distribution in all the study sites. Below figure 3 shows the relative abundance of species encountered among three study sites and among them only the species of *Macruglossum sp* .under Sphingidae family.

Among the three study sites, site -1 (agricultural area) had the highest relative abundance for *Lyssa sampa* (20.8%). Whereas, in site -2 (homegarden area) highest relative abundance has been contributed by *Timandra comae* and *Cnaphalocrocis medinalis* (18.2%). In site -3 (urban area) the highest relative abundance has been contributed by *Elophila obliteralis* (25%).

The result about the relative abundance of these highly abundant species among different study sites indicates that they are quite generalist in nature and thus are widely distributed. The concept of generalist and their higher diversity has been studied by Blackburn and Gaston, (2003).

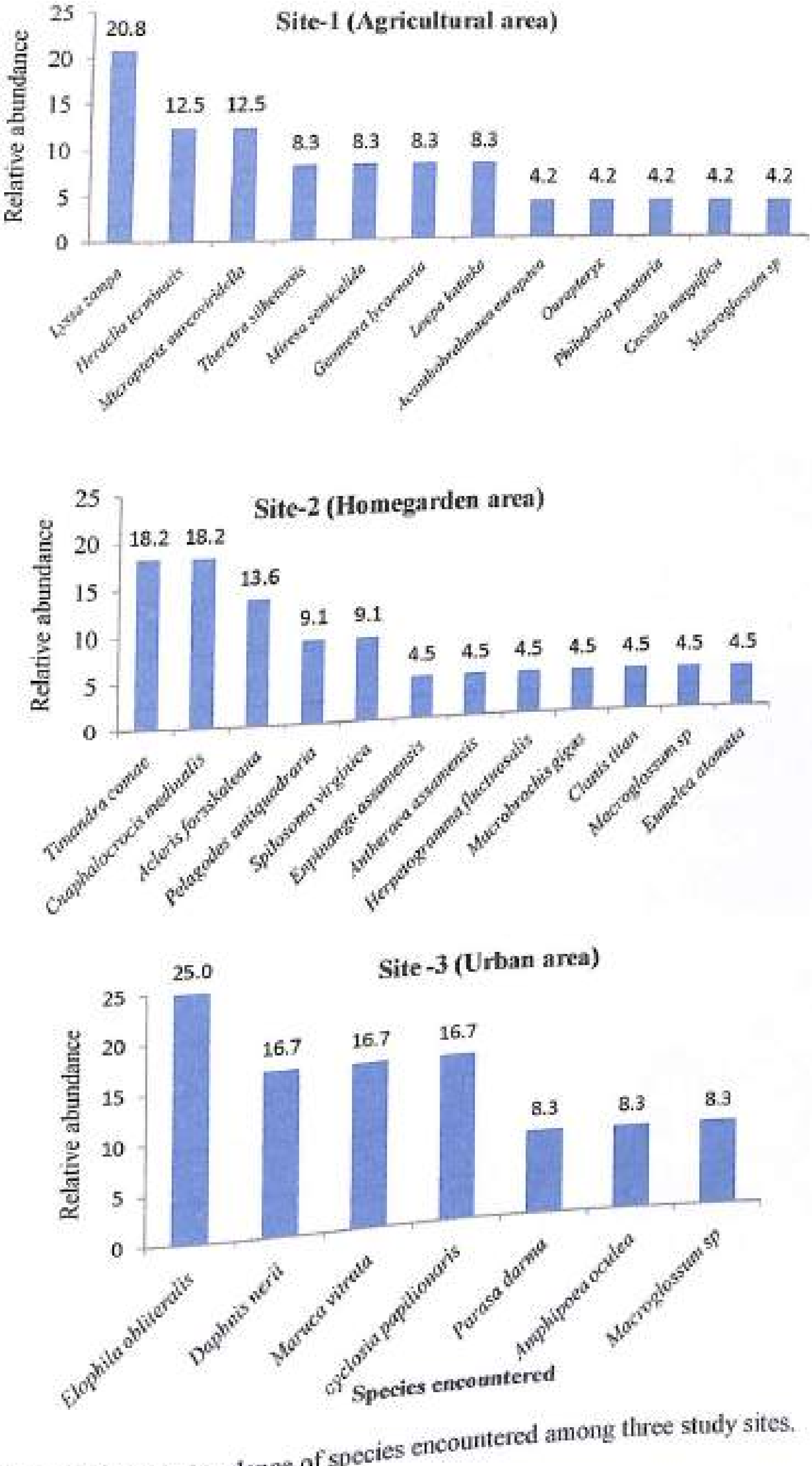


Figure 3. Relative abundance of species encountered among three study sites.

Plate showing the species of moths reported from present study

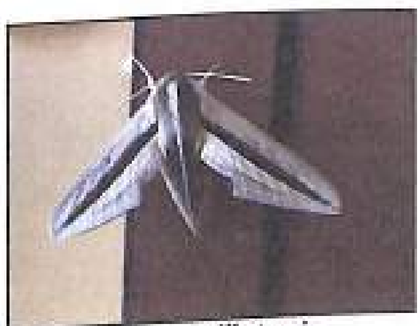
Antheraea sp.

Daphnis nerii

Enpinanga assamensis

Heraclia terminatis

Timandra comae

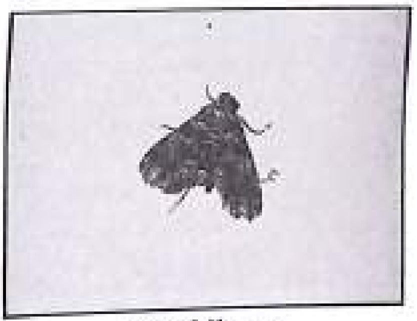


Theretra silhetensis

Miresa semicalida

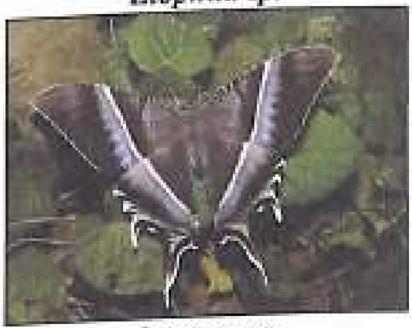
Cnaphalocrocis medinalis

Acleris forsskaleana

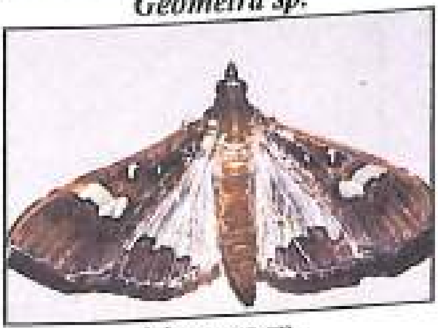


Elophila sp.

Geometra sp.



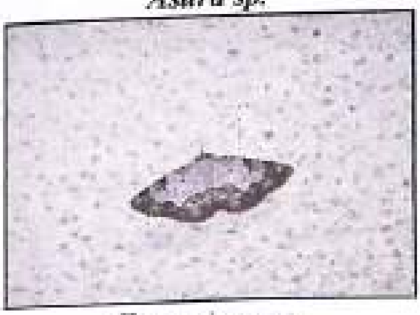
Lyssa zampa



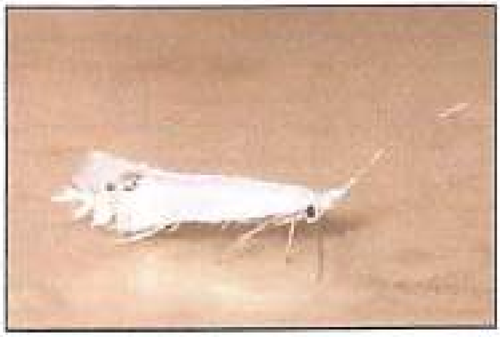
Marucas sp.

Asura sp.

Brahmaea hearseyi



Ennominae sp.



Liriomyza sativae

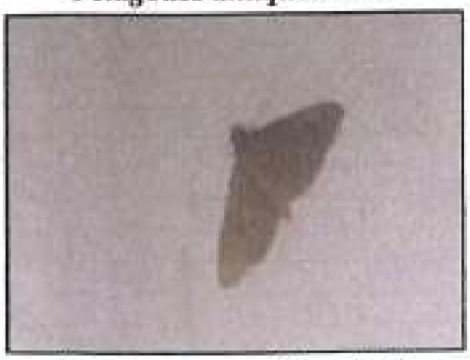
Loepa schintlmeisteri

Parasa pastorallis

Noctuidae sp.

Pelagodes antiquadraria

Spilosoma virginica



Herpetogramma licarsisalis

Macrobrochis gigas

Clanis titan

Macroglossum sp.

Cyclosia papilionaris

Cossula magnifica

Micropterix aureoviridella

Lasiocampoidea sp.

Conclusion:

This study observed that moth from the agricultural and home garden areas are richer in terms of species encountered than that of urban area. Moths being mostly associated with major cultivated plants and occurrence of some polyphagus moth species ,the results of reduction of vegetation to human settlements and monoculture cultivation of commercial plants.

This work will also be useful for the studies in future as it will create a database bank, for holding information regarding distribution and diversity of these species, serving as baseline information to the ecology and the importance of moths of this area. At the same time, the study has also shown that the area has different habitat with its favourable vegetation and climate, which provides an ideal location for the growth and diversity of moths.

This study may form basis for understanding the ecology of overlooked moth community in the study area strengthening the importance of continued scientific surveys and for observation of species as well as the habitat concerned.

Therefore, documenting the moths diversity pattern from this present study has provided data to justify the conservation of this ecosystem, as moths are sensitive and are easily affected due to habitat damage resulting from anthropogenic activities.

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