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Effect of Climate (Seasons) on Biodiversity of Noctuidae in Rajmahal hills area of Santhal Parganas, Jharkhand, India

Palli. K. Varghese, Michael Gabriel Paulraj and Savarimuthu Ignacimuthu*
Entomology Research Institute, Loyola College, Chennai – 600 034. Tamil Nadu.

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ABSTRACT
Noctuid moth diversity was studied in three selected places in Rajmahal hills viz., Maharo, Satia and Bathbanga from March 2011 to May 2013. Totally 58 species of Noctuids were identified and their diversity, evenness and dominance were calculated. The study revealed very good diversity and evenness of noctuid moths in Rajmahal hills. A 3.8 value of Shannon index showed very high diversity and 0.89 value of evenness showed the relative abundance of all species of moths. This study will encourage others to take up biodiversity studies in this region.

Introduction

Moths attract attention for various reasons. Besides being very beautiful to behold, they are economically and ecologically very important group of animals and their sheer number, around 1,54,626 known species so far (LEPINDEX), is a cause for closer study as we talk of degradation and fragmentation of ecosystems due to various reasons.

Moths are considered to be bio-indicators of the health of an ecosystem as they are very sensitive to changes in ecosystem due to external interference. Noctuidae is the largest and economically important family in the order Lepidoptera (Stojanović and Ćurčić, 2011). Economic importance of noctuid moths is mainly due to the harmfulness of their larval stages to agricultural and forest plants. Adult moths are involved in pollination of flowers.

Biodiversity studies of organisms are very important to understand their role and impact on human economy. Furthermore such studies may indicate the status of the environment. Jharkhand is comparatively a new state and not much scientific study is done on biodiversity though it is a state having 29.65% forest cover and much of it is being disturbed by mining, industrialization and urbanization. Maharo is a village surrounded by natural and man-made forests, 10 kilometers away from Dumka town in Dumka District.

Satia is a forest area in Pakur District where Paharia tribal people use part of the forest for shifting cultivation. Bathbanga is another forested area in Sahibganj district where Paharias and Santhals use part of the forest for shifting cultivation; all three places are in Rajmahal hills that run in a north-south axis across Santhal Parganas.

This hill range is supposed to have been formed by the volcanic activity during Jurassic period and so is one of the oldest ecosystems in India.

The present study aims at recording the noctuid moth fauna and its diversity in Maharo, Dumka and Bathbanga in Rajmahal hills in different seasons.

Materials and method

Study Area:

Santhal Parganas is a division of the state of Jharkhand in India. This division is populated mainly by the tribals like Santhals and Paharias. The main vegetation of this area consists of *Shorea robusta*, teak, Mahogani, sisso (*Dalbergia latifolia*), jamun, Arjun, Gamhar, Fig, many types of fruit trees like mango, jackfruit, litchi and sapodilla, drumstick trees and many others. Besides the trees, there are also grass covered hillocks meant for grazing the domesticated animals of the villages.

Geographically, Maharo is at 25° 17' N latitude and 83° 27' E longitude, Satia is at 24° 74' N latitude and 87° 57' E longitude and Bathbanga is at 25° 04' N latitude and 87° 39' E longitude and the average elevation of the three places are 328, 558.4 and 454 meters above sea level respectively.

Study period:

A month-wise collection of moths was done from March 2011 to May 2013 in all three chosen areas. The collection was done for two days in the beginning of the month, one day in the middle of the month and two days at the end of the month.

Collection method:

Sweeping net and modified night time light traps were used to collect specimens. A white cloth of about three meters long was tied to two poles and allowed to hang vertically with a 40W CFL bulb hanging a little above the cloth. All the moths sitting in and around the cloth were collected. The collected specimens were killed by ethyl acetate vapour and pinned to a board in insect boxes.

Identification:

Noctuid moths from the collected specimens were first isolated from the rest of the groups based on the morphological family characters. Then all the species in family Noctuidae were identified up to species level by studying their morphological characters following the identification keys provided by Hampson (1892, 1894, 1895, 1896), Bell and Scot (1937) and many other known materials available in the websites in the internet.

*Corresponding Author:
Tele: 044-28178348
E-mail address: entolc@hotmail.com

Diversity indices calculation:

Evenness, dominance, Shannon-Wiener index and Simpson's index of diversity were calculated using the software, PAST. Since the study was conducted for a period of over two years, monthly calculation of diversity, evenness, dominance etc. would be very cumbersome and so we divided the study period into seasons such as winter season of December, January and February, Summer season of March, April and May, Monsoon season of June, July and August and Post monsoon season of September, October and November in order to calculate the above mentioned diversity indices.

Meteorological data:

Rainfall and temperature records in the study areas were collected from the Meteorological Department, Dumka**,** Sahibganj and Pakur. The annual average rain fall is around 115 cm in Maharo, 122 cm in Satia and 186 cm in Bathbanga The average temperature in non-winter months is from 22°C – 37°C and in winter months is 10°C-25°C. The highest temperature recorded is 47°C and the lowest is 4°C. The monsoon begins around the middle of June and continues till the first week of October but the highest rain fall will be in the months of July-August.

Results

Species composition:

The list of noctuid moths identified so far from the three sites is given in Table 1. Totally 58 species of Noctuid moths grouped under 41 genera were identified in the study area. The genus *Bastilla* was dominant with five species and the genus *Anomis* contained 4 species. Maximum number of individuals were collected from Bathbanga (4074 individuals) and Satia (4053 individuals). All 58 species were found to be present in both Satia and Bathbanga, whereas five species were not recorded from Maharo during the study period. *Eudocima materna* was the most abundant moth in all the three study sites. Geneus *Erebus* was represented by 3 species.

Diversity indices:

The diversity indices are given in Tables 2-4. It was found that the Shannon-Wiener index was the lowest in winter season with 3.403 in 2012-13 and 3.497 in the winter of 2011-12 in Maharo, 3.619 and 3.715 in Satia and 3.655 and 3.742 in Bathbanga respectively in 2011 and 2012. The highest diversity was 3.919 in Maharo in the summer of 2012, 3.94 in Satia during post monsoon season and 3.958 in Bathbanga during the monsoon season. It also showed an average diversity of 3.8 which is a very high value. Simpson's index also showed the lowest diversity during winter seasons with 0.959, 0.9684 and 0.9703 respectively in Maharo, Satia and Bathbanga and the highest during the summer season with 0.9792, 0.9784 and 0.979 in Maharo, Satia and Bathbanga respectively. Hence both these diversity indices show similarity and agree to the fact that the diversity of moths in Rajmahal hills, Jharkhand, is very high. When we look into the evenness, it was the highest during the summer of 2012 in Maharo with a value of 0.9502, in Satia having a value of 0.9233 and in Bathbanga 0.9028 in Monsoon season. The average value for evenness was around 0.9 which again is very good as evenness is calculated on a scale of 0 to 1 in which higher the value better the evenness. Hence both the diversity and evenness of moth population in Rajmahal hills, Jharkhand, were found to be very high and good.

Climate on Noctuid diversity:

Another result of the present study is the effect of climate on the population of moths. In monsoon and post monsoon seasons 58 species of Noctuid moths were collected in Bathbanga and Satia and 53 species in Maharo and their number was very high reaching 823 in Satia, 886 in Maharo and 802 in Bathbanga in the post monsoon period of 2012 while the species collected and their number went down drastically during winter with only 36 species in Maharo and 44 species in Satia and Bathbanga. The number of individuals collected also was very negligible during winter with 58 in Maharo, 98 in Satia and 72 in Bathbanga. The number was also not very high during summer season with only 214 individuals in Maharo, 335 in` Satia and 318 in Bathbanga.

Discussion

Noctuidae is the largest family in the order Lepidoptera and many noctuid moths are important agricultural and forestry pests (Stojanović and Ćurčić, 2011). Kitching and Rawlins (1998) have reported 35,000 species of noctuid moths worldwide. In Jharkhand, few studies have been done near Ranchi on noctuid moth diversity. In the present study, 58 species of noctuid moths have been collected and identified from just three sites in Rajmahal hills. The total number of noctuid moths in this hill area may be many folds higher than the total number of 58 species recorded in this study, if an intense survey will be conducted. Stojanović and Ćurčić (2011) have recorded 564 species of noctuid moths classified under 231 genera and 23 subfamilies. Zahoor et al. (2003) have recorded 13 species of noctuid moths in agro-forest areas and stated that noctuid moth diversity was more in forest areas than agro-ecosystems. They also reported that diversity was influenced by climatic conditions.

In the present study the diversity of noctuid moths was found to be good in the study areas based on the high evenness index. Evenness is a measure of abundance of various species of organisms which in our case is the abundance of number of individuals in species identified. It is measured on a scale of 0-1. Our study shows an average evenness of 0.89 which is very close to 1 and so very good evenness. Shannon-Wiener index is calculated on a scale of 0 - and above, in which higher the score greater the diversity. Any score above 3 is considered as showing very good diversity. Our study shows an average of 3.8 on Shannon-Weiner index proving very good diversity of moths especially Noctuid moths in this area.

Winter proved to be the worst season for moths with their numbers declining too drastically. Even the number of species present also declined. In summer season also the number did not show much improvement. Monsoon brought cheers as the species count and the number of moths increased but the best season for moths was post monsoon season` of the moths of September, October and November. This can be due to various reasons like the availability of plenty of plants for feeding the caterpillars, increased humidity in the air, pleasant climate having moderate temperature and so on. What can be said is that climate definitely plays a part in the abundance or scarcity of moth assemblages.

Barlow and Woiwood (1989) found no correlation between seasonality and moth abundance in Peninsular Malaysia. Studies by Davidson and Andrewartha (1948) have often been cited as illustrating insect population controlled by weather. Studies in the Gangotri National Park and Govind National park in Uttarakhand showed that summer and post monsoon periods posted the greatest number of moths (Sanyal et al., 2011). Jaroensutasinee et al (2011) studied the effect of Weather on macro-moth diversity at Khao Nan national park, Thailand. They found that the number of individual macro-moths was positively correlated with mean/max/min temperatures and negatively correlated with relative humidity and not associated with rainfall.

Table 1. Different species and total number of individuals per species of Noctuidae recorded in three sites from Santhal Parganas in Rajmahal hills, Jharkhand during 2011-2013

No	Species	Form	Number of individuals collected in		
			Maharo	Satia	Bathbanga
1	*Achaea serva* (Fab.)	Adult	52	80	67
2	*Agrotis ipsilon* (Hufnagel)	Adult	00	16	31
3	*Anomis involuta* (Walker)	Adult	53	73	65
4	*Anomis mesogona* Walker	Adult	63	74	69
5	*Anomis privata* (Walker)	Adult	77	53	64
6	*Anomis scitipennis* Walker	Adult	38	56	44
7	*Artena dotata* (Fab.)	Adult	75	58	69
8	*Asota caricae* (Fab.)	Adult	119	133	148
9	*Asota ficus* (Fab.)	Adult	42	61	55
10	*Bastilla crameri* (Moore)	Adult	00	26	41
11	*Bastilla joviana* (Stoll)	Adult	30	38	42
12	*Bastilla stuposa* (Fab.)	Adult	85	128	110
13	*Bastilla maturata* (Walker)	Adult	83	99	99
14	*Bastilla simillima* (Guenee)	Adult	50	50	51
15	*Callopistria repleta* Walker	Adult	00	25	51
16	*Chalciope mygdon* (Cramer)	Adult	71	74	68
17	*Chasmina candida* (Walker)	Adult	79	58	64
18	*Chrysopera combinans* Walker	Adult	41	48	55
19	*Dasypodia cymatodes* Guenee	Adult	51	60	54
20	*Entomogramma fautrix* Guenee	Adult	49	55	55
21	*Erebus ephesperis* (Hubner)	Adult	34	51	53
22	*Erebus hieroglyphica* Drury	Adult	123	109	106
23	*Erebus macrops* (Linn.)	Adult	108	134	134
24	*Ercheia cyllaria* (Cramer)	Adult	52	50	48
25	*Ericeia inangulata (*Guenee)	Adult	69	93	85
26	*Eudocima fullonia* (Clerck)	Adult	122	153	141
27	*Eudocima materna* (Linn.)	Adult	158	175	164
28	*Fodina contigua* (Wileman)	Adult	00	14	39
29	*Grammodes geometrica* (Fab.)	Adult	62	70	66
30	*Helicoverpa armigera* (Hubner)	Adult	69	66	70
31	*Homoptera glausinans (*Guenee)	Adult	40	46	62
32	*Hulodes caranea* (Cramer)	Adult	88	136	123
33	*Hypena subvittalis* Walker	Adult	00	34	53
34	*Hypocala rostrata* (Fab.)	Adult	30	45	53
35	*Hypopyra pudens* (Walker)	Adult	46	50	37
36	*Hypopyra vespertilio* (Fab.)	Adult	62	76	60
37	*Ischyja manlia* (Cramer)	Adult	63	75	70
38	*Mecodina praecipua* Walker	Adult	48	60	50
39	*Mocis frugalis* (Fab.)	Adult	99	117	105
40	*Mocis undata* (Fab.)	Adult	99	121	112
41	*Mythimna unipuncta* (Haworth)	Adult	70	59	63
42	*Mythimna l-album* Linn.	Adult	35	53	51
43	*Odontodes seranensis* Prout	Adult	63	75	60
44	*Ophiusa olista* Swinhoe	Adult	79	93	88
45	*Ophiusa tirhaca* (Cramer)	Adult	40	40	43
46	*Oraesia emarginata* (Fab.)	Adult	53	45	41
47	*Pindara illibata* (Fab.)	Adult	74	61	49
48	*Polytela gloriosae* (Fab.)	Adult	00	27	46
49	*Proxenus* sp.	Adult	00	21	45
50	*Saroba antecedens* Walker	Adult	03	17	38
51	*Spirama helicina* (Hubner)	Adult	121	141	136
52	*Spirama retorta* (Clerck)	Adult	38	53	52
53	*Spodoptera litura* (Fab.)	Adult	77	53	61
54	*Spodoptera mauritia* (Boisduval)	Adult	78	61	66
55	*Thyas coronata* (Fab.)	Adult	97	119	120
56	*Trigonodes disjuncta* (Moore)	Adult	77	61	62
57	*Trigonodes hyppasia* (Cramer)	Adult	53	59	58
58	*Viridistria thoracica* (Moore)	Adult	74	75	62
		Total	3462	4053	4074

Table 2. Diversity indices of Noctuid moths in Maharo

Diversity Index	Summer 2011	Monsoon 2011	Post-Monsoon 2011	Winter 2011-12	Summer 2012	Monsoon 2012	Post-Monsoon 2012	Winter 2012-13	Summer 2013
Taxa (S)	51	53	53	38	53	53	53	36	53
Total no. of individuals	214	445	756	84	341	572	886	58	264
Dominance index (D)	0.02747	0.02242	0.02281	0.0343	0.02079	0.02188	0.02292	0.04102	0.0262
Shannon-Wiener	3.75	3.881	3.871	3.497	3.919	3.892	3.863	3.403	3.792
Simpson's index (1-D)	0.9725	0.9776	0.9772	o.9657	0.9792	0.9781	0.9771	0.959	0.9737
Evenness	0.8338	0.915	0.9054	0.8689	0.9502	0.9248	0.8982	0.8348	0.837
Menhinick	3.486	2.512	1.928	4.146	2.87	2.216	1.781	4.727	3.262
Margalef	9.318	8.527	7.845	8.351	8.917	8.19	7.662	8.62	9.326
Equitability	0.9538	0.9776	0.975	0.9614	0.9871	0.9803	0.973	0.9496	0.9552
Fisher's alpha	21.19	15.68	12.99	26.74	17.57	14.26	12.37	40.52	19.96
Berger-Parker	0.05607	0.0045	0.04233	0.07143	0.03226	0.03846	0.04402	0.1034	0.0568

Table 3. Diversity indices of Noctuid moths in Satia

Diversity Index	Summer 2011	Monsoon 2011	Post-Monsoon 2011	Winter 2011-12	Summer 2012	Monsoon 2012	Post-Monsoon 2012	Winter 2012-13	Summer 2013
Taxa (S)	54	58	57	44	53	58	58	46	54
Total no. of individuals	335	569	754	112	413	641	823	98	410
Dominance index (D)	0.02473	0.02192	0.02179	0.03157	0.02252	0.02167	0.0217	0.0266	0.0216
Shannon-Wiener	3.85	3.931	3.933	3.619	3.881	3.934	3.94	3.715	3.909
Simpson's index (1-D)	0.9753	0.9781	0.9782	0.9684	0.9775	0.9783	0.9783	0.9733	0.9784
Evenness	0.8702	0.8786	0.8954	0.8481	0.9145	0.8809	0.8922	0.8922	0.9233
Menhinick	2.95	2.431	2.076	4.158	2.608	2.291	4.647	4.647	2.667
Margalef	9.116	8.985	8.452	9.113	8.633	8.819	9.815	9.815	8.81
Equitability	0.9651	0.9681	0.9727	0.9565	0.9775	0.9688	0.9702	0.9702	0.98
Fisher's alpha	18.21	16.16	14.31	26.71	16.16	15.48	33.81	33.81	16.65
Berger-Parker	0.06866	0.04218	0.04111	0.08036	0.04116	0.039	0.0408	0.0408	0.0439

Table 4. Diversity indices of Noctuid moths in Bathbanga

Diversity Index	Summer 2011	Monsoon 2011	Post-Monsoon 2011	Winter 2011-12	Summer 2012	Monsoon 2012	Post-Monsoon 2012	Winter 2012-13	Summer 2013
Taxa (S)	54	58	58	44	58	58	58	47	58
Total no. of Individuals	318	591	802	88	438	626	774	72	459
Dominance index (D)	0.02405	0.0217	o.02131	0.0297	0.02139	0.02101	0.02154	0.02662	0.02101
Shannon-Wiener	3.86	3.943	3.953	3.655	3.953	3.958	3.95	3.742	3.954
Simpson's index (1-D)	0.976	0.9783	0.9787	0.9703	0.9786	0.979	0.9785	0.9734	0.979
Evenness	0.8792	0.8894	0.898	0.8785	0.8978	0.9028	0.8954	0.8977	0.8992
Menhinick	3.028	2.386	2.048	4.69	2.771	2.318	2.085	5.539	2.707
Margalef	9.198	8.932	8.524	9.604	9.372	8.852	8.569	10.76	9.3
Equitability	0.9677	0.9711	0.9735	0.9658	0.9734	0.9748	0.9728	0.972	0.9738
Fisher's alpha	18.67	15.93	14.35	35.02	17.92	15.61	14.52	58.75	17.57
Berger-Parker	0.0566	0.04569	0.04239	0.07955	0.0411	0.03994	0.0478	0.05556	0.03922

Our study confirms the findings by other investigators that moth assemblages are definitely affected by climate and seasons.

Conclusions

This study of ours proves the fact that Rajmahal hills have rich diversity of moths and can be considered as rich in biodiversity. Moths are surely affected by climate as they are abundant in post-monsoon season but are scarce during winter. They have a preference for forest edges than inner thicker forest and humidity, wetness and warm sunshine are factors that affect their diversity. This study will propel others to take up in-depth study in this area.

References

1. Barlow HS, Woiwood IP. Moth Diversity of tropical forest in Peninsular Malaysia. Journal of Tropical Ecology 1989; 5: 37-50.

2. Bell TRD, Scott FB. "The fauna of British India including Burma and Ceylon" Moths-V. Taylor and Francis Ltd, London. 1937; 533 pp

3. Davidson J, Andrewartha HG. The influence of rainfall, evaporation and atmospheric temperature on fluctuations in the size of a natural population of *Thrips imaginis* (Thysanoptera). J Anim Ecol. 1948; 17: 200-222.

4. Hampson GF. "The fauna of British India including Burma and Ceylon":Moths Vol I; Taylor and Francis Ltd, London. 1892; 527pp.

5. Hampson GF. "The fauna of British India including Burma and Ceylon":Moths Vol II; Taylor and Francis Ltd, London. 1894; 609pp.

6. Hampson GF. "The fauna of British India including Burma and Ceylon":Moths Vol III; Taylor and Francis Ltd, London. 1895; 546pp.

7. Hampson GF. "The fauna of British India including Burma and Ceylon":Moths Vol IV; Taylor and Francis Ltd, London. 1896; 594pp.

8. Jaroensutasinee M, Pheera W, Ninlaeard R, Jaroensutasinee K, Choldumrongkul S. Weather Affecting Macro-Moth

Diversity at Khao Nan National Park, Thailand. Walailak J Sci Tech. 2011; 8(1): 21-31.
9. Kitching IJ, Rawlins JE. The Noctuoidea. In: Kristensen NP, editor. Lepidoptera, Moths and Butterflies. Volume I: Evolution, systematic and Biogeography. Berlin (Walter de Gruyter). 1998; 355-401.
10. Sanyal AK, Uniyal VP, Chandra K, Bhardwaj M. Diversity and indicator species of moth (Lepidoptera: Heterocera) assemblages in different vegetation zones in Gangotri landscape, Western Himalaya, India. ENVIS Bulletin. 2011; 14(1): 114-129
11. Stojanovic D, Curcic S. The diversity of Noctuid moths (Lepidopetra; Noctuidae) I Serbia. Acta Zoologica Bulgarica. 2011; 63(1): 47-60.
12. Zahoor MK, Suhail A, Iqbal J, Zulfaque Z, Anwar M. Biodiversity of Noctuidae (Lepidoptera). In: Agro forest system. Int J Agri & Biol. 2003; 5(4):560-563