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Abundance and Diversity Gradient of Butterflies from Urban to Rural Habitats in Udaipur District, Rajasthan, India

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ABSTRACT

Rapid expansion of urbanization and industrialization are major reasons for biodiversity decline in urban area. Urbanization causes habitat fragmentation, alteration and lack of vegetation due to cutting of trees and human settlements and causes negative impact on butterflies diversity, abundance and evenness.The present study focuses on uncovering the significant gaps related to butterfly biodiversity in the study area and how the urbanization is affecting the overall ecology of butterflies in the urban, sub-urban and rural areas of district Udaipur.Study area has been divided in four categories on basis of percentage of vegetation and its composition in the study areas as Urban Site 1 (US1)with 5% - 8% vegetation followed by Urban Site 2 (US2)with 20% -30%vegetation, Sub Urban Site (SUS) with almost 40% -50% vegetation and Rural Area Site (RAS)which consists of almost 90% - 95% vegetation including herbs, shrubs, trees and crop plants. During the present studytotal 69 species of butterflies were recorded together from all four study areas. The minimum number of butterfly diversity, abundance and evenness was recorded in Urban Site 1 (US1)(Shanon-Wiener Diversity Index=2.132, Simpson Diversity Index=0.8496, Brillion Index-=1.993,Menhinick's Index=0.9864, Margalef's Index=2.201, Chao-1Index=12, Equability-J Evenness Index= 0.8578) and maximum butterfly diversity, abundance and evenness was recorded in Rural Area Site (RAS)(Shanon-Wiener Diversity Index=3.663, Simpson Diversity Index=0.9638, Brillion Index=3.556, Menhinick's Index=1.831, Margalef's Index=8.863, Chao-1Index=92, Equability-J Evenness Index=0.8807). Overall Beta Diversity of the four study areas wasrecordedwith the help of different indexes like Whittaker Beta Diversity Index=0.864, Cody's Beta Diversity Index=35 and Mourelle Index=0.315 of study area. The present study concludes that Rural Area Site (RAS) is rich in butterfly diversity and shows highabundance due to present of high density and variety of vegetation in this site.

Keywords: Urbanization, Diversity, Abundance, Evenness, Vegetation.

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INTRODUCTION

Butterflies are very beautiful and charming invertebrateand are key species of an ecosystem playing there important role in various ways in terrestrial ecosystems (Robbins and Opler 1997). Simultane-

ously they act as agood bio-indicator in analysing the health of various ecosystems. In the present time, natural habitats and plant species including herbs, shrubs and trees are rapidly declining due to rapid expansion and infrastructural developments in the urban and surrounding sub-urban and rural areas and establishment of various industrial areas in the same. These developments are one of the main causes for decline in vegetation and rich biodiversity of the local areas (Blair 1997, Bliar and Launer 1997, Clak et al. 2007, Tiple et al. 2007). Urbanization is becoming major threat and responsible factor for reduction in overall global biodiversity (Wilcove et al. 1998) and leads to overall modification and alteration in the habitats of different faunal species including insects. Butterfly richness and abundance are signs of good environmental health condition, while opposite of the sameis an indicator of polluted and poor quality ecosystem (Dwari and Mondal 2015). Butterflies and their larval stages usually feed upon host plants and show host-specific relationship and co-evolutionary process. The overall species richness and abundance of butter flies heavily depends upon variety of plant species including herbs, shrubs and cultivated plants (Padhyeet al. 2001). Most of the butterflies prefer particular habitats only and show periodic and seasonal variations in their life cycle throughout year (Kunte1997). Butterflies link different food chain and are important key connectors in the food webs in an ecosystem, while playing an important role of food resource to different faunal species including birds, reptiles, spiders and predatory insects. They are very sensitive and susceptible towards the changes in climate and environmental conditions even at micro level with respect to temperature, humidity, pollution and availability of host plants in an ecosystem (Thomas et al. 1998, Kunte 2000). Many species of animals, including butterflies and insects are rapidly declining and are becoming rare and even some species are facing risk due to loss of vegetation and high pollution of different types and enormous anthropogenic activities like urbanization, industrialization, construction of roads and buildings, habitat destruction, deforestation, forest fires, illegal collection of specimen and excessive use of insecticide and pesticides occurring in the vicinity of these natural habitats leading to decline in biodiversity in various ecosystems of the Earth (Ramesh et al. 2010,Rosin et al. 2010).

Study on butterflies has been started during 18th century and almost 19,238 species are discovered worldwide presently (Heppner 1998) and discovery of new species of butterflies is appearing to be a continuous and constant process throughout different continents of the world (Green and Huang 1998, Barua et al. 2004, Ambrose and Raj 2005, Alphonsa 2006, Chandra et al. 2007, Parag and Omkaar 2009). Entomologists and other related enthusiasts has documented around 1504 butterflies species widely distributed throughoutin the Indian subcontinent which includes 100 endemic and threatened butterfly species as per IUCN Red list of threatened animals (Singh and Pandey 2004,Tiple 2011). Very few studies have been conducted on butterflies in the southern part of the state Rajasthan particularly district Udaipur. Total 40 butterfly species were recorded in native vegetation and Prosopisjuliflora dominated area of Udaipur district, Rajasthan (Choudhary and Chishty 2020) which mainly belongs to four families of insects namely Papillionidae (12 species), Lycanidae (10), Nymphalidae (15) and Hespridiae (3).

MATERIALS AND METHODS

Study area

Udaipur is located in southern part of Rajasthan in Aravalli ranges, between 24°34’16.5720’’N latitude and 73°41’29.5584’’E longitude. Udaipur city area is surrounded by Aravalli hillranges with elevation range of 558 meter to 767 meter above sea level. The study area is specified by three remarkable seasons summer (March-June), Monsoon (July-October) and winter (November- February) with an average annual precipitation of 540-580mm. The average temperature of study areas is 6.8°C in winter season and a maximum temperature of upto 44°C in summer season. Urban area of Udaipur consist of different types of microhabitats which has a rich potential of enhancing biodiversity due to presence of numerous number of seasonal and perennial water bodies, agricultural land, fragmented forest areas including Sajjangarh Wildlife Sanctuary and rich floral species.

Study area has been divided in four categories on basis of percentage of vegetation and its composition in the study areas as Urban Site 1 (US1)with 5% - 8%

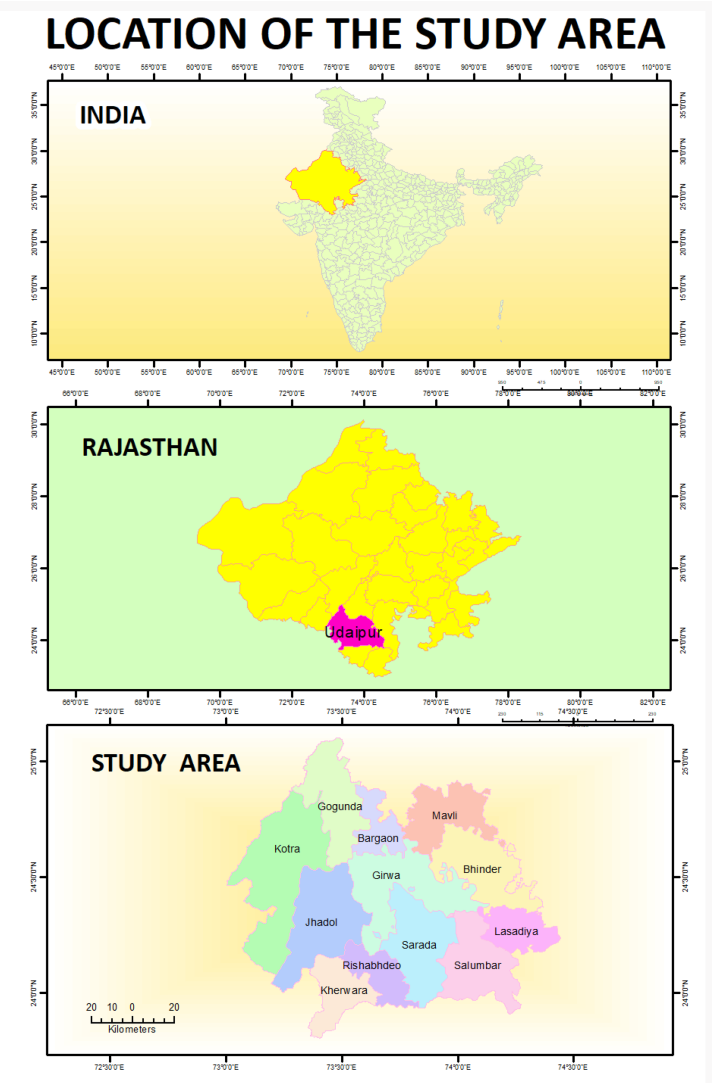

Figure 1. Geographic location of different study sites in Udaipur district.

vegetation followed by Urban Site 2 (US2)with 20% -30%vegetation, Sub Urban Site (SUS) with almost 40% -50% vegetation and Rural Area Site (RAS) which consists of almost 90% - 95% vegetation including herbs, shrubs, trees and crop plants.

Regular surveys were conducted to search for butterfly during the time period of August 2017 to December 2019. Data was collected twice a month using line transect, point count and quadrates methods from different localities of four study areas. Different study sites were divided in almost equal size of two linestransects and two quadrates. Length of transect was kept approximately 500 meter long and 5 meter wide where butterflies were easily identified by without capturing the specimen. Size of eachquadratewas kept 200 meter wide and 200 meter long. For observation the study site was visited twice a

day during time periods 8:00 am -11:00 am and 4:00 pm -7:00 pm. Identification of butterflies was done by using standard field guide and literature (Evans 1932,Wynter-blyth 1957, Gay et al. 1992, Haribal 1992,Kunte 2000, Kehimar 2008).

Statistical analysis

Alpha and Beta Diversity Indexes were calculated usingsoftware's SPSS and PASTandbutterfly diversity, species richness, abundance and evenness was calculated using following formula:-

Simpson's Diversity Index -It is generally used for biodiversity measuring in the study area.

Simpson's Diversity Index = 1-D

where D=Dominance

Shannon Diversity Index –It is used for the comparison of two or more study areas or sites in the biological community.

$$H_s = \sum\_(^{s}_{i=1}) = PilnPi$$

where Pi= i is the proportion of individuals found in the ithspecies represented in natural logarithm.

Brillouin Diversity Index- The index calculates and reflect the species abundance in the study area.

$$H_{B=} \left(\frac{\ln(\ N!)-\Sigma \ln(ni!)}{N}\right.$$

Where N = Total number of individuals in the community, ni = The number of individuals in the ithspecies.

Menhinick's Richness Index - The ratio of the number of taxa/ species to the square root of sample size.

$$D_{mn} = \left(\ ^{S}\!/_{\sqrt{N}}\ \right)$$

where N = Total number of individuals in sample size, S=Number of species in sample.

Margalef's Richness Index:

Margalef's Richness Index= $\left(\ ^{S-1}_{\ln(n)}\right)$

where S = the number of taxa/ species, n =the number of individuals.

Equitability J- Shannon diversity divided by the logarithm of number of taxa. This measures the evenness with which individuals are divided among the taxa present. This indices used for a calculated of equitability comparison of the Shannon- Weiner index and used for against the distribution of individuals between the observed species, they are widely distributed.

$$J = \left(\frac{H}{Log\ (S)}\right)$$

where S= Total number of species in sample size, H= Shanon-weiner index.

Chao-1- This index uses for the estimate of species richness in different habitat or area, proposed by (Chao 1984).

$$\hat{S}_{max} = S_{obs} + (a^2/2b)$$

where Sobs= Actual number of species present in sample, a = Number of species represented by a single individuals, b= Number of species represented by two individuals.

Beta diversity indices

Beta diversity calculates the species diversity with transects and it is mainly applicable on the analysis of environmental gradients. It is calculated on the basis of two different variables, the number of selective habitats within a region and the replacement of species by another disconnected part of same habitat.

1. **Whittaker's Beta Diversity Index**

$$\beta w = (S/\alpha) - 1$$

Where S= the total number of species recorded in study area, α = Average of species richness of the sample.

2. **Cody's Beta Diversity Index**

$$\beta c = g\ (H) + I\ (H)^2$$

Where g (H) = Number of species recorded in study area, I (H) = the number of species absent along transect.

Mourelle Index

$$B_{me} = \left(\frac{g\,(H) + 1\,(H)}{2a\quad (N\ -\ 1)} \right)$$

RESULTS AND DISCUSSION

During the present study total 69 species of butterflieswere observed in the study areas,which belongs to five families viz. Papillionidae(4), Pieridae (20), Lycanidae(21), Nymphalidae (19)and Hesperiidae(5). Out of them only 12 species of butterflies were observed in Urban Site 1 (US1) followed by 24 species observed in Urban Site 2 (US2), 48 species in Sub Urban Site (SUS) and maximum butterfly species were observed and recorded from Rural Area Site (RAS) (Table 1). Various diversity indexes were utilized during the present study to calculate the abundance and richness of butterfly species in the study areas. Shanon-Wiener Diversity Indexshowed maximum butterfly diversity in RAS (3.663), followed by SUS (3.251),US2 (2.515) and US1 (2.132).Similarly Simposon-Diversity Index showed maximum butterfly diversity in RAS (0.9638), followed by SUS (0.947),US2 (0.887) and US1 (0.8496).

Abundance estimation of butterflies of different areas was done through using Brillion Diversity Index which showed minimum abundance of butterflies was observed in US1 (1.993) followed by US2 (2.358), SUS (3.107) and maximum abundance was recorded in RAS (3.556). Butterfly richness was calculated through Menhinick's richness index, Margalef's richness index and Chao-1 richness indices. Value of Menhinick's index was obtained 0.9864 in US1 followed by 1.556 in US2, 2.019 in SUS and 1.831 in RAS. Margalef's Richness Index value was calculated to be 2.201(US1) followed by 4.203 (US2), 7.417 (SUS) and maximum richnesscalculatedwas 8.863 (RAS). According to Chao-1 species richness indices; minimum richness were observed in US1 (12), followed by US2 (45), SUS (83) and maximum richness observed was in RAS (92). Species evenness was calculated by using Equitability-J Index and following values of species evenness was obtained 0.8578 in US1 followed by 0.7914 in US2, 0.8399 in SUS and maximum evenness 0.8807 was observed in RAS. Figures 1 and 2 shows comparative analyses graphically shown for butterfly abundance and richness respectively in different study sites of the study area Udaipur depicting both maximum abundance and richness for butterflies for RAS and minimum for US1.

Over all beta diversity of butterflies of study

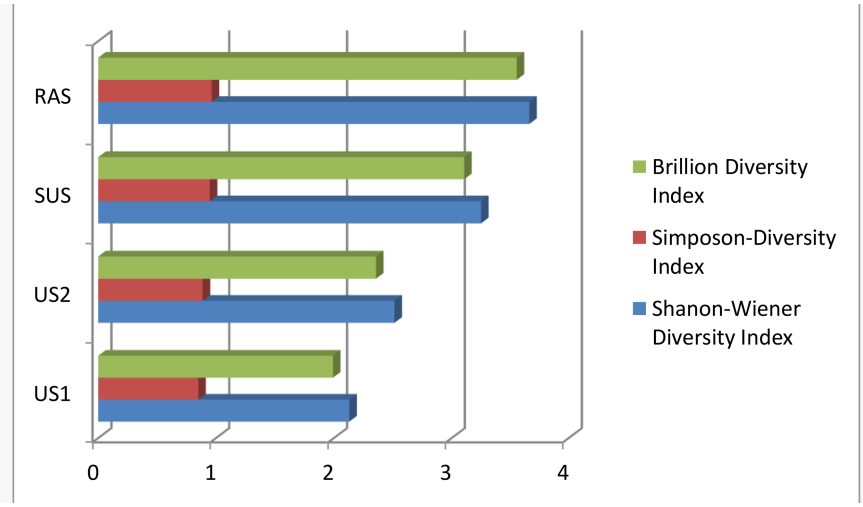

Figure 2. Comparative analyses of various abundance estimates for butterflies in different study sites in the study area of Udaipur (RAS = Rural Area Site, SUS = Sub Urban Site, US2 = Urban Site 2, US1 = Urban Site 1).

Table 1. Butterflies recorded from differnt sites in the study area of Udaipur. Note : + Means species present in study area, –means-species absent in study area.

Common name and families	Zoological name	Urban Site 1 (US1)	Urban Site 2 (US 2)	Sub-Urban Site (SUS)	Rural Area Site (RAS)
Papillionodae					
1 Tailed Jay	*Graphiumagamemnonagamemnon (Linnaeus 1758)*	–	+	+	+
2 Indian Common mormon	*Papiliolytesromulus (Cramer 1775)*	–	–	+	+
3 Lime butterfly	*Papiliodemoleus (Linnaeus 1758)*	+	+	+	+
4 Malabar Raven	*Papiliodravidarum (Wood-Mason*	–	+	+	+
Pieridae					
5 Small grass yellow	*Euremabrigitta (Cramer 1780)*	+	+	+	+
6 Common grass yellow	*Euremahecabe (Linnaeus 1758)*	–	+	+	+
7 Indian Spotless grass yellow	*Euremalaetalaeta (Boisduval 1836)*	–	–	+	+
8 Oriental Mottled Emigrat	*Catopsiliapyranthepyranthe (Linnaeus 1758)*	–	+	+	+
9 Common Emigrant	*Catopsiliapomonapomona (Fabricius 1775)*	–	+	+	+
10 Common gull	*Ceporanerissa (Fabricius 1775)*	–	–	–	+
11 Indian Little orange tip	*Colotisetrida (Boisduval 1836)*	–	–	+	+
12 Caper white	*Belenoisaurota (Fabricius 1793)*	–	–	–	+
13 White orange tip	*Ixias marianne (Cramer 1779)*	–	–	–	+
14 Yellow Orange tip	*Ixias pyrene (Fabricius 1764)*	–	+	+	+
15 Common/Indian Jezebel	*Delias eucharis (Drury 1773)*	–	–	+	+
16 Oriental Psyche	*Leptosianinanina (Fabricius 1793)*	–	–	+	+
17 Western Striped Albatross	*Appiaslibythea (Fabricius 1775)*	–	+	+	+
18 White Arab	*Colotisvestalis (Butler 1876)*	–	–	–	+
19 Modest Small Salmon Arab	*Colotisamatamodesta (Butler 1876)*	–	–	+	+
20 Dakhan Large Salmon Arab	*Colotisfaustafulvia (Wallace 1867)*	–	–	–	+
21 Blue Spotted Arab	*Colotisprotractus (Butler 1876)*	–	–	–	+
22 Red Line Small grass yellow	*Euremabrigitta rubella (Wallace 1867)*	–	+	+	+
23 Indian Orange Albatross	*Appiasgalba (Wallace 1867)*	–	–	+	+
24 Sahyadri Albatross	*Appiaswardii (Moore 1884)*	–	+	+	+
Lycaenidae					
25 Indian Tiny	*Zizulalylaxhylax (Fabricius 1775) grass blue*	+	–	–	+
26 Grass Jewel	*Freyeriatrochylus (Freyer 1845)*	+	–	–	+
27 Zebra blue	*Leptotesplininusplinius (Fabricius 1793)*	–	–	+	+
28 Gram blue	*Euchrysopscnejuscnejus (Fabricius 1798)*	+	–	+	+
29 Pea blue	*Lampidesboeticus (Linnaeus 1767)*	–	–	–	+
30 Striped pierrot	*Tarucusnara (Kollar 1848)*	–	–	+	–
31 Spotted pierrot	*Tarucuscallinara (Butler 1886)*	–	–	+	–
32 Black spotted pierrot	*Tarucusbalkanicanigra (Bethune-Baker 19180*	--	–	–	+
33 Lesser grass blue	*Zizinaotis (Fabricius 1787)*	–	–	–	+
34 Indian cupid	*Cupidolacturnus (Godart 1824)*	–	–	–	+
35 Small cupid	*Chiladesparrhasiusparrhasius (Fabricius 1793)*	–	–	+	+
36 Indian Lime blue	*Chiladeslajuslajus (Stoll 1780)*	–	–	–	+
37 Pale grass blue	*Pseudozizeeriamaha (Kollar 1884)*	–	–	+	+
38 Indian Common silverline	*Spindasisvulcanusvulcanus (Fabricius1775)*	–	+	+	+
39 Bright Babul Blue	*Azanusubaldus (Stoll 1782)*	–	+	+	+
40 Common Pierrot	*Castaliusrosimon (Fabricius 1775)*	–	+	+	+
41 Angled Pierrot	*Caletadecidia (Hewitson 1876)*	–	–	–	+
42 Oriental Plains Cupid	*Chiladespandavapansava (Horsfield 1829)*	–	+	+	+
43 Dark Pierrot	*Tarucusananda (de Niceville 1884)*	–	–	–	+

Table 1. Continued.

	Common name and families		Urban Site 1 (US 1)	Urban Site 2 (US 2)	Sub-Urban Site (SUS)	Rural Area Site (SUS)
44	Common Acacia blue	*Surendraquercetorum (Moore 1858)*	+	+	+	+
45	Indian Peacock Royal	*Tajuriacippuscippus (Fabricius 1798)*	–	–	+	+
Nymphalidae						
46	Danaideggfly	*Hypolimnasmisippus (Linnaeus 1764)*	–	+	+	+
47	Oriental Great eggfly	*Hypolimnasbolinajacintha (Drury 1773)*	+	+	+	+
48	Blue pansy	*Junoniaorithya (Linnaeus 1758)*	–	–	+	+
49	Peacock pansy	*Junoniaalmana(Linnaeus 1758)*	+	+	+	+
50	Yellow pansy	*Junoniahierta (Fabricius 1798)*	–	–	–	+
52	Grey pansy	*Junoniaatlites (Linnaeus 1763)*	+	–	+	+
53	Lemon pansy	*Junonialemonias (Linnaeus 1758)*	+	+	+	+
54	Common evening brown	*Melanitisleda (Linnaeus 1758)*	–	–	+	+
55	Dark evening brown	*Melanitisphedima (Cramer 1780)*	–	+	–	–
56	Common castor	*Ariadne merione (Cramer 1777)*	+	+	+	+
57	Common leopard	*Phalantaphalantha (Drury 1773)*	–	–	+	+
58	Plain tiger	*Danauschrysippus (Linnaeus 1758)*	+	+	+	+
59	Striped tiger	*Danausgenutia (Cramer 1779)*	–	+	+	+
60	Blue tiger	*Tirumalalimniace (Cramer 1775)*	–	+	+	+
61	Indian common crow	*Euploea core core (Cramer 1780)*	–	–	+	+
62	Indian Extra Lascar	*Pantoporiasandakadavidsoni (Eliot 1969)*	–	–	+	+
63	Chocolate pansy	*Junoniaiphita (Cramer 1779)*	–	–	–	+
64	Common four ring	*Ypthimahuebneri (Kirby 1871)*	–	–	–	+
Hesperiidae						
65	Brown Awl	*Badamia exclamations (Fabricius 1775)*	–	–	–	+
66	Common small flat	*Sarangesadasahardasahara (Moore 1866)*	–	–	+	+
67	Indian Pale palm dart	*Telicotacolon colon (Fabricius 1775)*	–	–	–	+
68	Indian Bush Hopper	*Ampittiadioscoridesdioscorides*	–	–	+	–
69	Spotted small flat	*Sarangesapurendra (Moore 1882)*	–	–	+	+
	Total number of species recorded in different study sites		12	24	48	64

area was calculated from Whittaker's Beta Diversity Index, Cody's Beta Diversity Index and Mourelle Index. Value of different Beta Diversity Indices obtainedwas 0.86486 forWhittaker's Beta Diversity Index, 35 forCody's Beta Diversity Index and 0.31 Mourelle Indexinclusively for all study areas.

Butterflies importance in agriculture

Butterflies show wide range of food choices and host specific relationship with plant to complete its life cycle. They plays important role in all ecosystems including forest, agricultural land and gardens. They pollinate various cropping plants all around year. They are excellentpollinator which helps incross pollination and hence increase production of crops all around world. Butterfly diversity and abundance are important part of agro ecosystem; they primarily creates link between plants and animals in food chains. Butterfly and other insects performs dual roles as a pollinator and control pests in agro ecosystem. In present time excessive use of pesticides and chemical in agricultural become limiting factors for butterflies survival and distribution. They are very sensitive to change in environment so its study helpful in determine changes in environment and habitats.

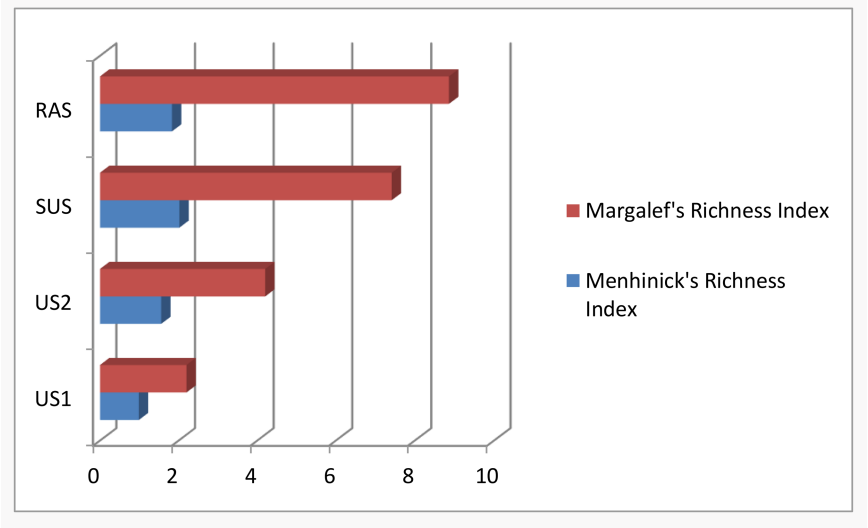

Figure 3. Comparative analyses of various richnss estimates for butterflies in different study sites in the study area of Udaipur (RAS = Rural Area Site, SUS = Sub Urban Site, US2 = Urban Site 2, US1 = Urban Site 1).

CONCLUSION

The present study represents total 69 butterfly species belonging to five families observed and recorded during the study period. Present study is important in understanding therelationship betweenurbanizationand its effects on butterfly diversity, density and abundance. Butterfly richness, abundance and diversity was observed andrecorded lowest in the urban area due to lack of flowering plants, natural vegetation and abundance of various anthropogenic activity centres and pollution. While maximum butterfly richness, abundance and diversity was recorded in the rural areas due to high density of plant community including flowering plant and cropsand less anthropogenic disturbances. Different plant species and crop plantsprove to bea suitable habitat for survival and sustainability of butterflies as they are direct good sources of food, nectar and shelter to themwhich is supported by different indices of abundance and richness and hence indicatethat vegetation is important for the survival and existence of butterflies.

REFERENCES

Alphonsa X (2006) Butterfly fauna of Government arts and Science College campus, Kozhikode, Kerala. Zoos' Print J 21 (3) : 2263—2264.

Ambrose P. D. and Raj D. S. (2005) Butterflies of Kalakad-Mundanthurai tiger reserve, Tamilnadu. Zoos'Print J 20 (12) : 2100 —2107.

Barua K. K., Kakati D., Kalita J. (2004) Present Staus of Swallowtail butterflies in Garbhanga reserve forest, Assam, India. Zoos' Print J 19 (4) :1439—1441.

Blair R.B, Launer A.E. (1997) Butterfly diversity and human land use: Species assemblages along an urban gradient. BiolConser 80 : 113—125.

Chandra K., Sharma R. M., Singh A., Singh R. K. (2007) A checklist of butterflies of Madhya Pradesh and Chhattisgarh States, India. Zoos' Print J 22 (8) : 2790—2798.

Chao A. (1984) Non-parametric estimation of the number of classes in a population. Scand. J. Stat. 11 : 265—270.

Clark P.J. Reed J.M., Chew F.S. (2007) Effects of urbanization on butterfly species richness, guild structures, and rarity: Urban Ecosystem 10 : 321—337.

Cody M.L. (1975) Towards a theory of continental species diversities: bird distributions over Mediterranean habitat gradients. Ecology and Evolution of Communities (eds Cody M.L. and Diamond J.M.), pp. 214—257. Belknap Press, Harvard.

Dwari S., Mondal A.K. (2015) Butterflies diversity of Agricultural fields of Howrah district, West Bengal, India with special reference to their host plants in Agroecosystem.Int.J.Sci and Nature 6 (3) : 389—396.

Evans W.H. (1932) The identification of Indian Butterflies, Bombay Natural History Society, Bombay.

Gay T., Kehimkar I.D., Punetha J.C. (1992) Common Butterflies of India. WWF-India and Oxford University Press, Mumbai, India, 88.

Green J., Huang A. (1998) Butterflies of South Vancouver

Island. Co-op resort. Royal British Columbia Museum. Available online at: http://rbcm.gov.bc.ca/nhpapers/ anneh/ text/coverpage.html

Haribal M.(1992) Butterflies of the Sikkim Himalaya and its Natural History. Sikkim Nature Conservation Society Publication, Gangtok, 217.

Heppner J. (1998) Classification of Lepidoptera. Holarctic. Lep. 5 (1) : 148.

Kehimkar I. (2008) The book of Indian Butterflies, Bombay Natural History Society and Oxford University Press, Mumbai.

Kunte K. (1997) Seasonal patterns in butterfly abundance and species diversity in four tropical habitats in northern Western Ghats. J. Biosci. 22 : 593—603.

Kunte K. (2000) Butterflies of Peninsular India, Universities Press, Hyderabad, India.

Kunte K.J.(2000) Butterflies of Peninsular India. Indian Academy of Science, Bangalore and University press, Hyderabad.

Magurran A. E. (1988) Ecological diversity and its measurement. London: Chapman and Hall.

Mourelle C., Ezcurra E. (1997) Differentiation diversity of Argentine cacti and its relationship to environmental factors. J. Veg. Sci. 8 : 547—558.

Narayan Lal Choudhary, Nadim Chishty (2020) Com parative study of butterfly between native vegetation and Prosopisjulifloradominated area in Udaipur district, Rajasthan. Int. J.Entomol. Res. Volume 5, issue 1; January 2020; page no- 70-73.ISSN- 2455—4758.

Padhye A.D., Pachoper S.A., Ghodke Y. (2001) Ant genera distribution across habitats of Pune city. J. Ecol. and Envi ronm.Sci. 23 : 173—178.

Parag E., Omkar D. (2009) Three additions to the known butterfly (Lepidotera: Rhopalocera and Grypocera) fauna of Goa, India. J. Threatened Taxa. 1(5) : 298—299.

Pielou E. C. (1975) Ecological Diversity. New York, Wiley Inter Science.

Ramesh T., Hussain K.J., Selvanayagam M., Satpathy K.K., Prasad M.V.R. (2010) Patterns of diversity, abundance and habitat associations of butterfly communities in heterogeneous landscapes of the department of atomic energy (DAE) campus at Kalpakkam, South India. Int. J.Biodiver.andConserv. 2 : 75—85.

Robbins R. K., Opler P. A. (1997) Biodiversity II, Under standing and protecting our biological resources, Joseph Henry Press, Washington DC.

Rosin Z.M., Myczko L., Piotr S., Lenda M., Moron D., Sparks T.H., Tryjanowski P. (2012) Butterfly responses to environmental factors in fragmented calcareous grassland. J.Insect Conserv. 16 : 321—329.

Singh A. P., Pandey R. (2004) A model for estimating but terfly species richness of areas across the Indian subcontinent: species proportion of Papilionidae as an Indica tor. J.Bombay Nat. Hist. Soc. Bombay 101 : 79—89.

Southwood T.R.E., Henderson P.A. (2000) Ecological Methods. Blackwell Science, Oxford.

Thomas J. A., Simox D. J., Wardlaw J.C., Elms W.G., Hochberg M.E., Clark R.T.(1998) Effects of latitude, altitude and climate on the habitat and conservation of the endan gered butterfly Maculineaarion and its Myrmica and host. J. Sect. Conserve. 2 : 39—46.

Tiple A.D.Khurad A.M., Dennis R.L.H. (2007)Butterfly diversity in relation to a human-impact gradient on an Indian university campus. Nota Lepidoptera logica30 (1) : 179—188.

Wilcove D.S. Rothstein D.,Dubow J., Phillips A.,Losos E. (1998) Quantifying threats to imperiled species in the United States.Biosci. 48 (8) : 607—615.

Wynter-Blyth M.A. (1957) Butterflies of the Indian Region, Bombay Natural History Society, Mumbai, pp. 523.