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REVIEW ARTICLE

ASSESSMENT OF HOST-PLANTS AND THEIR INTERACTION WITH THE DIFFERENT SPECIES OF BUTTERFLIES IN GIR PROTECTED AREA, GUJARAT, INDIA

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ABSTRACT

The present study is based on host-range and food preferences of butterflies, encountered in and adjacent to the Gir National Park, Gujarat, India. The larval host plants of 67 butterfly species were identified and their host specificity, abundance, perennation were recorded. Out of 74 host-plants, 22 were identified as annuals, 3 bi-annual and 49 perennials. These plant species are further categorised as to belong to different plant categories which include 21 trees, 22 herbs, 24 shrubs, 6 Climbers and one species of plant parasite. The findings revealed that the plant species belonging to families Memosaceae, Capparaceae and Caesalpiniceae were found most suitable food for butterfly species belonging to the 4 different families of butterflies in GNP. In addition, a number of significant differences between butterfly families and their host use patterns such as perination, host specificity etc. were studies and identified. Correlation coefficient ($r = 0.785$) confirms a strong correlation between host plants and butterflies and was found significant at 1% level ($p = 0.01$). Hence, more number of host-plant species attracts significantly more species of butterflies.

INTRODUCTION

During the past century numerous researches have been conducted and findings have been published on insect host plant interactions by earlier researchers. These have been primarily dealt with natural history, but many are theoretical as well (Brues 1946 and Gilbert 1972). Due to high degree of host - specificity, most of the butterflies appear to select their host plants on the basis of secondary products chemistry rather than on the basis of general ecological consideration. Other groups of insects are fewer hosts specific, and with these insects ecological theories have progressed (Gilbert 1972). However, with regard to herbivores such as butterflies, purely ecological data and theory apart from natural history observation is quite scarce (Gilbert and Singer 1975). The foundation for the study of insects host plant relationships were clearly delineated by Charles T. Brues in 1920' s (Brues 1920, 1924). Brues used three categories of phytophagous insects which are still widely used. Insects which feed on a definite few host plant species and those which feed upon a wide variety of host plant species are called oligophagous and polyphagous respectively. The chemicals are characteristic of the host plant used by butterfly, this causes the butterfly to oviposit on the correct type of host plants (Schoonhoven, 1973). The idea of coevolutionary balance between host plant resistance and herbivore "virulence" was used by Ehrlich and Raven (1964) to explain the observed pattern of butterfly/ host plant taxonomic relationship.

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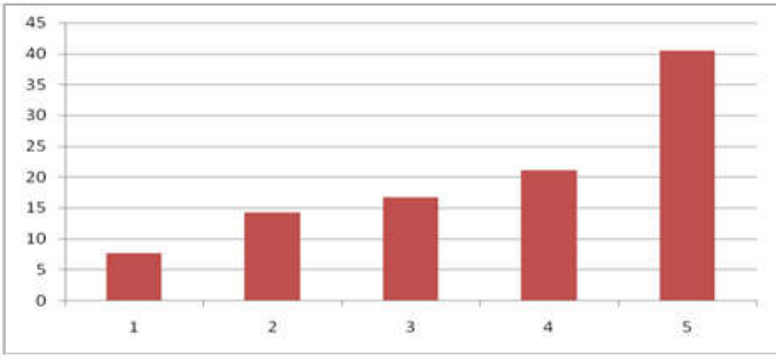
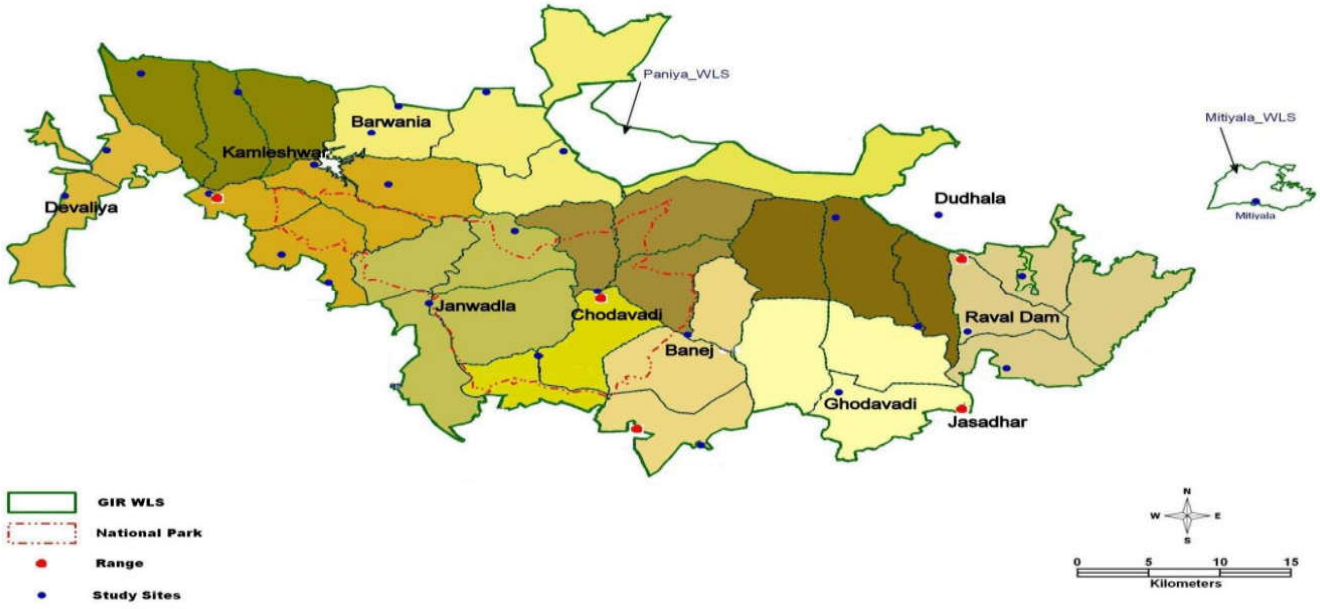
Thus, the relationship between any given butterfly species and its host plant is very specific. Among all the resources required by butterflies that comprise a habitat (Dennis *et al*. 2003, 2006; Dennis 2010), the larval hostplants are the key resource, being fundamental for reproduction. Knowledge of butterfly host plants is a prerequisite for any butterfly conservation programme. Therefore, it is necessary to know the exact needs of the immature stages to make conservation successful (New *et al.* 1995). But, knowledge concerning larval host plants is still poor in the case of many butterfly species, especially in the tropics (Kunte 2000). As such, the present study focuses on larval host plant use in the butterflies of biotopes within the confines of GPA Gujarat, India, building on the work of previous scientists. Janz, *et al.*,(2006) stated that Plant-feeding insects make up a large part of earth's total biodiversity. While it has been shown that herbivory has repeatedly led to increased diversification rates in insects, there has been no compelling explanation for how plant-feeding has promoted speciation rates. As per the recent report, a total of about 606 plant species (*viz.,* 245 spp of herbs, 128 spp of trees, 101 spp of shrubs, 85 spp of climbers and 47 spp of grasses) have so far been reported from GPAs (Meena and Sandeep, 2012).

MATERIALS AND METHODS

Study sites: Constitution of the study site contained Teak forest mixed with dry deciduous species.The flora of Gir forests published by the FRI in 1955 is comprised 403 species of plants which was updated later to 606 species by some later identification (Meena and Sandeep, 2012).



Percentage contribution of plant habits in Gir Protected areas ((1-grass, 2-climber, 3-shrub, 4-trees, 5-herb)



(Source: *Meena & Sandeep, 2012*)

Different Forests Ranges as selected study-sites in GPA

Some flowering and many nonflowering plants which appear during rains, were also identified far later after various research and monitoring program in Gir. The vegetation changes along with west to east axis. Thirteen vegetation types were categorized by Chavan (1993), eleven habitat types were identified by Khan (1993) and fifteen vegetation associations were categorized in Gir Protected Area.The study- sites were selected in GPA and observations on assessment of host – range of various species of butterflies were recorded in all the 10 selected study- sites Gir Protected Areas, located in the Saurashtra peninsula of Gujarat India (20^{o} 40' N to 21^{o} 50' N and 70^{o} 50' E to 71^{o} 15' E) extended upto 1412.1 sq. kms. The original biome in the area was very dry teak forest which falls under the type 5A/Cla. During the survey female butterflies were followed and the eggs were collected along with the plant parts on which eggs were laid. The foliage was also searched, along with other plant parts for eggs and larvae. The larvae observed during the survey were collected and brought to the laboratory along with their host plant leaves for rearing. The cage containing larvae were cleaned daily before old foliage was replaced by new leaves. The pupae were left in the cages undisturbed until their adult eclosion, and authentic identification. Although some larvae and broods were lost du to mortality, larvae were often sufficiently distinct to identify to species level. Butterfly species and larval host-plants were scored for a number of variables which were considered to influence herbivory. Butterfly species were distinguished for their host- specificity. Host - plants were scored for their growth or habit (such as herb, shrub, tree, climber, stem parasites),biotope (wild, cultivated and exotic), abundance (rare, frequent and abundant) and perennation (annual, biannual and perennial). These variables include common occurrence of the host - plant along with herb or shrubs track edges at rock face or wall, along stream or river bank and on hill tops *etc*. Those plants that were difficult to identify in the field were photographed or preserved by making dry herbarium sheet specimens including all details of plants for futher identification. The test specimens were later identified and confirmed by the expert of the Botanical Survey of India and Zoological Survey of India, Jodhpur. Data on oviposition, larval feeding and butterfly numbers were collected from ten study-sites during the year 2011-2012 in GNP.

Table 1. List of different species of butterflies showing their major host-plants and host-specificity

S.No	Familiy	Genus	Species	Host-plant (Family)	Host-plant specificity	*Host plant*
1	Papilionidae	Papilio	*polytes*	Rutaceae	P*	*Aegle marmelos, citrus limon, Murraya Koenigii*
2	Papilionidae	Papilio	*Demoleus linnaeus*	Rutaceae	P	*Aegle marmelos, citrus limon, Murraya Koenigii*
3	Papilionidae	Pachliopta	*Aristolochiae Fabricius*	Aristolochiaceae	M**	*Aristolochia indica*
4	Papilionidae	Pachliopta	*hector*	Aristolochiaceae	M	*Aristolochia indica*
5	Papilionidae	Graphium	*Agamennon linnaeus*	Magnoliceae Annonaceae	P	*Michelia champaca* *Polylathia longifolia*
6	Papilionidae	Graphium	*nomius*	Annonaceae	M	*Polylathia longifolia*
7	Nymphalidae	Danaus	*chrysippus linnaeus*	Asclepiadaceae Verbenaceae Asteraceae	P	*Calotropis gigantia, Ceropegia bulbosa* *Lantana spp.,* *Helianthus annus, Emilia sonchifolia*
8	Nymphalidae	Danaus	*genutia Cramer*	Asclepiadaceae Verbenaceae Asteraceae	P	*Calotropis gigantia, Ceropegia bulbosa* *Lantana spp.,* *Helianthus annus, Emilia sonchifolia*
9	Nymphalidae	Euploea	*Core Cramer*	Apocynaceae Acanthaceae Periplocaceae Moraceae	P	*Nerium indicum,* *Barleria prionitis* *Hemidesmus indicus* *Ficus bengalensis, Ficus religiosa*
10	Nymphalidae	Hipolimnas	*missipus Linnaeus*	Acanthaceae Malvaceae	P	*Barleria prioniti* *Hibiscus ovalifolius,Hibiscus rosa sinensis,Hibiscus lobatus, Hibiscus Sabdariffa, Abutilon indicum*
11	Nymphalidae	Hipolimnas	*bolinia*	Acanthaceae Malvaceae	P	*Barleria prioniti* *Hibiscus spp. , Abutilon indicum*
12	Nymphalidae	Junonia	*orithiya Linnaeus*	Acanthaceae Malvaceae Mimosaceae	P	*Barleria prioniti* *Sida spp.* *Mimosa spp.*
13	Nymphalidae	Junonia	*lemonias Linnaeus*	Acanthaceae Malvacea	P	*Barleria prioniti* *Sida spp.*
14	Nymphalidae	Junonia	*hierta Fabricus*	Acanthaceae Malvaceae	p	*Barleria prioniti* *Sida spp.*
15	Nymphalidae	Junonia	*iphita*	Acanthaceae Malvaceae	P	*Barleria prioniti* *Sida spp.*
16	Nymphalidae	Junonia	*almana linnaeus*	Acanthaceae Malvaceae Verbenaceae	P	*Barleria prioniti* *Sida spp.* *Phyla nodiflora*
17	Nymphalidae	Acraea	*violae Fabricus*	Passifloraceae Capparaceae Urticaceae	P	*Passiflora edulis* *Capparis spp.* *Pouzolzia zeylanica*
18	Nymphalidae	Ariadne	*ariadne Linnaeus*	Euphorbiaceae	M	*Ricinus communis*
19	Nymphalidae	Ariadne	*merione*	Euphorbiaceae	M	*Ricinus communis*
20	Nymphalidae	Phalanta	*phalanta*	Flacourtiaceae	M	*Flacourtia indica*
21	Nymphalidae	Trirumala	*limniace Cramer*	Asclepiadaceae	P	*Calotropis gigantia, Calotropis procera,*
22	Nymphalidae	Cynthia	*cardui*	Asteraceae	P	*Blumea fistulosa, Blumea membranacea,Blumea glomerata, Blumea mollis, Echinops echinatus*
23	Nymphalidae	Melanitis	*leda*	Poaceae	P	*Sorghum halepense, Zea mayas,*
24	Nymphalidae	Melanitis	*phedima*	Poaceae	M	*Grasses*
25	Nymphalidae	Ypthima	*asterope*	Poaceae	M	*Grasses*
26	Nymphalidae	Mycalesis	*spp.*	-	-	-
27	Nymphalidae	Euthalia	*nais*	Dipterocarpaceae	M	*Shorea robusta*
28	Nymphalidae	Charaxes	*fabius*	Caesalpiniaceae	P	*Tamarindus indica, Piliostigma malabaricum*
29	Nymphalidae	Byblia	*ilithyia*	Euphorbiaceae	P	*Ricinus communis, Jatropha curcas*
30	Pieridae	Delias	*eucharis Drury*	Loeanthaceae	M	*Dendropthoe faleata*
31	Pieridae	Ixias	*pyrene Linnaeus*	Capparaceae	P	*Capparis grandis, Capparis sepiaria*
32	Pieridae	Ixias	*marianne Cramer*	Capparaceae	M	*Maerua oblongiflora*
33	Pieridae	Anaphaeis	*aurota*	Capparaceae	M	*Cleome viscose,*
34	Pieridae	Eurema	*brigitta*	Caesalpiniaceae	M	*Cassia spp.,*
35	Pieridae	Eurema	*hecabe*	Caesalpiniaceae Mimosaceae	P	*Cassia fistula, Cassia tora* *Pithecellobium dulce, Albizia Spp.*
36	Pieridae	Eurema	*laeta*	Caesalpiniaceae	M	*Cassia pumila*
37	Pieridae	Eurema	*blanda*	Caesalpiniaceae Mimosaceae	P	*Cassia fistula, Cassia tora* *Pithecellobium dulce, Albizia Spp.*
38	Pieridae	Cepora	*nerissa*	Capparaceae	M	*Cleome viscose,*
39	Pieridae	Appias	*libythea*	Capparaceae	M	*Capparis sepiaria*
40	Pieridae	Parenonia	*valeria*	Capparaceae	P	*Capparis heyneana, C. Zeylanica*
41	Pieridae	Catopsilia	*pomomna*	Caesalpiniaceae	P	*Cassia fistula, Cassia tora*
42	Pieridae	Catopsilia	*pyranthe*	Caesalpiniaceae	P	*Cassia fistula, Cassia tora*
43	Pieridae	Catopsilia	*florella*	Caesalpiniaceae	p	*Cassia fistula, Cassia tora*
44	Pieridae	Catopsilia	*crocale*	Caesalpiniaceae	P	*Cassia fistula, Cassia tora*
45	Pieridae	Catopsilia	*duvivieri*	Caesalpiniaceae	P	*Cassia fistula, Cassia tora*
46	Pieridae	Colotis	*etrida*	Salvadoraceae	M	*Salvodora persica*
47	Pieridae	Colotis	*danae*	Capparaceae	M	*Cleome viscose,*

Continue….

48.	**Pieridae**	**Colotis**	***eucharis***	**Capparaceae**	**M**	***Cadaba indica***
49.	Pieridae	Colotis	*fausta*	Capparaceae	M	*Maerua arenaria*
50.	Pieridae	Colias	*fieldii*	Capparaceae	M	*Cleome viscose,*
51.	Pieridae	Colotis	*amata*	Salvadoraceae	P	*Salvadora persica, S. oleoides*
52.	Lycaenidae	Tarucus	*nara*	Rhamnaceae	P	*Zizyphus glabrata, Zizyphus mauritiana, Zizyphus oenoplia, Zizyphus xylopyrus, Zizyphus nummularia.*
53.	Lycaenidae	Euchrysops	*cnejus Fabricus*	Fabaceae Mimosaceae	P	*Tephrosia purpurea, erythrina indica* *Albizia lebbek*
54.	Lycaenidae	*Zizera*	*lysimon*	Amarantaceae Leguminosae	P	*Amarantus gracilis* *Zornia diphylla*
55.	Lycaenidae	*Curetis*	*thetis*	Leguminosae Meliaceae	P	*Pongamia pinnata, Derris scandens, Abrus precatorius,*
56.	Lycaenidae	*Rapala*	*iarbus*	Combretaceae Mimosaceae	P	*Quisqualis indica* *Acacia spp.*
57.	Lycaenidae	*Catlius*	*rosimon*	Rhamnaceae	P	*Zizyphus mauritiana, Zizyphus oenoploea*
58.	Lycaenidae	*Spindasis*	*vulcanus*	Rhamnaceae	P	*Zizyphus mauritiana, Zizyphus rugosa*
59.	Lycaenidae	*Catochysops*	*strabo*	Fabaceae	P	*Tephrosia purpurea,Desmodium spp.*
60.	Lycaenidae	*Leptotes*	*plinius*	Fabaceae Mimosaceae	P	*Indigofera spp.* *Albizzia lebbeck*
61.	Lycaenidae	*Lampides*	*boeticus*	Fabaceae	P	*Erthrina spp. Butea spp.*
62.	Lycaenidae	*Spindasis*	*ictis*	Loranthaceae	M	*Dendrophthoe spp.*
63.	Lycaenidae	*Tarucus*	*therophrastus*	Rhamnaceae	M	*Zizyphus rotundifolia*
64.	Lycaenidae	*Azanus*	*ubaldus*	Fabaceae Mimosaceae	P	*Taphrsposia purpurea; Erthrina indica* *Albizzia lebbeck*
65.	Lycaenidae	*Faegana*	*sp.indt*	-	-	-
66.	Lycaenidae	*Dendoryx*	*Epijarbas*	Sapindaceae Puniceae	P	*Sapindus emarginatus* *Punica granatum*
67.	Lycaenidae	*Azanus*	*Jeasons*	Mimosaceae	p	*Acacia leucophloea Acacia ferruginea*

*Polyphagous ** Monophagous

Different type of habitats was sampled. Butterflies were monitored, collected in different seasons as per the methodology of Pollard and Yates (1993). The sites differ in biotopes (vegetation structure) and in resources of butterflies (*eg*. larval host plants, flowering nectar plant species and physical structures used for oviposition and breeding).The relative abundances of butterfly species, were obtained from the transect records taken within confined bounds while walking at a steady path as per the methodology adopted by Tiple *et al*., (2009, 2010). Although, transect counts do not provide absolute estimates of butterfly populations owing to their different biotope association and conspicuousness to recorders, are not directly comparable (Dennis *et al*., 2006), the large range in numbers obtained for different species are regarded here as adequately reflecting relative differences in population sizes of butterfly species. Oviposition and breeding records, as well as nectar use and plant distributions, were obtained during independent surveys in the same sites.

RESULTS AND DISCUSSION

Larval host-plant database: A total of 67 species of butterflies were observed and recorded from ten study-sites of Gir Protected Area in Gujarat during the extensive field surveys, conducted in different seasons during 2011- 2012. The host-plants of all the species of butterflies were authentically identified except two species *viz.Mycalesis sp.*and *Faegana sp.,* which could not be identified because these species were always observed flying fast over the river reservoirs. A list of butterflies along with their host- plants has been presented in Table- 1. During the present study, it has been recorded that out of 6 species of family Papilionidae only two species *viz., Papilio polytes* and *Papilio demoleus* prefers to feed on the three plant species such as *Aegle marmelos, citrus limon* and *Murraya Koenigii,* belonging to family Rutaceae and both these species of butterflies are polyphagous in nature. One species belonging to genus *Graphium i.e.,Graphium agamennon* also exhibited polyphagy, while feeding on variety of host-plants *i.e., Michelia champaca, Polylathia longifolia* etc., of families Magnoliceae and Annonaceae whereas other species of genus *Graphium i.e., Graphium nomius* was noticed to feed on a single host-plant *i.e., Polylathia longifolia,* exhibiting its monophagous nature. Furthermore, other two species of family papilionidae, *Pachiliopta aristolochiae* and *P. hector* are monophagous in nature and both the species are highly host-specific in nature. and feed on *Aristolochia indica* of family Aristolochiaceae. Hence, the family Papilionidae represented by three polyphagous and three monophagous species in GPA. The second next family of butterflies of GPA *i.e*., Nymphalidae is represented by 23 species ; out of which 7 species are monophagous and rest of the 16 species are polyphagous in nature. Only two species (*Danaus crysippus* and *D. genutia*) of genus *Danaus* were observed feeding on different host-plants *viz., Calotropis gigantia, Ceropegia bulbosa, Lantana species, Helianthus annus* and *Emilia sonchifolia* of family Ascelepiadaceae, Verbenaceae and Asteraceae respectively, while majority of the species (8 species) such a *Euploea core, Hipolimnas missipus, H. bolinia* and all five species of Junonia are polyphagus in nature and prefer to feed on *Barleria prioniti, Hibiscus species* and *Sida species* plants belonging to families Acanthaceae and Malvaceae. Both the species of genus Ariadne and one species of *Byblia i.e., Byblia ilithyia* were seen to feed on *Ricinus communis* (Euphorbiaceae) and is monophagous is nature. Whereas, three other species (*viz*., *Melanitis leda, M. phedima* and *Ypthima asterope*) belonging to genus Melanitis prefer to feed on family Poaceae representing grasses. It is also noticed that each species of the genus Euthalia *i.e.,Euthalia nais* and genus Charaxes *i.e., Charaxes fabius,* were highly host-specific and monophagus in nature because they feed only on *Shorea robusta* of (Dipterocarpaceae) and *Tamarindus indica* (Caesalpiniaceae). It has been observed that all the species belonging to the family Pieridae prefer to feed mainly on the family of Capparaceae and Caesalpiniaceae. 11 species were seen feeding on family of Capparaceae; out of which 2 (*Ixias pyrene* and *Perenonia valeria*) are polyphagous and they

Table 2. Family- genera and species-wise distribution of butterflies in GPA

S.No.	Family	Common Names	Genera	Species
1.	Pailionidae	Swallowtail butterflies	3	6
2.	Pieridae	White and yellow butterflies	10	22
4.	Lycaenidae	Blues, hairstreaks & gossamer-winged butterflies	13	16
3.	Nymphalidae	Brush-footed butterflies	15	23
		Total	41	67

Table 3. Utilization of plant families as larval host plants by species of butterflies at Sasan gir National Park

S.No.	Host Plant Family	Papilionidae	Pieridae	Nymphalidae	Lycaenidae
1.	Rutaceae	2	0	0	0
2.	Aristolochiaceae	1	0	0	0
3.	Magnoliceae	1	0	0	0
4.	Annonaceae	2	0	0	0
5.	Asclepiadaceae	0	0	3	0
6.	Verbenaceae	0	0	3	0
7.	Asteraceae	0	0	3	0
8.	Periplocaceae	0	0	1	0
9.	Moraceae	0	0	1	0
10.	Malvaceae	0	0	7	0
11.	Mimosaceae	0	1	1	4
12.	Passifloraceae	0	0	1	0
13.	Capparaceae	0	10	1	0
14.	Urticaceae	0	0	1	0
15.	Euphorbiaceae	0	0	2	0
16.	Flacourtiaceae	0	0	1	0
17.	Poaceae	0	0	3	0
18.	Dipterocarpaceae	0	0	1	0
19.	Caesalpiniaceae	0	8	1	0
20.	Loeanthaceae	0	1	0	1
21.	Salvadoraceae	0	2	0	0
22.	Rhamnaceae	0	0	0	4
23.	Fabaceae	0	0	0	5
24.	Amarantaceae	0	0	0	1
25.	Leguminosae	0	0	0	2
26.	Meliaceae	0	0	0	1
27.	Sapindaceae	0	0	0	1
28.	Apocynaceae	0	0	1	0
29.	Acanthaceae	0	0	8	0
30.	Combretaceae	0	0	0	1
31.	Comneraceae	0	0	0	1
32.	Puniceae	0	0	0	1
	Total	6	22	39	22

Table 4. Data collected to establish correlation between host-plant species and butterfly species pertaining to their abundance and herbivory

S.No.	Host Plant Family	Host plant species	Number of host plant species	Number of Butterfly species	Number of Butterfly family
1.	Rutaceae	*Aegle marmelos, citrus limon, Murraya Koenigii*	3	2	1
2.	Aristolochiaceae	*Aristolochia indica*	1	1	1
3.	Magnoliceae	*Michelia champaca*	1	1	1
4.	Annonaceae	*Polylathia longifolia*	1	2	1
5.	Asclepiadaceae	*Calotropis gigantia, Ceropegia bulbosa*	2	3	1
6.	Verbenaceae	*Lantana spp.,*	1	3	1
7.	Asteraceae	*Helianthus annus, Emilia sonchifolia*	2	3	1
8.	Periplocaceae	*Hemidesmus indicus*	1	1	1
9.	Moraceae	*Ficus bengalensis, Ficus religiosa*	2	1	1
10.	Malvaceae	*Hibiscus ovalifolius,Hibiscus rosa sinensis,Hibiscus lobatus, Hibiscus Sabdariffa, Abutilon indicum, Sida spp.*	6	7	1
11.	Mimosaceae	*Mimosa spp. Acacia leucophloea Acacia ferruginea, Albizzia lebbeck,Mplumbago zeylanicaimusa, Pithecellobium dulce,*	6	6	3
12.	Passifloraceae	*Passiflora edulis*	1	1	1
13.	Capparaceae	*Cleome viscose, Cadaba indica, Maerua arenaria, Capparis heyneana, C. Zeylanica, Capparis grandis, Capparis sepiaria, Maerua oblongiflora*	8	10	1
14.	Urticaceae	*Pouzolzia zeylanica*	1	1	1
15.	Euphorbiaceae	*Ricinus communis, Jatropha curcas*	2	2	1

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16.	Flacourtiaceae	*Flacourtia indica*	1	1	1
17.	Poaceae	*Sorghum halepense, Zea mayas, Grasses*	3	3	1
18.	Dipterocarpaceae	*Shorea robusta*	1	1	1
19.	Caesalpiniaceae	*Tamarindus indica, Piliostigma malabaricum, Cassia fistula, Cassia tora Pithecellobium dulce, Albizia Spp.*	6	8	2
20.	Loeranthaceae	*Dendropthoe faleata*	1	1	1
21.	Salvadoraceae	*Salvadora persica, S. oleoides*	2	2	1
22.	Rhamnaceae	*Zizyphus glabrata, Zizyphus mauritiana, Zizyphus oenoplia, Zizyphus xylopyrus, Zizyphus nummularia, Z. rugosa*	6	4	1
23.	Fabaceae	*Taphrsposia purpurea, Erthrina indica, Butea spp., Desmodium spp.*	4	5	1
24.	Amarantaceae	*Amarantus gracilis*	1	1	1
25.	Leguminosae	*Zornia diphylla, Pongamia pinnata, Derris scandens, Xylia dolabriformis*	4	2	1
26.	Meliaceae	*Abrus precatorius, Heynia trijuga*	2	1	1
27.	Sapindaceae	*Sapindus marginatus, S. trifoliatus*	2	1	1
28.	Apocynaceae	*Nerium indicum,*	1	1	1
29.	Acanthaceae	*Barleria prioniti*	1	8	1
30.	Combretaceae	*Quisqualis indica*	1	1	1
31.	Conneraceae	*Connarus wightii,*	1	1	1
32.	Puniceae	*Punica granatum*	1	1	1

Table 5. Correlation between butterflies and host plant species

	Host Plant species	Butterfly species	Butterfly families
Host Plant species	1		
Butterfly species	0.784731**	1	
Butterfly families	0.45418**	0.39366*	1

feed on the 4 species of host-plants (*Capparis grandis, C. sepiaria, C.heyneana and C. zeylanica*) whereas rest 9 species such as *Ixias Marianne, Anaphaeis aurota, Cepora nerissa, Appias libythea*, 3 species of genus Colitis *i.e*., *Colotis eucharis, C. danae, C. fausta* and 1 species of genus Colias (*Colias fieldii*) are monophagous in nature. 9 species prefer to feed on Caesalpiniaceae, out of these 2 species (*Eurema brigitta* and *E. Laeta*) were seen feeding on only one species of Cassia and exhibit their monophaguos nature, whereas remaining species (*E. hecabe, E. blanda*, all species of genus Catopsilia such as *Catopsilia pomomna, C. pyranthe, C. florella, C.crocale and C. duvivieri*) are polyphaguos in nature and feed on different host-plants *viz*., *Cassia fistula, C. tora*. Of these, *E. blanda* and *E. hecabe* were also seen while feeding on certain species of family Mimosaceae *i.e*., *Pithecellobium dulce, Albizia specices* whereas the rest two species of genus Colotis (*C. amata and C. etrida*) were seen feeding on species of family Salvadoraceae such as *Salvadora persica* and *S. oleoides.Delias eucharis* is the single species of the family pieridae which feed on the host-plant of family Loranthaceae *i.e*., *Dendropthoe faleata* and is strictly host-specific and monophagus in nature. Family Lycaenidae is represented by 16 species in GPA ; Of them, only two species (*Spindasis ictis and Tarucus therophrastus*) were recorded to feed on *Dendrophthoe sp.,* and *Zizyphus rotundifolia* belonging to the families of Loranthaceae and Rhamnaceae respectively while other 13 species have also exhibited their polyphagus nature. Of them, *Tarucus nara, Castalius rosimon, Spindasis vulcanus* seen feeding on plants such as *Zizyphus glabrata, Z. Mauritiana, Z. Oenoploea, Z. Xylopyrus, Z. nummularia* and *Z. rotundifolia*. The remaining species such as *Euchrysops cnejus, Catochrysops strabo, Leptotes plinius, Lampides boeticus, Azanus ubaldu* and *A. jeasons* were noticed to feed on various plants (*Tephrosia purpurea, Erythrina indica, Indigofera species, Erthrina species, Butea species, Desmodium species, Albizia lebbek*, *Acacia ferruginea* and *A. leucophloea*) belonging to the families of Fabaceae and Mimosaceae. *Zizera lysimonfeed* and *Curetis thetis* were seen feeding on various plant species (*Amarantus gracilis, Zornia diphylla, Pongamia pinnata, Derris scandens, Abrus precatorius*) belonging to the families *Leguminosae, Meliaceae and Amarantaceae.* While, *Dendroryx epijarbas* feed entirely on different families *i.e.,* Spindaceae and Puniceae having host-plants such as *Spindus emarginatus, Punica granatum.* A total of 74 plant species were recorded, serving as host-plants for 67 species of butterflies in GPA. Of them, 66 plant species were found as wild species whereas remaining 8 species were either cultivated or found in wild form. These plant species are further categorised as to belong to tree species (21 species), herbs (22 species), shrubs (24 species), Climber (6 species) and stem parasite (1 species). It has also been observed that out of 74 host-plants , 49 species belong to perennials whereas 22 species as annuals and remaining 3 species were recorded as to belong to bi- annual category of plant species. A detail taxonomic breakdown of GPA butterflies is presented in Table- 2. The family Nymphalidae was found dominant with 15 genera and 23 species followed by family Pieridae representing 10 genera and 22 species. Family Lycinidae is comprisied of 14 genera and 16 species whereas Papilionidae with 3 genera and 6 species. During the present investigation, it has also been observed that the only four butterfly families were found to feed on 74 host-plants species representing 32 plant families at GPA (Table-3). The plant species belonging to families Memosaceae, Capparaceae and Caesalpiniceae were found to be the most suitable food for butterflies. Papilionidae had its food preference for family Rutaceae, while Nymphalidae preferred to feed on Acanthaceae and Malvaceae, Furthermore, family Pieridae had a preference for family Caparaceae and Caesalpiniaceae and the members of family Lycaenidae mostly found to feed on families Mimosaceae and Fabaceae. Other butterfly families overlap in the use of host plants from the same plant family but to a lesser extent. Taxonomic contrasts in

host use and herbivory: Significant contrasts among butterfly families occur for host use of different host plant life forms , biotopes, host plant perennation but not for host plant abundance nymphalidae used more herbs than expected. An excess of nymphalidae host plant occurred wild as compared to an excess of papilionidae that were cultivated/wild. Corresponding with these contrasts, an excess of nymphalidae used annual/ biannuals, whereas papilionidae, lycaenidae and, to a lesser extent, pierdae, used more perennials than expected. Families also differed for host specificity (phagy) having a significant tendency towards morphology and lycaenidae towards polyphagy. Landscape contrasts among host plants for butterflies families occurred for stream banks and hill tops but not shrub wood edges. An excess of nymphalidae hosts plant were found on stream banks, and a deficit of host plants belonging to papilionidae and pierdiae. Hill tops had an excess of pierdae and nymphalidae host-plants and defic it of papilionidae and, to a lesser extent, hesperiidae host plants. The number of absences was too small for a comparision of host-plant occurance along tracks through herbs and shrubs of all families, but an excess of hesperiidae occurred along tracks compared to those of nymphalidae and lycaenidae, the latter two not differing in frequency. The basic objective of the GPA study was to generate a database on resources for butterflies to further their future conservation. The database allow progress in two important areas- First, it may supply firm information on resources and thier use by butterflies; secondly, it may provide the means for identifying taxonomic traits for and interactions among life history and ecological variables in order to ensure that resources are allocated in an efficient, holistic manner to conserve and build butterfly communities in suitable sites.

Correlation coefficient between number of host plant species and Butterfly species was found (r = 0.785) and was significant at 1% level (p = 0.01), shows strong correlation between host and plant. Hence, more number of host-plant species attracts significantly more species of butterflies. Similarly, correlation coefficient (r = 0.454) between number of host plant species and butterfly family was also found significant at 1% level (p = 0.01) and also shows that more butterfly families were attracted significantly the host plant species as their number increases. Whereas, correlation coefficient between butterfly species and butterfly family calculated as (r = 0.394) which shows medium correlation between these two but was significant at 0.5% level (p = 0.05) (Table-5). The study has focused on collecting fundamental information of butterfly resources within Gir Protected Area, India. Data on the other vital consumer resource, nectar flowers (Tudor *et al*., 2004) have already been reported (Tiple *et al*., 2006, 2009). Basic information has been collected on host plant life forms, basic biotopes, perennation, abundance, and host plant distribution.

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