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Diversity of Hawk Moths (Lepidoptera: Sphingidae) of Malabar Region of Kerala

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ABSTRACT
Some opportunistic observations on the diversity of hawk moths have been done from June 2015 to May 2016 in North Malabar region of kerala. We have identified10 genera and 23species of Hawk moth belongs to3 subfamilies of Sphingidae. Of these 20species of hawk moths are new records to Malabar region. From our study we come to a conclusion that Malabar region is a suitable habitat for these highly sensitive families of moths. The paper gives details regarding Collection methodology, Diversity indices of each three subfamilies of sphingidae, effect of lunar periodicity in the diversity of the moth species and seasonal fluctuations.

Introduction

The moths, cousin sisters of butterflies are dominant components of the web of life. Like butterflies being so diverse and ecologically important, they are the first to get affected by any disturbances to their habitat, even if it is only very delicate. The moths which are being conspicuous insects like butterflies and dragonflies are therefore particularly valuable in monitoring ecological changes and serve to warn us of today's deteriorating environment. They have a significant and beneficial role as the bioindicators of the changes in the nature. The moths are coming under the order Lepidoptera. There are wide varieties of moths in our ecosystems. So the moths order Heterocera is divided into a lot of superfamilies.One of the largest superfamily of Lepidoptera is the Superfamily Bombycoidea. This super family is divided into different families. Of these one of the important families is the family Sphingidae.The family Sphingidae comprises largest moths. Family Sphingidae is represented by as many as 1354 species and subspecies on world basis, out of which 204 species belong to India (Hampson, 1892; Belland Scott, 1937; Roonwal*et. al* 1964; D' Abrera, 1986) and they are commonly known as hawk moths, sphinx moths, and hornworms. The family Sphingidae is divided in to three sub families namely, Sphinginae, Smerinthinae and Macroglossinae.

Members of the Sphingidae are medium-sized to large, heavy bodied moths with long narrow fore wings and relatively small hind wings; in BC species, wingspans range from about 40 to 140 mm. In the fore wing vein M2 arises a little nearer M3 than M1. Veins Sc and Rs in the hind wing are parallel to end of discal cell and beyond (or may nearly meet); near the midpoint of the discal cell they are connected by an oblique crossvein. Some species have much of wings devoid of scales and resemble bumblebees (*Macroglossumsp*).

A frenulum is present but is often rudimentary in the Smerinthinae. The antennae are threadlike or often thickened and somewhat spindle-shaped towards the tip. Sometimes they are comb-like. The eyes lack hairs and ocelli are absent. The proboscis is usually long (sometimes much longer than the body, especially in the Sphinginae) but sometimes is short or vestigial, as in some Smerithinae. Most larvae lack obvious hairs and usually have a spine or button-like process near the end of the body, thus giving them the name hornworms. The sides of larval abdominal segments 1 to 7 in species of subfamilies Sphinginae and Smerithinae bear an oblique stripe. Most species pupate in the soil or in leaf litter; the sheath of the developing proboscis sometimes resembles the handle of a cup or jug. Sphinx moths fly strongly with rapidly beating wings; many feed on flower nectar much as do hummingbirds, probing tubular blooms with the proboscis.

They are probably important pollinators of some BC plants. Some suck oozing tree sap or fluids from rotten fruit. Most fly and feed at dusk or at night, but a few of the most familiar, such as species of*Macroglossum*fly during the day. Species in these genera probably mimic bumblebees. Larvae of some species damage commercial crops. Some of the species known as the serious pests of tomato plants and tobacco. Larvae often rear up when disturbed and, in this position, have reminded some imaginative people of the Sphinx of Egypt. About 1200 species of Sphingidae are placed in 200 genera worldwide. North America has approximately 125 species in 42 genera; BC records 21 species in 10 genera. The subfamily Sphinginae includes three genera in BC. The subfamily Smerinthinae in BC consists of five transcontinental species whose adults are grey or brown with pink hind wings that usually bear eyespots. They feed on a wide range of trees and shrubs, including cherries and plums. This study is to assess the hawk moth's diversity in the Malabar region.

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Together with this, this study accounts the effect of lunar periodicity in the diversity of hawk moths of Malabar region. No comprehensive studies have been carried out in this area on the diversity and effect of lunar periodicity on the diversity of hawk moths. By knowing the diversity of these particular moths will be able to conserve these moths and other insects and their host plants and there by the entire ecosystems.

Methodology:

Study area:

The collection of hawk moths was done from five different sites of north Malabar region. Malabar region is an area of southern India lying between the Western Ghats and the Arabian Sea. The Southern part of this narrow coast is the South Western Ghats moist deciduous forests. Climate-wise, the Malabar Coast, especially on its westward-facing mountain slopes, comprises the wettest region of southern India, as the Western Ghats intercept the moisture-laden Southwest monsoon rains. Malabar's climate is classified as warm and temperate. There is a great deal of rainfall in Malabar, even in the driest month. The average annual temperature in Malabar is 22.4 °C. The average annual rainfall is 1251 mm.The five different areas of Malabar were the study was carried out are Kannur (11.8745° N,75.3704°E),Kozhummal(12.1790°N,75.2173°E),Taliparamba(12.0383 °N,75.3675 °E), Morazha (11.9873°N, 75.3500°E), Payyanur(12.1051°N, 75.2058° E).

Collection method:

Collection of Sphingidae was carried out from different areas of the Malabar region. The collection Sampling of Sphingidae was carried out at each of the collection sites using battery operated light traps specially fitted with switching device to facilitate automatic operation at specified hours (Mathew and Rahamathulla, 1995). The light trap consisted of 12 watts UV tube. An electronic timer was used to switch the UV tube on and off so that trapping carried out at desired hours. The timer was set such that the UV tube in the traps was switched on at 6.30 pm and off at 10.30 pm, ensuring that the trap was operated for a constant period of 4 hours thereby facilitating uniform sampling, each time the trap was operated. In addition to that collection of Sphingidae was carried out during the night time with the help of portable light traps. The insects trapped in the collection chamber of the light-trap were collected on next morning. Besides this, some specimens were collected at night to an illuminated vertical white sheet.(Shamsudeen *et al*, 2005).The sheet method was used, which allows collection of all the specimens individually without any damage. A white cloth sheet (70cm ×55cm) was hung between two vertical poles in such a way that it touched the surface and extended forward over the ground slightly away from direct source of light placed at such a point that the whole sheet from edge to edge brightly reflected the light. A 160 watt mercury vapour lamp was used as a light source through the night. Moths started collecting on the sheet just after sunset between 6.30pm to 10.30pm, after that the abundance of moths slowly declined.

The collected moths were killed by using ethyl acetate, pinned, stretched and preserved in airtight insect box, having naphthalene balls as fumigant. The methodology discussed by workers such as Mikkola(1986) as well as by Landry and Landry (1994) was followed for the pinning, stretching and preservation of specimens. The standard techniques given by Robinson et *al*. (1994) and Zimmerman (1978) were followed for wings and genitalia respectively. Each specimen was provided with a label indicating the scientific name, locality and date of collection. The specimens were then identified up to species level with the help of identified specimens and available literature by T.R.D Bell and F.B.Scott (1937), and other published literatures.

Effect of lunar periodicity:

This study also taken an account on the effect of moon phases in the number of hawk moths. To assess the influence of moon light and lunar periodicity, the position of moon phase for each calendar day of observation was worked out form Indian Almanac. The brightness of moon light for each lunar day was measured in terms of degree of moon phase or the relative illuminated area of moon disc. The 360° moon phase was considered full moon and 0° moon phase as no moon with the division of 360° by 15, each day represented a change of 24° increase in ascending phase (24° - 360°) and of lunar cycle.(Mishra ,1999).

Data Analysis:

Indices of diversity, species richness and evenness, dominance of moth species were assessed for each month and calculated by using Shanon-Wiener diversity index(1949), Margalef's index (1958) and evenness index (Pielou, 1966) (Magurran,1988) and confirmed with the help a software, PAST (version 3.14; November 2016).

a) Measurement of diversity:

The type of diversity used here is α- diversity which is the diversity of species within a community or habitat.

The diversity index was calculated by using the Shannon – Wiener diversity index (H) (1949) and Simpson diversity index (D).

Diversity index

$H = -\Sigma$ Pi In Pi,p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), ln is the natural log, Σ is the sum of the calculations, and s is the number of species.

$D=1/\Sigma pi^2$, p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), Σ is still the sum of the calculations, and s is the number of species.

b) Measurement of species richness:

Margalef's index and Menhinick's indexwere usedas simple measuresof Species richness.

Margalef's index = (S – 1) / In N S = total number of species N = total number of individuals in the sample In = natural logarithm

Menhinick's index= S /√N where S equals the number of different species represented in your sample, and N equals the total number of individual organisms in your sample.

c) Measurement of evenness:

For calculating the evenness of species, the Pielou's Evenness Index (e) was used (Pielou, 1966).

e = H / In S H = Shannon – Wiener diversity index S = total number of species in the sample.

Results and Discussion

Through this study, we have increased our knowledge regarding the diversity of Hawk moths inhabiting in Malabar region of Kerala. This study was carried out in five different sites of north Malabar between June 2015 to may 2017. During the study 10 genera and 23 species belongs to 3subfamilies of Sphyngidae were identified (Table 1).Of these 20 Species are new records to Malabar. According to our collection, Macroglossinae was the dominant subfamily (14 species) (Table2).Least number of species (2) was recorded in the subfamily Smerinthinae the subfamily Sphinginae comprises 7species.This study indicated that the

diversity index (Simpson and Shannon), species richness and evennessof subfamily Sphynginae were(0.6422, 1.438), 1.324 and 0.6016 respectively and the diversity index, species richness and evenness of Smerinthinae were (0.48, 0.673), 0.6213, 0.9801 respectively and for subfamily Macroglossinae (0.8287, 2.184), 0.6345, 2.526 respectively (Table 2). The Fig.1, Fig2 and Fig3 show the comparative diversity index, evenness and species richness of Sphynginae, Smerinthinae and Macroglossinae of Malabar region respectively.

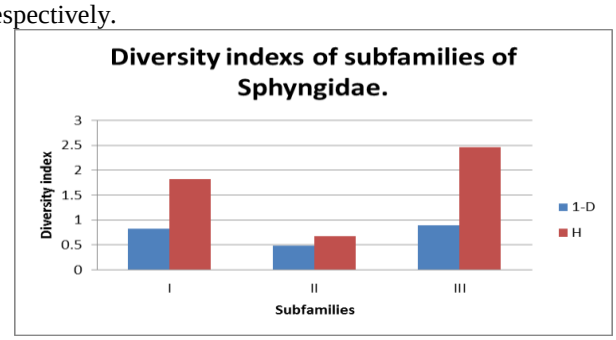

Fig 1. Graph showing diversity index of Sphynginae (I), Smerinthinae (II) and Macroglossinae (III) of family Sphyngidae of Malabar.

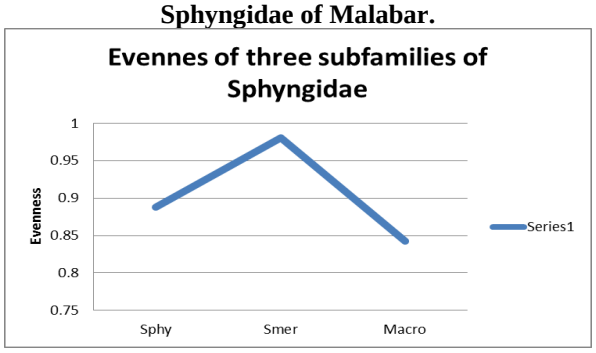

Fig 2. Graph showing Evenness of Sphynginae, Smerinthinae and Macroglossinae of family Sphyngidae of Malabar.

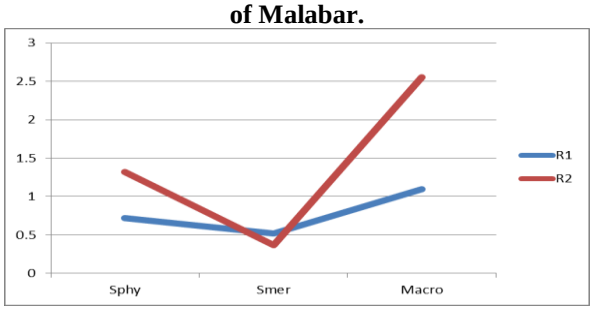

Fig 3. Graph showing Species richness [Menhinick (R1) & Margalef (R2)] of Sphynginae, Smerinthinae and Macroglossinae of family Sphyngidae of Malabar.

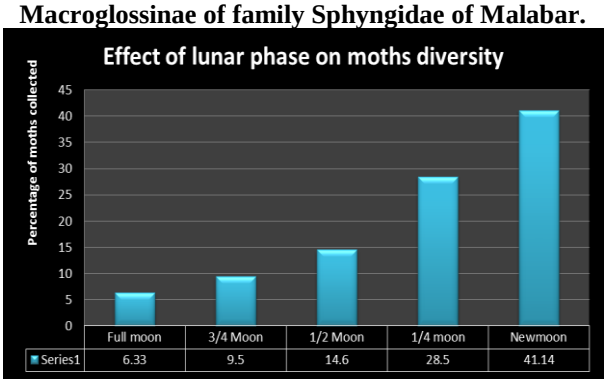

Fig 4. Effect of lunar periodicity on the diversity of Hawk moths of Malabar region.

Monthly wise collection of hawk moths was done for 24 months (June2016-May2017).Diversity index, species richness; evenness of hawk moths in each months have been calculated using past(3.14 version) (Table 3). Overall data clearly showed that speciesrichness was higher in August 2015 and August 2016 (3.624 & 3.6 respectively).Maximum number of species (18) was recorded in August and September months of both 2015and 2016. 1n both 2015-2016 and 2016-2017 periods Maximum moth individuals were recorded during September, but the number moths collected was less in September, 2016 compare to September 2015. The lowest number of species andindividuals were collected during December and January months. The maximum dominance (1) was recorded during December, 2016 and lowest (0.0727) during September, 2016.And the maximum dominance during the year 2015 was during December (0.5) and least during October (0.08). Simpson's diversity index was maximum in September 2016(0.9273) and October 2015 (0.92) and minimum was recorded in December 2016 (0).But in December, 2015 the diversity index was 0.5.The Shannon diversity index was also maximum (2.763) in September, 2016.In 2015 it was maximum in August (2.71).Diversity index was least in December, 2016(0).But in 2015 diversity index in December was 0.6931.Maximum evenness was 1 and in 2015-16 period for 9 months of this period share evenness of 1.and in 2016-2017 period 4 months of this period shares commonevenness of 1. Very low evenness (0.8347) values of the hawk moths species were recorded in August 2015.in august 2016 the evenness was 0.8429.Menhinick index value (3) for hawk moths was common for two months (June 2015 and March 2016).And the maximum value was recorded during August 2016 (3.624), September 2016 (3.464),October2016 (3.441) and June 2016(3.051).In 2015 maximum value was recorded during August (3.6),October (3.578), September (3.286) and July (3.162).Margalef index was maximum in August 2015 (5.281) and August 2016(5.176) followed by 5.158 in September 2016 and 5.007 in October ,2015.

The biodiversity (diversity index, species richness) of moth fauna in the site 12.1790° N, 75.2173°E is more than the other 4 sites of Malabar (Table 4). The vegetation of this area is high compare to the other study areas. So the vegetation of this area plays an important role for the existence of insect fauna in a community as it provides the main source of food etc. Through this study, we have increased our knowledge regarding the diversity of species

Of Sphingidae inhabiting in Malabar region .The more common sphinx moths seen in Malabar region are *Pergesa acteus* followed by *Psilogramma renneri*and *Psilogramma vates*. The other species are less common.

By analyzing the number of hawk moths collect in different months in both the years came to a conclusion that the lunar periodicity showed a highly significant difference in the attraction response' of moths between moonlit nights (24° - 360° moon phase) and dark nights (336° - 0° moon phase) *(Fig.* 4). In all the lunar cycles, the attraction response of the moths was consistently very low during moonlit nights around full moon where only a fraction of the natural population was attracted to the light trap. It is evident from the *Fig.* 4 that there was a decrease in the first half (full moon) and gradual increase in the attraction response of moths ¾ moon to new moon. The response was clearly associated with the change in the degree of moon phase. More number of hawk moths was collected during the New moon time.

Table 1. Taxonomic composition and total number of individuals of hawk moths collected from five different sites of Malabar region of Kerala.

Sl No.	**Species**	**Common Name**	**Number of moths collected from five different sites**				
			I	**II**	**III**	**1V**	**V**
	FAMILY:SPHYNGIDAE						
	***Sub family :*Sphynginae**						
1	*Acherontia lachesis* Fabricius 1798	GREATER DEATH'S HEAD HAWKMOTH	*1*	*2*	*4*	*3*	*3*
2	*Acherontia styx* Westwood 1848	LESSER DEATH'S HEAD HAWKMOTH	*0*	*1*	*3*	*2*	*2*
3	*Herse convolvuli Lin*		*1*	*1*	*2*	*0*	*0*
4	*Psilogramma renneri* Eitschberger 2001	GREY –BROWN HAWKMOTH	2	1	7	1	2
5	*Psilogramma increta* Walker 1865	PLAIN GREY HAWKMOTH	*3*	*3*	*5*	*6*	*5*
6	*Psilogramma menephron* Cramer 1780	LARGE BROWN HAWKMOTH	*2*	*2*	*10*	*5*	*4*
7	*Agrius convolvuli* Linnaeus 1758	CONVOLVULUS HAWKMOTH	1	2	4	2	2
	Sub family: Smerinthinae						
8	*Marumbaindicus*Walker 1856	LESSER SWIRLED HAWKMOTH	0	2	3	2	2
9	*Marumbajuvencus* Rothschild 1912	DULL SWIRLED HAWKMOTH	*1*	*1*	*2*	1	*1*
	Sub family: Macroglossinae						
10	*Daphnis nerii* Linnaeus 1758	OLEANDER HAWKMOTH	*0*	*1*	*3*	*1*	*2*
11	*Acosmeryx anceus* Stoll 1781	ROSY FOREST HAWKMOTH	1	2	2	0	1
12	*Macroglossum stellatarum* Linnaeus 1758	EURASIAN HUMMINGBIRD	*0*	*1*	*3*	1	*1*
13	*Macroglossum belis* Linnaeus 1758	COMMON HUMMINGBIRD HAWKMOTH	*0*	*1*	*2*	*1*	*3*
14	*Macroglossum aquila* Boisduval 1875	LOBED HUMMINGBIRD HAWKMOTH	*2*	*1*	*1*	1	*3*
15	*Hippotion boerhaviae* Fabricius 1775	PALE STRIATED HAWKMOTH	*1*	*2*	*4*	*2*	*2*
16	*Hippotion celerio* Linnaeus 1758	COMMON STRIATED HAWKMOTH / SILVERSTRIPED HAWKMOTH	2	1	5	*1*	3
17	*Hippotion rosetta* Swinhoe 1892	SWINHOE'S STRIATED HAWKMOTH	2	2	6	*2*	2
18	*Theretra nessus* Drury 1773	ORANGE-SIDED HUNTER HAWKMOTH / YAM HAWKMOTH	*1*	*2*	*5*	*2*	*2*
19	*Theretra clotho* Drury 1773	COMMON HUNTER HAWKMOTH	2	1	2	1	1
20	*Theretra oldenlandiae* Fabricius 1775	WHITE-BANDED HUNTER HAWKMOTH	1	2	5	2	2
21	*Theretra alecto* Linnaeus 1758	LEVANT HUNTER HAWKMOTH	3	1	2	*1*	4
22	*Pergesa acteus* Cramer 1777	GREEN PERGESA HAWKMOTH	2	5	19	7	7
23	*Rhagastis castor* Walker 1856	COMMON MOTTLED HAWKMOTH	1	1	4	1	1
	Total no of individuals		29	38	103	45	55

Table 2. Diversity indices of moth fauna in three different subfamilies of Shyngidae.

Subfamily	**Sphynginae**	**Smerinthinae**	**Macroglossinae**
Taxa_S	7	2	14
Individuals	94	15	164
Dominance_D	0.1756	0.52	0.1066
Simpson_1-D	0.8244	0.48	0.8934
Shannon_H	1.827	0.673	2.467
Evenness_e^H/S	0.8876	0.9801	0.8421
Brillouin	1.7	0.5679	2.31
Menhinick	0.722	0.5164	1.093
Margalef	1.321	0.3693	2.549
Equitability_J	0.9387	0.971	0.9349
Fisher_alpha	1.749	0.6198	3.661
Berger-Parker	0.2447	0.6	0.2439
Chao-1	7	2	14

Table.3. Diversity indices of Hawk moths of Malabar region from June, 2015 to May 2017.

Sl No.	Month &Year	Dominance_D	Diversity index		Evenness_e^H/S	Menhinick	Margalef
			Simpson_1-D	Shannon_H			
1	June,2015	0.1111	0.8889	2.197	1	3	3.641
2	July,2015	0.1	0.9	2.303	1	3.162	3.909
3	August ,2015	0.0848	0.9152	2.71	0.8347	3.6	5.281
4	September,2015	0.08889	0.9111	2.667	0.7999	3.286	4.998
5	October,2015	0.08	0.92	2.666	0.899	3.578	5.007
6	November,2015	0.125	0.875	2.079	1	2.828	3.366
7	December,2015	0.5	0.5	0.6931	1	1.414	1.443
8	January,2016	0.3333	0.6667	1.099	1	1.732	1.82
9	February,2016	0.2	0.8	1.609	1	2.236	2.485
10	March,2016	0.1111	0.8889	2.197	1	3	3.641
11	April,2016	0.125	0.875	2.079	1	2.828	3.366
12	May,2016	0.1	0.9	2.303	1	3.162	3.909
13	June,2016	0.09091	0.9091	2.398	1	3.317	4.17
14	July,2016	0.1006	0.8994	2.352	0.9548	3.051	3.899
15	August ,2016	0.09091	0.9091	2.662	0.8429	3.624	5.176
16	September,2016	0.0727	0.9273	2.763	0.8804	3.464	5.158
17	October,2016	0.08587	0.9141	2.598	0.8953	3.441	4.755
18	November,2016	0.28	0.72	1.332	0.9473	1.789	1.864
19	December,2016	1	0	0	1	1	0
20	January,2017	0.1667	0.8333	1.792	1	2.449	2.791
21	February,2017	0.1563	0.8438	1.906	0.961	2.475	2.885
22	March,2017	0.1667	0.8333	1.792	1	2.449	2.791
23	April,2017	0.2	0.8	1.609	1	2.236	2.485
24	May,2017	0.1563	0.8438	1.906	0.961	2.475	2.885

Table 4. Diversity indices of five different sites of Malabar region.

Study sites	I	II	III	IV	V
Taxa_S	18	23	23	21	22
Individuals	29	38	103	45	55
Dominance_D	0.0654	0.05679	0.07192	0.07753	0.0605
Simpson_1-D	0.9346	0.9432	0.9281	.9225	0.9395
Shannon_H	2.805	3.011	2.909	2.797	2.945
Evenness_e^H/S	0.9185	0.8827	0.7973	0.781	0.8643
Brillouin	2.166	2.372	2.583	2.28	2.459
Menhinick	3.343	3.731	2.266	3.13	2.966
Margalef	5.049	6.048	4.747	5.254	5.24
Equitability_J	0.9706	0.9602	0.9277	0.9188	0.9528
Fisher_alpha	20.26	24.67	9.194	15.33	13.59
Berger-Parker	0.1034	0.1316	0.1845	0.1556	0.1273
Chao-1	22.5	29.6	23	26.63	23

Fivesites:I(11.8745°N,75.3704°E),II:(12.1790°N,75.2173°E),III(12.0383°N,75.3675°E),IV(11.9873°N,75.3500°E),V:(12.1051°N, 75.2058° E).

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Reference:

Bell, T.R. and Scott, L.F.B. The Fauna of British India including Ceylon and Burma: Moths, Sphingidae, Taylor and Francis Ltd., London 1937; 6: 1-533.

Gadhikar Dr. Y. A., Sambath S .A Preliminary Report on the Moths (Insecta: Lepidoptera: Heterocera) Fauna from Amravati, Maharashtra International Journal of Science and Research (IJSR). July 2015; 4.438 Volume 4 Issue 7.

George Mathew, R.S.M .Shamsudeen ,C.M Brijesh Insect fauna of Neyyar wild life sanctuary,Kerela,India Zoos' print journal 22(12):2930-2933

Hampson G.F. Fauna of British India including Ceylon and Burma, Moths vol. 1, Taylor and Franics Ltd.: London, 1892; 527.

Heppner J.B."Classification of Lepidoptera", vol.5. 1998

Islam A.T.M.F, IslamM.H, Saifullah A.S.M., Akira Yamanaka "A preliminary report of moth's fauna in the campus of Atomic Energy Research Establishment (AERE),Savar, Dhaka, Bangladesh"International journal of fauna and biological studies 2013;1 (1): 56-62© 2013 AkiNik Publications.

Kitching, I.J. and Cadiou, J-M.*Hawkmoths of the World: an Annotated and Illustrated Revisionary Checklist.*8 pls. Cornell University Press. 2000;viii+227 pp.

Kailash Chandra and Sambath S.Moth diversity of Tawang District, Arunachal Pradesh, India Journal of Threatened Taxa, www.threatenedtaxa.org. January 2013; 5(1): 3565–3570

Landry, J.F. & B. Landry. A technique for setting and mounting Gelechioidea. Journal of the Lepidopteran Society 1994; 48(3): 205-227.

Mathew, G. and V. K. Rahamathulla.Biodiversityin the Western Ghats – a study with reference to Moths (Lepidoptera: Heterocera) in the Silent Valley National Park, India. Entomon, 1993; 20(2): 25-33.

Magurran A.E. Ecological Diversity and Its Measurement. London: Croom Helm. A general book on ecological diversity.Models (for the distribution of species). 1988;101-189.

Mikkola, K. Tower spreading, a handy method for provisional field preparation for Gelechioidea.*Notulae Entomologicae.*1986; 66: 101-102.

Mishra, P.N, Singh M.P and AutiyalM.C.Effect of Moon Light and Lunar Periodicity on the Attraction of Black Cutworm Moth *Agrotisflammatara*on Light Trap .PertanikaJ. Trap. Agric. Sci.1999; 22(1): 69-72

Nair, K.S.S. and Mathew George. Diversity of insects in Indian forests- the state of our knowledge. Hexapoda, 1993; 5(2): 71-78.

Robinson, G.S., K.R. Tuck and M. Shaffer. A field guide to smaller moths of South East Asia. Malaysian Nature Society, Malaysia, 1994. ; pp: 309

Zimmerman, E.C.Gelechioidea. Insects of Hawaii, Vol. 9. University Press of Hawaii, Honololu.,1978;Xviii+1903.