A COMPARATIVE STUDY AND SEASONALITY OF BUTTERFLY FAUNA AT TWO SELECTED SITES, JUNAGADH, GUJARAT, INDIA

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ABSTRACT

The order Lepidoptera includes both butterflies and the moths. Butterflies are most essential creatures for the environment, which have the potential value towards the pollinating agents. Butterflies are elegant flying representatives of nature. Butterflies have mutual relationships with the plants and both are coevolved on the track of evolution. The present study represents the seasonal diversity of butterfly fauna at two different study areas. These two sites were the Bhakta Kavi Narsinh Mehta University campus and an agro land area of Junagadh district, Gujarat. The study period was from February 2019 to February 2020. Total 60 species belonging to 5 families were recorded from both the sites. Where in 54 species were recorded from the agro land site and 36 species were recorded from Bhakta Kavi Narsinh Mehta University campus site. 30 species were found at both the studied sites. The number of individuals from the family Lycaenidae (33%) was highest followed by Pieridae (28%), Nymphalidae (25%), Papilionidae (7%), and Hesperiidae (7%). The behavioral activities of butterflies were also noted. Butterfly diversity was observed highest in the September 2019. Up to the monsoon butterfly numbers increased and after the monsoon its number tends to be slowly decreased.

Keywords: Butterfly, Diversity, Pollinating agents, Lepidoptera, Junagadh

INTRODUCTION

Butterflies are insects belonging to the phylum Arthropoda. Taxonomically order Lepidoptera includes both butterflies the moths. In animal taxonomy, the phylum Arthropoda has highest diversity and population on the earth as compare to all other animal phylum. In which the class insecta plays a major role in co-ordination with agriculture field as pollinator. Butterflies are masterpiece of art and beauty of Nature (Rafi *et al.*, 2000). Butterflies are known as the Bio-indicators. Lepidoptera are appreciated for their aesthetic value and also beneficial as pollinators, silk producers and indicators of healthy environment. Some of the lapidopterans are responsible for economic loss as they feed on crops. Butterflies Behavioral studies shows that butterfly use their wings to sense infra-red and visible radiation responding with specialized behaviors to prevent over heating their wings (Cheng *et al.*, 2020).

There are about 18,000 species of butterfly in the world (Kehimkar, 2008), out of which India comprises 1501 species of butterflies (Parasharya and Jani, 2007). For the butterfly and moth there is a common classification up to order but many morphological and behavioral differences do exist between them.

Butterflies are elegant flying creatures of nature not only adding brilliance to their surroundings but also pollinating flowers and revealing the healthiness of the communities (Suryanarayana *et. al.*, 2018). Butterflies maintain the ecosystem by acting as pollinator, prey, biological pest controlling agent, inducing genetic variation among plants, and enhancing environmental beauty (Ghazanfar *et al.*, 2016). All the stages of the butterfly's life cycle are threatened by the predators or other creatures. Many species of insectivorous birds depends on the caterpillars or pupa of butterfly for their food. They are utilized as food by a number of animals, including birds, spiders, and lizards.

MATERIALS AND METHODS

Study area

Junagadh is one of the city of Saurashtra region, located at the foot of the Girnar hills. Girnar is one of the favorite destinations for tourists. The geographical coordinates: 21° 31' 0" North, 70° 28' 0" East. In

Junagadh district an annual rainfall of 1492.2 mm was recorded in the year 2019. The average temperature was 25.6 °C (http://www.jau.in).

Site-A: There were two sites selected for the survey of butterfly diversity. The first site was agriculture field which is located at Patrapasar village, Taluka and District-Junagadh. Site-A located at 70°23'19" E longitude and 21°34'9"N latitude. The vegetation contains crop lands, plantation of mango and lemon plants. The River named Uben is located just near the farm (site-A) and river was the source of water for the irrigation. The seasonal crops were grown in the farm. Total land area is eight acres, out of which the plantation of mango trees in 6 acres, plantation of lemon plants in one acre and the rest of one acre was diverse vegetation cropland.

Site-B: The second site was Bhakta Kavi Narsinh Mehta (BKNM) University campus near the Dungarpur village in the Junagadh district. It is located at 70°30'12"E longitude and 21°26'14"N latitude. Many flowering plants are planted in the campus. The Government polytechnic college is situated just beside the university campus. The highway road is just near to the campus and many anthropogenic activities continue at site B.



Fig 2: Map of Junagadh District, Gujarat, India (Source of image: https://www.google.com/maps/place/Junagadh+Gujarat)





 Figure 3 A: study site-A
 Figure 3 B: study site-B

 (Source of image: http://googleearth.com)

The study of butterfly diversity was conducted by the pollard walk method (Pollard, 1977). Where the study area was divided into 5 fixed transect for the site-A and 4 transect for site-B. Morning (9 am) to mid noon (4 pm) time period was chosen for the survey because butterflies are observed very much active in this time duration. During the survey sighted butterflies were observed, the food plants, individual numbers of butterfly species and their activity were noted. Most of the butterflies photographed by the camera (Canon Power Shot SX500 IS) and by mobile phone in the field. A few butterflies were observed, and identified by standard identification keys (Kehmikar 2008, Kunte 2000).

Statistical Analysis:

The statistical analysis was conducted with the help of PAST (version-3) software. Diversified statistical measures were used in the study of butterfly diversity which is given below:

1. Simpson Diversity Index-D:

Simpson diversity index measured by D. It calculates proportion of species concerned to total number of species. If the diversity of community increases the value of index increased. The value of D is increases as richness increases. The formula is:

$$D = \underline{\Sigma(n-1)}$$

(N-1)

Where,

n = Number of individuals,

N = Total number of individuals in community.

2. Shannon-Weiner Index:

This index proposed by the Shannon and Weiner (1949). The index represented by the symbol H'.

 $H'=-p\sum_{i}^{k}i \ln p$

Where,

H' = Shannon diversity index,

Pi = Proportion of individuals of species.

3. Margalef Index:

The Margalef Diversity Index (Margalef, 1958) defines as 'd' calculated by:

 $d = (S-1) / \ln N$

4. Berger-Parker Dominance:

It is represented by the most abundant species in the community. The Dominance is symbolized by D.

$$D = \underline{Nmax}$$

N Where,

Nmax = Number of individuals of most abundant species, N = Total number of individuals in community.

RESULTS AND DISSCUSSION

During the study total 60 species belonging to 5 families were found from both the site-A and site B, out of which 54 species found from the agro land and 36 species found from the BKNM university campus site. 30 species were commonly found at both the studied sites. Papilionidae (4), Pieridae (17), Nymphalidae (15), Lycaenidae (20) and Hesperiidae (4) species were observed.



Figure 4: Percentage of various families of butterflies

In present study Lycaenidae showed the highest percentage with twenty species from both the sites, followed by Pieridae with seventy species, Nymphalidae with fifteen species and Papilionidae and Hesperiidae both have four species. In which lime swallowtail and common rose butterflies belong to Papilionidae were recorded from the both sites. As mentioned in (Fig. 4).



Figure 5: Month wise numbers of individuals of both the sites

At site-A maximum number of individuals, (341) were found in September and minimum number twenty found in February 2019. At site-B highest numbers of individuals (298) were found in September and lowest numbers of butterflies eighty seven were found in December 2019. Highest numbers of individuals were found in post monsoon season (September 2019) at both the studied sites, as per our observation September 2019 was breeding season (Fig. 5).

At site-A, Pioneer species *Belenois aurota* (Fabricius, 1793) was observed thirty nine times and Small grass yellow *Eurema brigitta* (Stoll, 1780) observed thirty three times so, both were dominant. The Blue tiger *Tirumala limniace* (Cramer, 1775) and Mottled emigrant *Catopsilia pyranthe* (Linnaeus, 1758) were observed three times in the study period.





While at site-B Dark grass blue *Zizeeria karsandra* (Moore, 1865) was observed twenty eight times and Tiny grass blue *Zizula hylax* (Fabricius, 1775) observed twenty six times, so, both were dominant, whereas the Painted lady *Vanessa cardui* (Linnaeus, 1758) was observed only one time during the study period. Month wise butterfly population shows that Pieridae has highest numbers of individuals with nine hundred fourteen individuals during the study period, following from the Lycaenidae has three seventy four individuals, Nymphalidae has three twenty eight individuals, one forty five individuals from the Papiliionidae, and Hesperiidae has lowest in a peak with seventy one individuals of butterflies. As mentioned in (Fig. 6).





Total seven species of butterflies from our study comes under the Wildlife Protection Act 1972. The Lycaenidae has highest four species under the scheduled which are *Lampides boeticus* (Linnaeus, 1767), *Euchrysops cnejus* (Fabricius, 1798), *Rapala varuna* (Horsfield, 1829) and *Castalius rosimon* (Fabricius, 1775) followed by Pieridae has two species *Cepora nerissa* (Fabricius, 1775) and *Appias libythea* (Fabricius, 1775), Nymphalidae has one species *Hypolimnas misippus* (Linnaeus, 1764) under the WPA 1972. As mentioned in (Fig.7).



Figure 8: Family wise Genera and Species of Butterflies

Lycaenidae has fifteen genera followed by Nymphalidae which has ten genera, Pieridae has eight genera, Papilionidae has three and Hesperiidae also has three genera. In Pieridae highest five species from the genera *Colotis* was reported, in Nymphalidae 4 species from the genera *Junonia*, in Pieridae four species from the genera *Eurema* and Lycaenidae has three species from the genera *Chilades*. As mentioned in graph (Fig. 8).

No.	Population Index	Site-A	Site-B		
1	Simpson Diversity Index [1-D]	0.88	0.82		
2	Shannon-Weiner Index H'	2.29	1.84		
3	Margalef Index	1.59	0.85		
4	Berger-Parker Dominance	0.18	0.26		

Statistical Analysis of the data

Simpson Index value for site-A was 0.88 as compared to site-B which was 0.82 the Shannon diversity also highest in Agriculture site which was 2.29. Margalef index is law at site-B which was 0.85 and Berger-Parker dominance which defines the most abundant species, the value was 0.26 which was high in site-B.

If we compare the obtained results with previous researches, we found that, Nair *et al.*, (2014) recorded forty nine species of butterflies belonging to five families and thirty six genera from Sarojini Naidu college campus Kolkata. Gohel and Raval (2019) studied butterfly diversity from three sites of Junagadh district. They recorded thirty two species from the BKNM University campus. They recorded species like tawny coster, joker, Orange emigrant and crimson tip which were we have not found from the BKNM University campus.

Table	1:	Butterfly	family,	common	name,	scientific	name,	wildlife	protection	act	1972	schedule
status and occurrence of species at both sites:												

S -	lly				Wildlife	Occurr-	
No. Ha		Comm	on Name	Scientific Name	Act (1972) Schedule	Site -A	Site -B
1	lae	1.	Common rose	Pachliopta aristolochiae (Fabricius, 1775)		+	+
2	nic	2.	Lime swallowtail	Papilio demoleus (Linnaeus, 1758)		+	+
3	ilio	3.	Common Mormon	Papilio polytes (Linnaeus, 1758)		+	-
4	Pap	4.	Tailed jay	Graphium Agamemnon (Linnaeus, 1758)		+	-
5		1.	Common jezebel	Delias eucharis (Drury, 1773)		+	-
6		2.	White orange tip	Ixias marianne (Cramer, 1779)		+	+
7		3.	Pioneer	Belenois aurota (Fabricius, 1793)		+	+
8		4. yellow	Spotless grass	Eurema laeta (Boisduval, 1836)		+	+
9		5.	Little orange tip	Colotis etrida (Boisduval, 1836)		+	-
10		6.	Large salmon Arab	Colotis fausta (Olivier, 1804)		+	-
11		7.	Crimson tip	Colotis danae (Fabricius, 1775)		+	-
12		8. yellow	Three spot grass	Eurema blanda (Boisduval, 1836)		+	+
13	lae	9.	Small salmon Arab	Colotis amata (Fabricius, 1775)		+	-
14	eric	10.	Small grass yellow	Eurema brigitta (Stoll, 1780)		+	+
15	Pi	11.	Lemon emigrant	<i>Catopsilia pomona</i> (Fabricius, 1775)		+	+
16		12.	Plain orange tip	Colotis aurora (Cramer, 1780)		+	-
17		13.	Common gull	Cepora nerissa (Fabricius, 1775)	Π	+	-
18		14. albatro	Western Striped ss	Appias libythea (Fabricius, 1775)	IV	+	-
19		15.	Yellow orange tip	Ixias pyrene (Linnaeus, 1764)		+	+
20		16. yellow	Common grass	Eurema hecabe (Linnaeus, 1758)		+	+
21		17.	Mottled emigrant	Catopsilia pyranthe (Linnaeus, 1758)		+	+
22		1.	Plain tiger	Danaus chrysippus (Linnaeus, 1758)		+	+
23		2.	Lemon pansy	Junonia lemonias (Linnaeus, 1758)		+	+
24		3.	Blue pansy	Junonia orithya (Linnaeus, 1758)		+	+
25	lae	4.	Painted lady	Vanessa cardui (Linnaeus, 1758)		+	+
26	phalid	5.	Tawny coster	Acraea terpsicore (Linnaeus, 1758)		+	-
27	Nym]	6.	Great egg fly	Hypolimnas bolina (Linnaeus, 1758)		+	+
28		7.	Joker	Bybliai lithyia (Drury, 1773)		+	-
29		8.	Blue tiger	Tirumala limniace (Cramer, 1775)		+	+
30		9. brown	Common evening	Melanitis leda (Linnaeus, 1758)		+	+

31		10.	Angled Castor	Ariadne ariadne (Linnaeus, 1763)		+	+
32		11.	Peacock pansy	Junonia almana (Linnaeus, 1758)		+	+
33		12.	Danaid egg fly	<i>Hypolimnas misippus</i> (Linnaeus, 1764)	Ι	+	+
34		13.	Yellow pansy	Junonia hierta (Fabricius, 1798)		+	-
35		14. brown	Dark evening	Melanitis phedima (Cramer, 1780)		+	-
36		15.	Common three ring	Ypthima asterope (Klug, 1832)		-	+
37		1.	Pea blue	<i>Lampides boeticus</i> (Linnaeus, 1767)	II	+	-
38		2. cupid	Oriental plains	<i>Chilades pandava</i> (Horsfield, 1829)		+	-
39		3.	Dark grass blue	Zizeeria karsandra (Moore, 1865)		+	+
40		4.	Gram blue	<i>Euchrysops cnejus</i> (Fabricius, 1798)	II	+	-
41		5.	Striped pierrot	Tarucus nara (Kollar, 1848)		+	+
42		6.	Indigo flash	Rapala varuna (Horsfield, 1829)	II	+	-
43		7.	Zebra blue	Leptotes plinius (Fabricius, 1793)		+	+
44		8.	Lime blue	Chilades lajus (Stoll, 1780)		+	-
45		9.	Little tiger pierrot	Tarucus balkanica (Freyer, 1844)		+	+
46	nidae	10.	Small cupid	<i>Chilades parrhasius</i> (Fabricius, 1793)		+	+
47	Lycae	11.	Common silverline	Spindasis vulcanus (Fabricius, 1775)		+	+
48		12.	Tiny grass blue	Zizula hylax (Fabricius, 1775)		+	+
49		13. silverli	Common shot	Spindasis ictis (Hewitson, 1865)		+	-
50		14.	Tailless lineblue	Prosotas dubiosa (Semper, 1879)		+	-
51		15.	Indian sunbeam	Curetis thetis (Drury, 1773)		+	-
52		16.	Common red flash	Rapala iarbus (Fabricius, 1787)		+	-
53		17.	Lesser grass blue	Zizina otis (Fabricius, 1787)		-	+
54		18.	Apefly	Spalgis epius (Westwood, 1851)		-	+
55		19.	Common pierrot	<i>Castalius rosimon</i> (Fabricius, 1775)	Ι	-	+
56		20. jewel	Black spotted grass	Freyeria putli (Kollar, 1844)		-	+
57	lae	1.	Lesser rice swift	Borbo bevani(Moore, 1878)		+	+
58	riid	2.	Rice swift	Borbo cinnara (Wallace, 1866)		+	+
59	spe	3.	Smaller dartlet	Oriens goloides (Moore, 1881)		+	-
60	Ie	4.	Oriental palm bob	Suastus gremius (Fabricus, 1798)		-	+

Basavrajappa *et al.*, 2018 studied butterfly composition and diversity in Karnataka. In which they recorded one thirty eight species and calculates Anova of butterfly diversity (Basavrajappa *et al.*, 2018). Karmakar *et al.*, 2018 reported early stages and larval host plants of seventy eight butterfly species, few of them were rare and endemic (Karmakar *et al.*, 2018).

Gandhi and Kumar, 2015 studied on diversity, abundance and utilization of plant resources in Vadodara, Gujarat. In their study Nymphalidae and Pieridae families shows high number of butterfly species, nectar resources like *Lantana camara, tridex procumbens* and *Ixora coccinea* (Gandhi and Kumar, 2015).

Biswas et al., 2019 recorded eighty two species of butterflies belongs to six families during their study period at Mindapore, West Bengal (Biswas et al., 2019). Adhikari and Kulkarni, 2020 sighted two species of butterfly's which were common Onyx Horaga, Onyx cingalensis (Moore, 1857) and Purple-spotted Flitter, Zographetus ogygia (Hewitson, 1866) were rare butterflies in Northern Western Ghats (Adhikari and Kulkarni, 2020).

Sometimes many adult butterflies are eaten by the insectivorous birds. Many spider species directly feed on butterflies which are caught in their webs, and some spiders lie in and wait on flowers, whenever the butterfly try to nectar from flower, spiders will grasp them. We found some incidence where spiders were consuming butterfly (Fig .9). The natural dwelling places of butterflies being destroyed by the anthropogenic pressure. So, maintaining natural habitat will help conserving the butterfly. In current scenario butterfly gardening has a certain economical scope by attracting the tourist.

CONCLUSION

The present study shows that site-A was comparatively rich in the population of butterfly as compared to the site-B. The study shows the seasonal fluctuation in the butterfly diversity. Species like dark grass blue, small grass yellow, plain tiger, tiny grass blue and lemon emigrant were commonly recorded from both the sites. Species like Common pierrot, Apefly, common three ring, Black spotted grass jewel and Palm bob were recorded only at BKNM university campus site. While common jezebel, Pea blue, Gram blue, indigo flash, and Indian lime blue were recorded only in Agriculture field site. Based on study we can conclude that the species richness was highest at site-A because of the vegetation composition was good as compare to the site-B.



Figure 9: Tarucus balkanica captured by a spider while nectaring

Family: Papilionidae





Lime Swallowtail Common Rose **Papilio** Polytes Papilio demoleus Pachliopta aristolochiae Figure 10a: Photographs of Butterflies Observed During the Study



Common Mormon



Tailed Jay Graphium agamemnon

Family: Pieridae



Common Jezebel *Delias eucharis*

Family: Nymphalidae



White Orange Tip Ixias marianne



Crimson Tip *Colotis danae*



Plain Orange Tip Colotis aurora



Plain Tiger Danaus chrysippus

Family: Lycaenidae



Peacock Pansy Junonia almana



Blue Pansy Junonia orithya



Tawny Coster Acraea terpsicore



Plains Cupid Chilades pandava

Family: Hesperiidae



Rice Swift Borbo cinnara



Zebra Blue Leptotes plinius



Shot Silverline Spindasis ictis



Common Pierrot Castalius rosimon



Lesser Rice swiftSmaller DartletIndiBorbo bevaniOriens goloidesSuaFigure 10b: Photographs of Butterflies Observed During the Study



Indian Palm Bob *Suastus gremius*

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