Journal of Global Biosciences ISSN 2320-1355
Vol. 3(2), 2014, pp. 452-463 http://mutagens.co.in
Date of Online: 19, March- 2014

DIVERSITY OF TROPICAL BUTTERFLIES IN URBAN ALTERED FOREST AT GAUHATI UIVERSITY CAMPUS, JALUKBARI, ASSAM, INDIA

Malabika Kakati Saikia

Assistant Professor,
Animal Ecology & Wildlife Biology,
Department of Zoology Gauhati University,
Guwahati-781014, Assam.

Abstract

The survey of butterfly diversity in Gauhati University Campus, Jalukbari, Assam was conducted from September, 2003 through August, 2010. Numbers of surveys, covering all four seasons were made in four different study zones of Gauhati University campus, Jalukbari, and altogether 140 species of butterflies were recorded belonging to the families of Papilionidae, Nymphalidae, Lycaenidae, Hesperiidae and Pieridae. The study revealed that the monsoon season has the highest diversity than winter, pre-monsoon and retreating monsoon. Lowest diversity was found during winter season. The higher butterfly diversity during monsoon season may be due to wide range species, whereas the low diversity during winter season may be due to non-availability of wide range species. The analysis of correlation between seasonal abundance and species phylogeny shows significance result.
Key words: Jalukbari, Tropical Butterfly, Diversity, distribution range, Seasonality.

INTRODUCTION

The Eastern Himalaya is one of the richest areas of butterflies species within Indian-subcontinent. Fifty eight percent of the butterflies that occurring in Indian-subcontinent and Myanmar are found in Eastern Himalayas as well as in northeast India alone (Evans 1932). The main reason for this phenomenal diversity is the region's unique bio-geographic location at the junction of Indian and Indo-Chinese sub-regions. The greatest diversity of plants, habitats, topography and climates are the major influences on butterfly distributions, diversity and abundance (Vidya 1996; Kakati, 2006a). Butterflies, besides being recognised important resources in aesthetics, educational and environmental investigations are now considered as ecological indicators (Gunathilagoraj *et al.*, 1997). Apart from the studies of Kakati (2002), Kakati & Kalita (2002), Kakati et al. (2005a), Kakati et al (2005b), Kakati & Saikia, (2006) there is a lacuna of information regarding the recent information of butterflies species assemblages in north-eastern parts of Assam in the recent years. In Himalayan region, the works of Mani (1986), and Haribal (1992), are the only works of butterfly study, however, the Assam Himalayas are one of the major eco-geographical divisions of the Himalayan region in regards to the butterfly species (Mani 1986). The Northeast India extending from Sikkim through Assam to north Burma (now Myanmar) up to Shan state is one of the richest and interesting butterfly areas in the world (Evans 1932); hence, it requires proper exploration in various ecological pockets of natural and disturbed habitat.

The present study emphasises to investigate the diversity and abundance of butterflies fauna in urban altered area of Jalukbari and its adjoining area with special reference to seasonal abundance. The study was also tried to investigate whether the seasonal abundance are influenced by the species range of geographic distribution and its phylogenetic (sub-family level) status.

STUDY AREA

The study sites of Gauhati University campus, Jalukbari has covered the area of Gauhati University Campus, University Botanical garden, Satmile area and Kaleswar Hill Area that have lies between 25°5" - 25°53" N latitude and 91°22" E to 91°28" E longitude in the direction of south west corner of Kamrup district and in the southern bank of river Brahmaputra. It is located about 8 km apart from the

major cosmopolitan centre of Guwahati city. The average total area covered was approximately 40 km^2, most of which are undulating hilly terrain and floodplains of river Brahmaputra. The plain includes the parts of Gauhati University Campus (including gardens, University residential campus, Institutional campus, etc.), Sundarbari, Satmile and the hilly area includes the hills of University campus, Lankeswar and Kaleswar, Assam Police Radio Operation Campus etc. The area is highly rich with natural and cultivated flora. The vegetation of low hilly area within Gauhati University Campus and Botanical garden is highly dense but reduce gradually its density with the declination of height. Diverse types of vegetation are found throughout gauhati University campus and Jalukbari, which represents evergreen, semi-evergreen, deciduous type, shrubs and grasslands of tall and short. The herbs and shrubs are mainly dominated by *Ageratum conyzoids, Bigonia lanciniata, B. roxburghii, Centrala asiatica, Hydrocotyle rotundifolia, Eupatorium odoratum, Melastoma malabarthricum* and *Lantena camera.* The natural vegetation comprised of *Cassia fistula, C. sophera, C. nodosa C. tora, M. prurita, Psidium guava, Citrous sp. Wild Citrous, Murraya koenigii, Ficus religiosa, F. glomarata, F. benghalensis, Aegle marmelos, Bombax ceiba, Zezyphus jujuba* etc. The *Polialthea longifolia, Delbergia sisso, Nepenthes khasiana, Eucalyptus alba, Somania saman* and *Tectona grandis* are commonly found planted trees.

The climate of gauhati University campus, Jalukbari is tropical mesothermal with high humidity and moderate temperature. Climatically, the study area could be divided into four distinct seasons such as winter (December to February), pre-monsoon (March to May), monsoon (June to September) and retreating monsoon (October to November). Again, on the basis of average total rainfall, the months from May to September (total 6 months) could be distinguished as wet season and October to April could be distinguished as dry season (Source: Department of Environmental Science, Gauhati University). The temperature ranges between 10.6° C - 32°C and the average annual precipitation ranges between 300- 400mm. The most rainfall takes place during monsoon period with a maximum temperature of 32°C and minimum temperature of 24° C and relative humidity between 55.5-85.5%.

METHODS OF STUDY

Study has been carried out in Jalukbari area an urban altered forest of Guwahati from the months of September 2003 through August 2010. The whole area was divided into 4 study zones namely (a) Gauhati University Campus (b) Botanical Garden (c) Kaleswar hill area (d) Satmaile area. Butterfly specimens and necessary data were collected in various dates and months to meet taxonomic information as well as to obtain the study objectives.

Identification and Geographical distribution of butterflies

The identification of butterflies and knowledge of their geographical ranges were followed on the information of Haribal (1992), Evans (1932), Mani (1986), Bingham (1905) and Talbot (1939)

The geographical distribution ranges were categorised on a scale of 1-5 (smaller to largest) as used by Spitzer et al. (1997): (1) Eastern Himalayas (from Sikkim to Assam) Yunan and Northern Indo-china; (2) Northeastern India and all Indochina (3) Indo-Malayan region (4) Indo-Australian region or Australasian tropics. (5) Paleotropic. No species was found beyond Paleotropic range during survey.

Sampling designed

Altogether nine randomly selected permanent transects (fixed length and breadth) were established in six study zones of Jalukbari (four transacts in Gauhati University campus and one each in other study zones) representing the plains and undulating hilly terrain. The transact number-1 (T_1; total length, 800m and breadth 20m), 2(T_2; total length, 500m and breadth 20 m), 3 (T_3; total length, 850m and breadth, 20m), and 4(T_4; total length, 900m and breadth 20m) were established in zone '**a**', whereas the transact number- 5 (T_5; total length, 1500m and breadth 20m) was established in zone '**d**', transact number –6 (T_6; total length, 1000m and breadth 20m) in zone '**c**', transact number 7 (T_7; total length, 500m and breadth 20m) in zone '**b**' transact number 8 (T_8; total length, 500m and breadth 20 m) in zone '**e**', transact number 9 (T_9; total length, 850m and breadth 20m) was established in zone '**f**'.

Data Collection

Intensive regular samplings were made thrice monthly in each study zones from September 2003 to August 2010. Surveys were carried out only during good weather and during active periods of butterflies (sunny days and from 09.00hrs. - 14.00 hrs.). The data were collected using transact methods described by Pollard et al. (1975) and Pollard (1977) with some modification described in sampling designed as used by Kakati (2006). Four observers were walking together along each

transact at the speed of approximately 100 meter per 20 minutes and recorded/collected all butterflies seen, using butterfly net in a belt of 20 meter width. Altogether 72 samplings were completed within 24 months and collected the butterfly data in each months of the year.

DATA ANALYSIS

For analytical purposes, the monthly abundance of butterfly data was computed to convert seasonal abundance in each species and analyses seasonal diversity and abundance pattern. Diversity was estimated in terms of species richness and evenness, as well as using the Shannon-Wiener index, which combines richness and abundance into a single measure (Magurran 1988). Species richness also estimated using 1st order Jackknife in each season. Bootstrap method was used to calculate 95% confidence intervals for Shannon-Wiener's indices. In order to test for differences in diversity between seasons, pair-wise randomization tests were carried out based on 10,000 re-samples of species abundance data following Solow (1993). Percentage cumulative abundance was plotted ('K'dominance) against log species rank (Lambshead et al. 1983) for comparing diversity between samples. The variables such as ranked species distribution range, seasonal abundance of the butterfly communities were compared using standard statistical methods (ANOVA).

RESULTS

Diversity

All total 5133 individuals from 140 species (Table 2) were recorded during the study period. The largest numbers of species were sampled in the monsoon (M) season (n= 140 species) compared to pre-monsoon (PM) (n= 99 species), retreating monsoon (RM) (n=88species) and winter (W) (n= 42 species). Comparison of diversity in different seasons showed that the species richness was different among the samples of pre-monsoon, monsoon, retreating monsoon and winter. (1st order Jacknife estimates 42-163.0) and the Shannon index was highest in monsoon compared to pre-monsoon, retreating monsoon and winter (Table 1; monsoon vs. winter randomisation test, Δ = 1.18, p= 0.001, monsoon is more diverse than winter at 5% level; monsoon versus pre-monsoon randomisation test, Δ = 0.31, p= 0.01, monsoon is more diverse than pre-monsoon at 5% level; monsoon vs. retreating monsoon randomisation test, Δ = -0.45, p= 0.001, monsoon is more diverse than retreating monsoon at 5% level; pre-monsoon vs. retreating monsoon randomisation test, Δ=-0.143; p =0.007, pre-monsoon is more diverse than retreating monsoon at 5% level and pre-monsoon vs. winter randomisation test, Δ = 1.23, p= 0.001, pre-monsoon is more diverse than winter at 5% level). The percentage of cumulative abundance plotted (K dominance, Fig 1) against log species rank for comparing diversity between samples (PM, M, RM and W) showed that diversity of butterflies in Monsoon season was higher (lower line) than PM, RM and W. All four sample data sets such as pre-monsoon (χ^2= 7.66 df=4; p=0.104; λ=261.12; with predicted species in the community was 99.19 and species behind the veil line = 0.19), monsoon ((χ^2= 1.23 df=5; p=0.97; λ=311.57; with predicted species in the community was 139.06 and species behind the veil line = 0.06), retreating monsoon (χ^2= 1.98; df =4; p=0.73; λ=207.08; with predicted species in the community was 89.22 and species behind the veil line = 1.22) and winter ((χ^2= 4.63; df=3; p=0.20; λ=93.46; with predicted species in the community was 44.13 and species behind the veil line = 2.13) seasons were feet the truncated log normal model (Fig 2 a, b, c and d).

DISCUSSION

Diversity pattern and faunal composition differ significantly between seasons: Species diversity was consistently higher during the monsoon season (Table 1), primarily due to a greater abundance of species with broad geographical distribution (Fig 3). These effects are also strongly associated with changes in the relative abundance of species with different geographical distributions and hence conservation value (Thomas 1991; Vane-Wright et al. 1991; Kakati 2006). During winter season the declination of species diversity and abundance are associated with habitat dryness and differences in microhabitat conditions with monsoon, pre-monsoon and retreating monsoon season (Figure 1). This variation indicates that, the abiotic factors of rainfall, temperature and humidity played a vital role in influencing the distribution and abundance (Hill et al. 2003; Shubhalakshmi & Chaturvedi, 1999). Almost 75% butterfly species sampled in Gauhati University Campus, Jalukbari is seasonal rather

than distributed equally throughout the year. Ranging from the later half of the retreating monsoon through winter up to early pre-monsoon seasons, the phonological pattern of study area has greatly changed, and these changes are influencing majority of butterfly communities to utilize the seasons or to avoid it. This emphasizes the need for biodiversity assessments to cover sufficiently long period to account for seasonal variation in species abundance in different habitats. Differences in phenology across the seasons and among the species could be a mechanism to reduce competition (Clench 1967; Wolda & Fisk 1981). The differences in diversity between seasons and seasonality of butterflies could be possible due to monthly collection of data for a longer period of two years. This emphasizes the need for biodiversity assessments to cover sufficiently long period to account for seasonal variation in species abundance in different habitats.

Of the total 14 species of sub-family Papilioninae 12 shows distinct seasonality in Jalukbari that belonging to five genera (Appendix 1). The seasonality of these species may be related to its host plant availability and dry weather condition. During winter season majority of the Papilioninae host plant become defoliated or no new foliages are appearing. Evolutionary reasons behind seasonal patterns in tropical insects are largely unknown although tuning in to host plant seasonality does seem to be a major force in at least some species (Wolda 1989). The seasonality pattern in butterfly species could therefore result from differences in the seasonal timing of leaf production by host plants in different microhabitats, or from seasonal variation in larval mortality in different microhabitats, or from seasonal variation in larval mortality in different microhabitats (D' Amico & Elkington 1995).

The butterfly sampled in all four seasons, the highest representing sub-families during dry season (winter) were Haliconinae (100%), Satyrinae (67%) and Pierinae (60%) and these sub-families have more adaptability even during dry season than possess by others sampled in study area. However, the lognormal distributions of the relative abundance (see results and Fig 2 c &d) indicate that the large sampling size of retreating monsoon and winter season could unveil the less abundant (rare) species actually present there. These findings are also evidence of frequent survey, necessary for dry season than wet to get full species inventories.

In the face of drastic habitat changes, emphasis increasingly is being placed on rapid assessments of biodiversity in natural and altered tropical forests, where a lack of resources combined with exceptionally high diversity make full species inventories difficult to achieve (Jones & Eggleton 2000; Kitching et al. 2001). Such assessments have typically focussed on insects and other invertebrates, which respond more rapidly than vertebrates is disturbance and may be much more important than vertebrates the maintenance of vital ecosystem process (Wilson 1987; Liow et al. 2001). The present findings suggest that short-term assessments that do not take account of seasonality will be misleading and so reliable rapid assessment technique may prove elusive (Hamer et al. 2005).

ACKNOWLEDGEMENTS

The authors are highly acknowledged the Ministry of environment & forest Govt. of India (Biosphere Reserve Research Programme) and DST Women Scientist Scheme for financial support to conduct the butterfly study at Assam, without which we could not complete our present butterfly survey at Jalukbari, Gauhati University campus and its surrounding areas. The authors are also acknowledged the field assistant of the MoE.F project. Mr. Jayanta Das and Hari Charan Barman for their help during field survey.

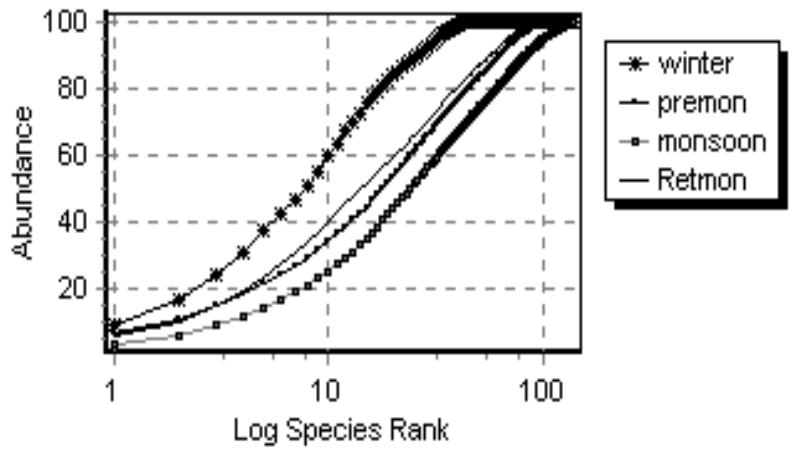
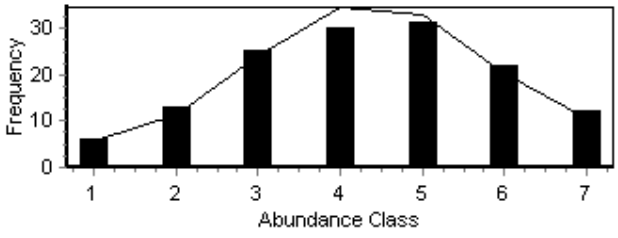
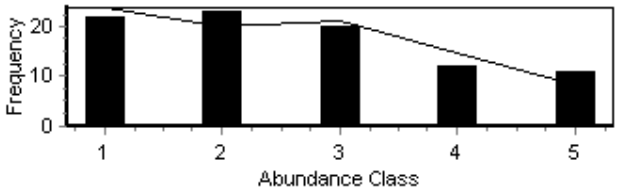


Figure 1 K dominance plotted for the comparing diversity among pre-monsoon, monsoon, retreating monsoon and winter season samples. Winter (dotted grey line) = winter season; Pre-mon (grey line) = pre-monsoon season; Monsoon (dark dotted line) = monsoon season; Ret-mon (dark line) = retreating monsoon. Dotted dark line goes lower which indicate the higher diversity than others (see Lambshead et al. 1983).

(a)



(b)



(c)

(d)

Figure 2 Log normal distribution of relative abundance of butterflies species sampled in Gauhati University Campus, Jalukbari, Assam in seasons from (a) pre-monsoon (b) monsoon (c) retreating monsoon and (d) winter season. Note that the lognormal distribution slides to the right as the sample size is increased.

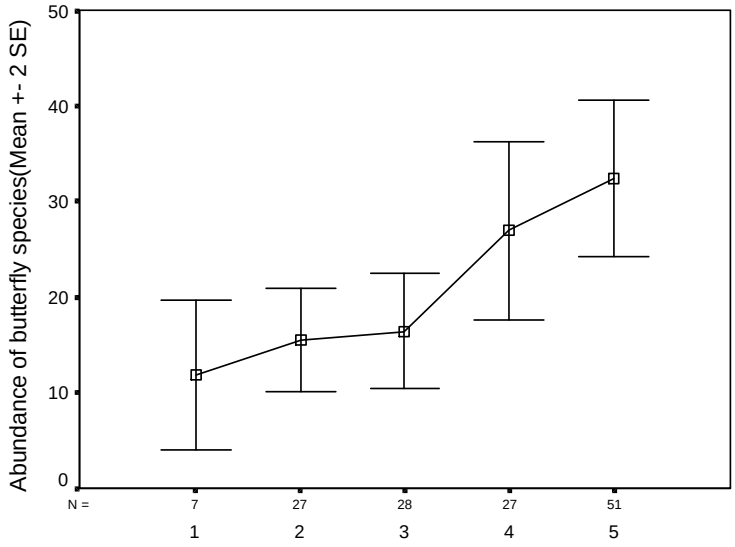


Fig 3: Abundance of butterfly species during monsoon season in relation to its geographical distribution range.

Table 2: Butterfly species sampled in study site during Pre-monsoon, Monsoon, Retreating monsoon and winter with Ranked scores for geographical distribution. The highest ranked species (rank 1) is endemic to this region; the lowest ranked (5) is the most widespread species recorded during study.

Species/ Families/Subfamilies	Winter	Pre-monsoon	Monsoon	Retreating monsoon	Rank range
Papilionidae **Papilioninae**					
Pachliopta a. aristolochiae (Fabricius)	1	7	19	3	3
Graphium doson axion (Fel.,C&R)	0	15	65	2	4
G.a. agammemnon(Linnaeus)	0	7	42	2	4
Princeps demoleus(Linnaeus)	0	18	64	3	5
P. polytes romulus(Cramer)	1	22	92	7	5
P. memnon agenor(Linnaeus)	0	9	36	2	3
Princeps castor polas (Jordan)	0	5	12	0	1
Graphium s. Sarpedon (Linnaeus)	0	18	47	0	4
G. cloanthus(Westwood)	0	0	14	0	3
Princeps. h. helenus (Linnaeus)	0	2	17	1	3
Pachliopta hector (Linnaeus)	0	0	7	0	5
Troides helena cereberus (C&R Fe)	0	0	13	0	4
Chilasa clytia dissimilis (Linnaeus)	0	0	9	0	3
Chilasa clytia clytia (Linnaeus)	0	5	20	1	3
Nymphalidae **Satyrinae**					
Discophora sondiaca zal Westwood	0	0	21	0	3
Melanitis leda ismene (Cramer)	17	10	62	31	5
M. phedima bela Moore	15	8	60	30	4
Elymnias m. malelas (Hewitson)	10	5	23	2	2
E. hypermnestra undularis (Drury)	15	17	96	21	5
E. patna patna (Westwood)	0	3	8	0	2
Lethe europa niladana Fruhstorfer	0	6	4	0	4
Neope confusa confusa Aurivillius	1	3	15	3	2
Mycalesis perseus blasius (Fabricius)	2	18	73	5	4
M. mineus mineus (Linnnaeus)	1	23	58	3	3
Orsotrioena m. medus (Fabricius)	0	57	86	10	5
Ypthima b. baldus (Fabricius)	2	12	69	24	4
Charaxinae					
Charaxes polyxena hierax Felder	0	5	31	3	4
C. marmax Westwood	0	2	18	1	2
C. kaharuba Moore	0	0	3	2	2
C. aristogiton Felder	0	0	2	2	1
Polyura a. athamas (Drury)	0	11	27	5	5
Nymphalinae					
Ariadne merione assama (Evans)	0	9	33	19	3

A. a. pallidior (Frusthorfer)	3	5	22	11	5
Phalanta phalantha (Drury)	0	12	52	3	5
Cirrochroa tyche mithila Moore	0	5	7	4	4
C. aoris aoris Doubleday	1	5	12	6	4
Issoria sinha sinha (Kollar)	1	3	4	2	5
Argyreus h. hyperbius (Johanssen)	0	2	2	0	5
Precis a. almana (Linnaeus)	0	17	66	25	3
P. l. lemonias (Linnaeus)	2	32	90	5	5
P. a. atlites (Johanssen)	21	7	71	35	4
P. i. iphita (Cramer)	0	5	15	3	3
Symbrenthia lilaea khasiana Moore	0	3	17	29	2
Kallima i. inachus (Boisduval)	10	8	2	7	2
Hypolimnas bolina (Linnaeus)	2	20	46	2	5
Neptis hylas varmona Moore	1	35	24	9	4
N. yerburi sikkima Evans	0	7	6	2	1
N. sappho adara Moore	0	39	27	9	2
N. soma soma Moore	3	5	7	4	2
Phaedyma columella ophiana (Moore)	0	2	3	0	3
Lassipa v. viraja Moore	0	0	5	8	2
Pantoporia h. hordonia (Stoll)	5	10	5	0	5
Parathyma cama (Moore)	0	20	20	0	2
Parathyma nefte inara(Doubleday&H)	0	6	32	19	3
P. perius (Linnaeus)	0	4	13	2	3
Moduza p. procris (Cramer)	0	7	17	0	5
Lebadea martha ismene (Doubleday)	6	23	62	9	2
Tanaecia l.lepidea (Butler)	11	6	7	9	3
T. l. miyana Frusthorfer	4	17	24	10	4
Euthalia aconthea suddhodana Frusth.	2	11	15	15	3
Euthalia jama jamida (Felder)	0	5	4	0	4
Heliconinae					
Cethosia cyane Drury	4	9	19	2	2
C. biblis tisamena Fabricius	2	0	8	4	3
Acrainae					
Pareba vesta (Fabricius)	0	3	4	1	2
Danainae					
Danaus genutia (Cramer)	0	0	17	2	5
D. chrysippus (Linn.)	17	6	23	21	5
Tirumala septentrionis (Butler)	0	3	17	0	5
T. limniace leopardus (Butler)	0	2	36	16	2
Parantica aglea melanoides (Moore)	1	5	19	0	5
Euploea m. mulciber Cramer	0	10	41	0	5
E. k. klugii Moore	0	7	64	5	5
E. core core Cramer	6	23	106	7	5
E. algea deione Fruhstorfer.	0	0	13	0	2
Lycaenidae **Miletinae**					

Spalgis e. epius (Westwood)	0	4	10	0	5
Curetinae					
Curetis dentata Moore	0	0	52	0	4
Theclinae					
Surendra q. quercetorum (Moore)	0	0	14	0	5
Nilasera centaurus pirithous(Moore)	0	0	12	0	5
Loxura atymnus continentalis Fruhsto.	0	3	26	0	5
Rapala jarbas jarbas (Fabricius)	0	0	2	12	1
Spindasis lohita himalayanus Moore	0	0	9	3	4
Lycaeninae					
Heliophorus brahma Moore	0	2	9	0	3
Polyommatinae					
Jamides c. celeno (Cramer)	0	2	36	7	5
J. alecto eurysaces Fruhstorfer	0	7	15	0	5
Lampides boeticus (Linnaeus)	0	3	11	0	5
Zizeeria t. trochilus (Freyer)	2	5	13	0	5
Lycaenopsis marginata (De Niceville)	0	3	16	0	1
Neopithecops zalmora Butler	3	18	38	4	5
Euchrysops cnejus (Fabricius)	0	4	62	8	5
Hypergyria gaetulia	0	0	6	0	4
Castalius r. rosimon Fruhstorfer	0	2	11	0	5
Tarucus ananda (De niceville)	0	0	10	0	2
T. nara Kollar	0	2	15	0	5
Chilades laius (Cramer)	0	4	26	6	5
Pseudozizeeria maha (Kollar)	2	4	5	5	5
Catochrysops strabo (Fabricius)	0	3	5	0	5
Acetolepsis puspa gisca Fruhstorfer	0	3	7	0	5
Edales pandava (Horsfield)	0	0	25	2	4
Riodininae					
Zemeros flegyas indicus Fabricius	8	5	30	11	2
Abisara echerius suffusa Moore	0	0	5	3	5
Hesperidae					
Pyrginae					
Tagiades atticus khasiana M	0	0	17	0	3
Coladenia dan festa Evans	0	0	14	7	4
Odontoptilum a. angulata (Felder	0	0	6	1	4
Ampittia dioscorides F.	0	0	10	0	4
Hesperinae					
Gangara t. thyrsis (Fabricius)	0	0	7	2	2
Matapa aria (Moore)	0	0	16	0	2
Cupitha purreea Moore	0	0	5	3	3
Ochlodes s. siva Moore	0	0	6	3	4
Caltoris kumara moorei Evans	0	0	8	0	3
Udaspes folus (Cramer)	0	0	6	3	3
Ancistroides nigrita diocles(Moore)	2	8	12	1	2

Notocrypta curvifascia	0	0	5	3	3
N. fiesthamelii alysos Moore	0	0	4	0	2
Suastus g. gremius(Fabricius)	0	0	4	3	4
Iambrix s. salsala (Moore)	0	0	3	0	2
Baoris cahira Evans	0	2	9	5	3
Sancus pulligo subfasciatus M	0	0	7	0	4
Zographetus satwa (De Niceville)	2	0	3	0	3
Oriens gola pseudolus (Mabille)	0	0	2	3	2
Pairidae					
Pierinae					
Leptosia n. nina (Fabricius)	9	38	90	22	5
Pieris canidia indica Evans	10	0	3	4	3
P. brassicae nepalensis Gray	7	2	2	0	2
Appias lyncida elenora (Boisduval)	3	2	6	1	3
A. albina darada (C& R, Felder)	3	0	5	0	5
A. l. libythea	0	12	40	0	4
Cepora n. nerissa (Fabricius)	0	5	21	0	5
C. n. Nadina (Lucas)	0	15	4	0	4
Ixias pyrene familiaris Butler	10	2	5	0	5
Hebomoia glaucippe(Linnaeus)	0	3	18	5	5
Delias eucharis (Drury)	2	2	15	7	5
D. a. agostina (Hewitson)	1	2	26	3	2
D. a.aglaia (Linnaeus)	10	2	36	5	2
D.d. descombesi (Boisduval)	0	2	32	7	1
D. hyparete indica Wallace	0	5	3	0	3
Coliadinae					
Catopsilia pomona (Fabricius)	1	16	69	5	5
C. pyranthe (Linnaeus)	2	23	64	11	5
Gandaca harina assamica Moore	0	5	5	0	2
Eurema brigitta rubella (Wallace	0	92	13	7	5
E. hecabe contubernalis (Moore)	12	16	50	2	5
E. a. andersoni (Moore)	0	2	16	4	5
E. blanda silhetana (Wallace)	0	0	17	3	5

REFERENCES

1. Bingham, C. T. (1905). The fauna of British India, Butterflies- Vol. I (Edited by W. T. Blandford), Taylor and Francis, London, 511 pp.
2. Clench, H. K. (1967). Temporal association and population regulation in eastern Hesperiine Butterflies. *Ecology* 48: 1000-1006.
3. D' Amico, V & J. S. Elkington, (1995). Rainfall effects on transmission of gypsy moth (Lepidoptera: Lymantriidae) nuclear polyhedrosis virus. *Environmental Entomology* 24: 1144-1149.
4. Evans, W. H. (1932). *The Identification of Indian Butterflies.* 2nd edition, International book Distributors, 9/3, Rajpur Road, (first floor), Dehradun-248001, India. XXXii Pls. and ix Text figures. 454 PP.

5. Gunathilagaraj, M. K, G. & P. T. Ramesh (1997). Butterflies of Coimbatore. *Zoos' Print Journal* 12(1): 26-27.
6. Hamer, K. C., J. K. Hill, N. Mustaffa, S. Benedick, T. N. Sherratt, V. K. Chey & M. Maryatis (2005). Temporal variation in abundance and diversity of butterflies in Bornean Rainforests: opposite impacts of logging recorded in different seasons. *Journal of Tropical Ecology* 21(40): 417-425.
7. Haribal, M. (1992). *The butterflies of Sikkim Himalaya and their natural History*. Published by Sikkim nature conservation Foundation (SNCF). 217 PP.
8. Hill, JK, K. C. Hamer, M. M, Dawood, J. Tangah and V. K, Chey (2003). Rainfall but not selective logging affects changes in abundance of a tropical forest butterfly in Sabah, Borneo. *Journal of Tropical Ecology*. 19: 35-42.
9. Jones, DT & P. Eggleton, (2000). Sampling termite assemblages in tropical forests: testing a rapid biodiversity assessment protocol. *Journal Applied Ecology* 37: 191-203.
10. Kakati, D. (2002). Studies on conservation Biology of Swallowtail Butterflies of Kamrup District, Assam. *Ph.D. Thesis*, Gauhati University, 265 pp.
11. Kakati, D. and Kalita, J. (2002). Diversity and population Status of Swallowtail Butterflies in Garbhanga Reserve Forest, Kamrup (Assam). *Journal of Nature Conservation 1*4(2):237-243.
12. Kakati, M. & P. K. Saikia (2006). Diversity of Butterflies Fauna in Manas Biosphere Reserve, Assam, India. pp 44-59. In: Rabha, A., Saikia, B. P., Dey, N. K. and Basumatary, C. K. (eds). *Manas (a set of Technical reports).* Special publication of Manas Biosphere Reserve Centinnary Celebration, Baska, Assam. 167pp.
13. Kakati, M. (2006). Diversity, Distribution & Ecology of Nymphalidae Butterflies in Rani-Garbhanga reserve forest, Kamrup, Assam. *P. hD. Thesis.* Submitted to Gauhati University, 172 pp.
14. Kakati, M., J. Kalita, & P. K. Saikia (2005b). Biology of Common Leopard Butterfly-*Phalanta phalantha* (Lepidoptera) in Assam. *Journal of Ecobiology* 17(4): 383-392.
15. Kakati, M., P. K. Saikia & J. Kalita (2005a). Studies on the Diversity and Seasonal variation of Butterflies in greater Jalukbari, Kamrup Assam. *Journal of Tropical Zoology* 3: 29-41.
16. Kitching, R. L., Li, DQ & N. E. Stork (2001). Assessing biodiversity 'sampling packages': how similar are arthropod assemblages from different tropical rainforests? *Biodiversity Conservation* 10: 793-813.
17. Lambshed P., J. D. Platt & H. M. Shaw (1983). Detection of differences among assemblages of marine benthic species based on an assessment of dominance and diversity. *Journal of Natural History* 17: 859-874.
18. Liow, L. H, N. S. Sodhi, & T. Elmqvist (2001). Bee diversity along a distance gradient in tropical lowland forests of south-east Asia. *Journal of Applied Ecology* 38: 180-192.
19. Magurran, A. E (1988). *Ecological Diversity and its Measurement.* Croom Helm, London. Chapman and Hall, 179 pp.
20. Mani, M. S. (1986). *Butterflies of the Himalaya.* Oxford & IBH Publishing Co. New Delhi. 181 pp.
21. Pollard, E, D. O. Elias, M. J. Skelton & J. A. Thomas (1975). A method of assessing the abundance of butterflies in Monks Wood national Nature Reserve in 1973. *Entomological Gazette* 26: 79-88.
22. Pollard, E. (1977). A method for assessing changes in abundance of butterflies. *Biological Conservation*: 12: 116-134.
23. Shubhalaxmi, V. & Chaturvedi, N. (1999). Abundance and distribution of Moths of the Families Saturnidae and Sphingidae in Sanjay Gandhi National Park, Mumbai. *Journal of Bombay Natural History Society* 96(3):379-386.
24. Solow, A. R (1993). A simple test for change in community structure. *Journal of Animal Ecology* 62: 191-193.
25. Spitzer, K., J. Jaros, J. Havelka, & J. Leps (1997). Effects of small-scale disturbance on butterflies of an Indochinese montane rainforest. *Biological Conservation*. 80: 9-15.
26. Talbot, G. (1939). The Fauna of British India including Ceylon and Burma (Butterflies), I: (Published by Taylor and Francis, London) xxix+506 pp., 2pls., 1 map..

27. Thomas, C.D. (1991). Habitat use and geographic ranges of butterflies from the wet lowlands of Costa Rica. *Biological Conservation* 55: 269-281.
28. Vane-Wright, RI, C. J. Humphries & P. H. Williams (1991). What to protect?- systematics and the agony of choice. *Biological Conservation* 55: 235-254.
29. Vidya, R. A. (1996). *Butterflying in namdapha*. Hornbill1996 (4). PP. 4-6.In: Wilson, EO (ed.). The little things that run the world (the importance and conservation of invertebrates). *Conservation Biology:* 1: 344-346.
30. Wolda H. (1989). Seasonal cues in tropical organisms. Rainfall? Not necessarily! *Oecologia* 80: 437-442.
31. Wolda, H & F. W. Fisk (1981). Seasonality of tropical insects. II. Blattaria in Panama. *Journal of Animal Ecology* 50: 827-838.