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Diversity of Noctuid moths (Lepidoptera: noctuidae) in TamilNadu part of Western Ghats (Nilgiris biosphere and Kodaikanal hills), India

K. Sivasankaran, S. Gnanasekaran, D. Parandhaman and S. Ignacimuthu

Entomology Research Institute, Loyola College, Chennai - 600 034.

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ABSTRACT

The diversity of Noctuid moths of the Nilgiri, an important International Biosphere in the Western Ghats of South India, was studied in four different places namely Coonoor, Doddabedda, Kothagiri and Ooty in the Nilgiri Biosphere and Kodaikanal. The data obtained between January 2009 (140 species) and December 2010 revealed the presence of 154 species of Noctuid moths classified under 85 genera and 23 subfamilies. Total number of taxa and individuals of Noctuid moths were found maximum in the year 2010.

Introduction

Lepidoptera is the second largest and the most diverse order of the class Insecta (Benton, 1995). Many investigators have used Lepidoptera as model to assess the impact of disturbance and management practices on forest ecosystems (Willott *et al*., 2000; Lewis, 2001; Beck *et al*., 2002; Stork *et al*., 2003; Axmacher *et al*., 2004; Brehm, 2005). Noctuidae is the largest family in the order Lepidoptera. The sub-order Heterocera of Lepidoptera which contains the moths has important roles in forest ecosystems as herbivores and as food for various predatory and parasitic organisms. Many are also serious pests of crops (Bellocq *et al*. 1994; Young 1997). Noctuidae is one of the dominant and economically important families of the order Lepidoptera. Many are pests of various agricultural, horticultural and plantation crops. Studies on diversity of Noctuidae in forest ecosystems can provide useful information on their role in the ecosystem. The present study was undertaken to investigate the diversity of Noctuid moths in the Nilgiri Biosphere. The present knowledge on the insect fauna of Indian forests is largely based on earlier studies by pioneer workers like Hampson, (1896-1898). Although a series of revisionary studies has been subsequently carried out from different geographical regions, no exhaustive survey has so far been done specifically from the various forests. This is particularly true with regard to the Western Ghats region which is noted for its richness in biodiversity.

Materials and Methods

Study area: Noctuid moths were collected from five different sites situated in four different areas namely, Coonoor, Ooty, Kothagiri, Doddabedda and Kodaikanal. The study was conducted from January 2009 to December 2010. Nilgiri biosphere reserve (NBR) covers an area of 5,520 sq. km in the states of Karnataka, Kerala and Tamil Nadu. It lies between 11° 08′ to 11° 37′ N and 76° 27′ E to 77° 4′ E. NBR is characterized by great altitudinal (from 100 m to 2554 m above mean sea level) and climatic gradients. The natural vegetation of NBR is of different types: tropical wet evergreen forest, montane stunted Shola forest and progressively drier deciduous forests ending in thorny scrub. These variations in climate and vegetation are favourable for a great diversity of insects. Doddabedda is the highest mountain in the Nilgiris Hills, at 2637 meter (8652 feet). It is 9 km from Ooty, on Ooty-Kotagiri Road in the Nilgiris District of Tamil Nadu (11°24′8.7″N 76°44′12.2″E). The major collection site in the study is Coonoor situated on the eastern side of the southern extremity of Doddabetta range, at an altitude of 1,858 m above the sea level. It is the second largest hill station in the Nilgiris. Coonoor is located 19 km away from Ooty (Latitude 11°35″ 00 Longitude 76°8″16 Altitude: 4927 feet. Lat (DMS) 11.20' 60 N, Long DMS 76.49' E Altitude meters 1501. Rainfall: 121cms. Another collection site in the study Kotagiri is situated at an elevation of around 1793 m above sea level and is one of the three popular hill stations located in the Nilgiris. Kotagiri is located at 11.43°N 76.88°E. It has an average elevation of 1793 meters (5882 ft).

The monthly average rainfall in Nilgiris is 94.20 mm. The months of June-September and October-November receive a rainfall that is more than the annual average rainfall. The district has the highest average number of rainy days with 7.3 per month. Mean maximum average temperature is 20.7°C; mean minimum average temperature is 9.6 °C and mean relative humidity is a maximum of 76.9% and minimum of 75.8%.

Kodaikanal has a subtropical climate. Kodaikanal sits (Fig. 2) on a plateau above the southern escarpment of the upper Palni Hills at 2,133 m (6,998 ft), between the Parappar and Gundar Valleys. These hills form the eastward spur of the Western Ghats on the Western side of South India. It has an irregular basin as its heartland. This place is situated in Dindugul district, Tamil Nadu, India; its geographical coordinates are 10° 14' 6" N; 77° 29' 6" E. During summers (March to May) the average temperature ranges between 11°C to 20°C. Winters are very cool

Tele: 044 28178348; Fax-044 2817 4644
E-mail addresses: entolc@hotmail.com

with a maximum temperature of about 17°C and minimum of about 8°C. The total area of Kodaikanal is 21.45 km^2.

Collection methods: Sampling of moths was done at night hours (6.30 – 10.00 P.M.) and morning hours (5.00 – 6.00 A.M.) using mercury vapour lamps (200/220w) for five consecutive days every month. Moths which were attracted to the traps were collected by using a sweeping net (25 cm diameter). The moths collected were killed by Ethyl acetate vapour and properly mounted and stored in insect storage boxes.

Identification of specimens: The Noctuid moths were identified up to species level based on the keys provided by (Hampson, 1894). The number of subfamilies, genera, species and total number of individuals collected during the study period were recorded. All the specimens collected from study area have been deposited at Entomology Research Institute, Loyola College, Chennai, India.

Diversity indices: The total numbers of individuals collected under each identified species in different seasons were recorded and diversity indices namely dominance index, Shannon's diversity index (H'), richness index, evenness (e^H/S) index, Menhinick and Margalef were calculated using PAST software package (PAST; version = 2.02).

Results

Species composition: A total of 4,679 individuals of 140 species of noctuid moths belonging to 83 genera and 23 subfamilies were collected in the year of 2009 (Table 1). In 2010, 5,607 individuals of 154 species 85 genera 23 subfamilies were recorded (Table 2). The total number of species collected during the entire study period was 154 (Table 3).

Diversity indices: Overall data clearly showed that species richness was higher (155 species) in 2010 than in 2009 (140 species). In 2009, maximum number of species (102) and individuals (1338) were recorded during April followed by March and May. The lowest number of species (9) and individuals (42) were collected during November 2009. In 2010 maximum number of species (103) and individuals (1567) were recorded during April, and also during March, May and October.

The maximum dominance (0.208) was recorded during November 2009 and lowest (0.034) during May 2009. The maximum values of Shannon's diversity index (H^1) were recorded in April 2009 (3.604) and May 2009 (3.901) and minimum was recorded in November 2009 (1.793). High value was recorded in March 2009 (3.104) and October 2009 (3.265). Simpson's diversity index was maximum in May 2009 (0.965) and October 2009 (0.945) and minimum was recorded in November 2009 (0.791). Maximum evenness (0.891) of Noctuid moths species was observed in July 2009. Higher evenness of (0.810) and (0.780) was recorded in June 2009 and September 2009 respectively. Very low evenness (0.405) values of the Noctuid moths species were recorded in March 2009. Margalef index (R1) was maximum in April 2009 (14.03) and May 2009 (13.36). Menhinick index (R2) value for Noctuid moths fluctuated throughout the study period and the maximum (R1) was recorded during April 2009 (2.789), May 2009 (3.053), July 2009 (2.711) and October 2009 (2.229).

Noctuid moth are observed in 2010; interestingly the maximum number of species (103) and individuals (1567) was recorded in April 2010 and also in March 2010 and May 2010. The lowest number of species (6) and individuals (41) was observed in November 2010. Maximum value of Shannon's diversity index (H^1) was recorded in May 2010 (4.066) and October 2010 (3.533) and minimum value was recorded in January 2010 (1.837) and November 2010 (1.468). Higher values were also observed in March 2010 (3.084), April 2010 (3.293) and October 2010 (3.533). Simpson's diversity index was maximum in May 2010 (0.976) and October 2010 (0.958) and minimum in November 2010 (0.729) and January 2010 (0.727). Maximum evenness of Noctuid moths species was observed in June 2010 (0.86), July 2010 (0.846) and November 0.723 respectively. Low evenness was observed in April 2010 (0.261). Margalef index (R1) value was maximum in April 2010 (13.86) and May 2010 (13.96) and minimum value was recorded in November 2010 (1.346). Menhinick index (R2) was maximum in July 2010 (3.727) and may 2010 (3.037) and minimum was recorded in November 2010 (0.937). The present study was undertaken to assess the seasonal variation in the Noctuid moth diversity in selected places of Tamil Nadu part of Western Ghats.

Lacero noctilio Guenée, 1852., *Spirama helicina* Hampson, 1984., *Polydesma boarmoides* Guenée, 1852 *Eudocima homanea* Hübner, [1823]., *Eudocima sikhimensis* Butler, 1895., *Doryodes grandipennis* Barnes & Mc Dunnough, 1918., *Targalla atripars* Hampson, 1912., *Eutelia adulatricoides* Mell,1943., *Lophotera squammigera* Guenée, 1852., *Lophotera squammilinea* Guenée, 1852., *Odontodes seranensis* Guenée, 1852., *Stictoptera cucullioides* Guenée, 1852., *Stictoptera signifera* Walker, 1857., *Aegilia sundascribens* Holloway, 1976., *Aegilia describens* Walker, 1858., *Actinotia polydon* Clerk, 1759., *Chasmina candida* Walker, 1865., *Pandesma quanavadi* Guenée, 1852., *Parallelia calefaciens* Walker, 1858., and *Pindara illibata* (Fabricius, 1775)., were recorded for the first time for the Western Ghats (Nilgiris Biosphere and Kodaikanal) Tamil Nadu part; *Lygephila maxima* Bremer, 1861., and *Sasunaga leucorina* Hampson, 1894 were recorded for the first time in India.

Discussion

Among insects, the moths belonging to Lepidoptera are economically very important since they are the primary herbivores in the forest ecosystem. They are diverse in their habits and are adapted to a variety of conditions. Being highly sensitive to changes in the environment, they are easily affected by even relatively minor perturbations in the habitat; they have been considered as indicators of environmental quality (Kosenberg *et al*., 1986).

Tropical forest ecosystems are under enormous pressure all over the world (Sundufu and Dumbuya, 2008). Due to human activities the fauna and flora in natural habitats like forests are facing severe threat. The diversity and distribution of moth fauna may reflect the status of the ecosystem in which they live. In their study (Zahoor *et al*., 2003) have reported that Noctuidae was predominant among the moths. Fayle *et al*, (2007) have studied the effect of light trap types on catch size and species composition of British lepidopteran moths. In their study they found that Noctuidae was the predominant family. Similarly (Schmidt & Roland 2006) and Park *et al*. (2009) have also reported that Noctuid moths were predominant with maximum number of species. As the family Noctuidae is the largest family in the order Lepidoptera, this family can be used as a model for assessing the impact of biotic and abiotic factors on the diversity of organisms.

Fayle *et al*. (2007) have collected 44 Noctuid species near fields and gardens. Zahoor *et al*. (2003) studied the biodiversity of Noctuidae in agroforest area of Faisalabad. They collected 13 Noctuid species from both agricultural and forest areas among

which 25.9 and 24.7 per cent noctuids were from agricultural and forest areas respectively.

In the present study, Noctuid moth diversity was found to be fluctuating greatly in different seasons. Their diversity was maximum in early spring seasons (March-May). This clearly indicated that the climatic factors during these months were favourable for the development and emergence of most of the Noctuid species in the study area. The climatic factors particularly temperature and rainfall played important role in the diversity of Noctuid moths. The diversity of Noctuid moths decreased from November to December and the decrease was coinciding with the decrease in the rainfall during these months. Increased diversity from May to October 2007 was also found to be correlated with the increased rainfall during these months. The diversity was also positively correlated with the atmospheric temperature.

The maximum evenness of 0.891 was recorded in June and July during both study years. Hence it is clear that all Noctuid species were equally distributed during this period. The diversity index and dominance index showed opposing trends suggesting inverse proportionality between them. Evenness index also showed opposing proportionality with dominance values. Lower dominance values indicated that the distribution of each species was more even. Noctuid moths have a wide range of host plant record including food crops and hence they are economically important. Availability of host plants also played vital role in the occurrence of moths in a particular area. Lindenmayer & Hobbs (2004) and (Kanowski *et al*., 2005) have reported that landscape heterogeneity may increase the species richness and diversity. *Agrotis c-nigrum* and *Thysanoplusia orichalcea*, which were collected in the present study, are minor pests of cabbage, cauliflower and potato (Nair, 1970; Butani and Jotwani, 1984; Bhatia and Verma, 1995; David, 2001). These host plants are available in the study area. *Oxyodes scrobiculata* occurs throughout year. This species contributed for more than 50 per cent of the total population collected in the month of April. According to (Ricklefs, 1987) the global population size of a species is determined by two variables namely local abundance and geographical distribution of the species. The present study has given credence to this.

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Table 1. Diversity indices of Noctuid moths in Tamil Nadu part of Western ghats (Nilgiri biosphere and Kodaikanal) from January 2009 to December 2009

Month & Year	No. of Taxa Collected	Individuals	Dominance	Shannon _H	Simpson_I_D λ	Evennes _e^H/S	Menhinick (R2)	Margalef (R1)
January	14	70	0.187	2.1	0.812	0.583	1.673	3.06
February	15	111	0.167	2.251	0.832	0.633	1.424	2.973
March	55	1253	0.71	3.104	0.928	0.405	1.554	7.57
April	102	1338	0.083	3.604	0.916	0.360	2.789	14.03
May	92	908	0.034	3.901	0.965	0.537	3.053	13.36
June	17	218	0.082	2.623	0.917	0.810	1.151	2.971
July	13	23	0.096	2.45	0.903	0.891	2.711	3.827
August	12	41	0.161	2.118	0.838	0.693	1.874	2.962
September	13	98	0.123	2.317	0.876	0.780	1.313	2.617
October	40	322	0.159	3.265	0.945	0.654	2.229	6.754
November	9	42	0.208	1.793	0.791	0.667	1.389	2.14
December	29	253	0.121	2.617	0.878	0.472	1.823	5.06
Overall	411	4677	2.131	32.143	10.601	7.485	22.983	67.324

Table 2. Diversity indices of Noctuid moths in Tamil Nadu part of Western ghats (Nilgiri biosphere and Kodaikanal) from January 2010 to December 2010

Month & Year	No. of Taxa Collected	Individuals	Dominance	Shannon _H	Simpson_I_D λ	Evennes _e^H/S	Menhinick (R2)	Margalef (R1)
January	13	82	0.272	1.837	0.727	0.482	1.436	2.723
February	14	104	0.161	2.234	0.838	0.667	1.373	2.799
March	54	1769	0.071	3.084	0.928	0.404	1.284	7.087
April	103	1567	0.135	3.293	0.864	0.261	2.602	13.86
May	98	1041	0.023	4.066	0.976	0.594	3.037	13.96
June	20	175	0.063	2.854	0.936	0.867	1.512	3.679
July	25	45	0.056	3.052	0.943	0.846	3.727	6.305
August	12	59	0.188	2.057	0.811	0.651	1.562	2.698
September	17	74	0.122	2.447	0.877	0.679	1.976	3.717
October	51	370	0.041	3.533	0.958	0.671	2.651	8.455
November	6	41	0.270	1.468	0.729	0.723	0.937	1.346
December	31	280	0.095	2.752	0.904	0.505	1.853	5.324
Overall	444	5607	1.497	32.677	10.491	7.35	23.95	71.953