Chapter 2

Review of Literature

Butterflies are one of the most fascinating insects belonging to the order Lepidoptera. Members of this group are attracted by their peculiar coloration and beauty. Butterflies are distributed worldwide and a vastly studied group of insects. The study has drawn the attention of many Lepidopterists in different parts of the world and conducted different types and levels of studies since long back. This chapter deals with the gist of research works had been conducted from the different parts of the world which provided supportive ideas to carry out this research work.

2.1 Gujarat

Sidat & Bhatt (2020) from The Maharaja Sayajirao University of Baroda, Vadodara studied the species diversity of butterflies in Ankleshwar, an industrial town in Gujarat documented a total of 63 species of butterflies belonging to five families. They also observed that urbanization directly threats the butterfly diversity and human activities have a strong influence on the biodiversity of all the existing species. A couple of years back Gandhi et al. (2018) Department of Zoology, The M S University of Baroda also studied the butterfly diversity in and around an irrigation reservoir in the semi-arid zone of central Gujarat and recorded 42 species of butterflies dominated by the family Nymphalidae (38%) over the family Pieridae (31%), family Lycaenidae (21%) and Papilionidae (10%). Wildlife Institute of India, Dehradun conducted a study to know the butterfly diversity in an arboretum in Vadodara recorded 61 species of butterflies comprised of 6 species of Papilionidae, 3 species of Hesperiidae, 20 species of Nymphalidae, 13 species of Pieridae, and 19 species of Lycaenidae. They also revealed that diversity of butterflies is largely dependent on a rich flora, because larval host-plant relationships are frequently very specific. Therefore, conservation strategies can be achieved by the enhancement of vegetation in habitats specifically preferred by butterflies Bhatt & Nagar (2017).

Gandhi & Kumar (2016) from Department of Zoology, The Maharaja Sayajirao University of Baroda, reported 70 species of butterflies belonging to 5 families from the Fragmented Habitats of Waghai Botanical Garden of The Dangs –Gujarat out of which family Nymphalidae was got maximum number of species and minimum representation was from the family Hesperidae.

Studies on seasonal diversity revealed that highest numbers of butterfly species were found during post-monsoon season compared to winter, pre-monsoon and monsoon season. Same authors carried out a research on Butterfly diversity, abundance and utilization of plant resources in urban localities of Vadodara also and revealed that families Nymphalidae and Pieridae showed more number of butterflies species and *Lantana camara*, *Tridax procumbens* & *Ixora coccinea* were major nectar resources for the butterflies Gandhi & Kumar (2015). Some years back two authors from Kotak Institute of Science, Rajkot documented 15 species of butterflies belong to 4 families from Hingolgadh area of Jasdan and suggested that with the increase in vegetation, there is an increase in butterfly diversity too Bhambhania & Vaghela, (2014).

Patel & Pandya (2014) Ecology Laboratory, Department of Botany, The Maharaja Sayajirao University of Baroda, Vadodara a study was conducted to identify the common wild and cultivated butterfly host plants and their season wise distributions in the university campus. Highest species diversity was recorded in monsoon season and also found that at undisturbed site species diversity was more than the other one. Plants such as *Tridax procumbens* and *Cassia occidentalis* were the most dominant host plants throughout the year. Kumar (2013) EnVision Enviro Engineers Pvt. Ltd, Surat conducted a study on Butterfly diversity from different sites of Jhagadia, Ankleshwar and identified a total of 484 individuals belonging to 58 species of 9 families. Pieridae was found to be the most dominant family among them. Trio authors from R.R Mehta college of Science and C.I Parikh college of Commerce, Palanpur revealed a total of 43 species of butterflies belonging to 5 families and their 110 associated plant species in Gandhinagar. Butterfly fauna depends mainly on the floristic elements, climate, rainfall, temperature in Gujarat. They also suggested that conservation of butterflies can be achieved only by planting butterfly attracting plants and allowing them to flourish in their own plant world Mali et al. (2012).

Another research work published Ruchi et al. (2012) from Division of Entomology, Department of Zoology, The Maharaja Sayajirao University of Baroda, Vadodara observed that the diurnal rhythm in intensity of light and quality of light, temperature, moisture and food influence the occurrence and abundance of Lepidopterans. Same department conducted a study to know the diversity of butterflies in Gir Protected area and recorded a total of 44 species belonging to six families. Family Pieridae represented with maximum number of species. Diversity was highly affected by season and most preferred season was monsoon to late winter.

Seasonal variation was due to availability of host plants, suitable temperature and humidity Ahir & Parikh (2010).

2.2 India

Lepidopterologists from different parts of the country worked in various aspects such as life cycle, diversity, abundance, seasonal variations, responses to environmental factors, larval host plant assocoations, nectar plant association of butterflies. Sreekumar et al. (2018) from Centre for Wildlife Studies, College of Forestry, Kerala Agricultural University, Kerala conducted study and identified 85 species of butterflies belonging to six families including 8 species which are endemic to Western Ghats from the montane habitat of Eravikulam National Park. Tiple, (2018) of Department of Zoology, Vidhyabharti College, Wardha, Maharshtra revealed 91 species of butterflies belong to six families. Family Nymphalidae was found to be the highest diversed and Riodinidae was the least diversed family in Seloo city. Duo authors from Forest Protection Division, Arid Forest Research Institute, Jodhpur (Rajasthan) noticed that butterflies were found to be more in the disturbed forest because butterfly interact maximum in disturbances hence they are considered as the indicators of climate change. Sharma & Sharma (2017**)**

Mehra et al. (2017) from the Department of Zoology and Environmental Sciences, Punjabi University have studied about the Biodiversity and conservation status of Butterflies in Western Himalaya and revealed that most of the butterfly species were not assessed under IUCN 2016 and it also noticed severe loss of biodiversity and degradation of habitat. Two authors from P. G. Department of Zoology, Manoharbhai Patel College of Arts, Bhandara, Maharashtra reported 24 butterfly species belong to 5 families in the paddy growing area of Silezari, Vidarbha during winter and pre-monsoon season. Family Nymphalidae showed maximum number of species while family Papilionidae represented only one species Ganvir & Khune (2016).

Investigators from Arid Forest Research Insitute, Jodhpur Sharma et al., 2016 studied the butterflies and their interaction with the different host-plants species in Sasan Gir National Park, Junagarh. They Identified 74 host plants of 67 butterfly species comprising 22 annuals,
3 biennials and 49 perennials and different plant types. More et al. (2016) Department of Zoology, R.B. Madkholkar Mahavidyalaya Maharashtra, reported 52 species of butterflies belonging to 36 genera and 5 families and Family Nymphalidae remained dominant one and

family Hesperiidae was the most infrequent one. Fernandes et al. (2016) from the Viva College of Arts, Science and Commerce, Virar, Maharashtra, showed that family Nymphalidae was the most dominant family having species richness and Hesperiidae was the least dominant family represented only 3 species at Vasai Fort.

Ghosh & Saha (2016) from the Post Graduate Department of Zoology, Bethune College, Govt. of West Bengal conducted a study to understand the Seasonal diversity of butterflies with reference to habitat heterogeneity, larval host plants and nectar plants at Taki, West Bengal, The result showed that monsoon is the most favorable season for the species richness and abundance. The pattern of abundance were associated with the nutritional support and foliage supplied by their host plants. Along with climate, the altitudinal gradient also affects the butterfly diversity. Duo authors Jeevith & Samydurai (2015) Department of Botany, Bharathiar University, Coimbatore enumerated the butterfly nectar food plants in Glenmorgan, Nilgiris District, Tamil Nadu. They identified and recorded 84 species of plants belong to 69 genera and 30 families for 65 species of butterflies. Two authors Ghorai & Sengupta (2014) from Kolkata studied distribution of Papilionid butterflies along with their larval host plants in the adjoining regions of the protected areas of Gorumara National Park and Neora Valley National Park. They found that a total of 26 species of butterflies known to occur throughout the study site and 35 species of plants serve as larval host plants for these butterflies. Moreover, the authors also reported abthe out monophagous and ologophagous nature of butterflies.

Nair et al. (2014) from the Department of Zoology, Sarojini Naidu College for Women, Kolkata documented 49 species of butterflies under 5 families and 36 genera in the campus of Sarojini Naidu College. Family Nymphalidae represented with highest number of species and Hesperiidae represented with least number of species. Kumar & Murugesan (2014) from Sri Paramakalyani Centre of Excellence in Environmental Sciences, Manonmaniam Sundaranar University, Tamilnadu have worked and recorded 64 species of butterflies belong 47 genera of the families Nymphalidae, Pieridae, Lycaenidae, Papilionidae and Hesperiidae. The relative abundance for Nymphalidae was high and found to be dominant family in terms of species, general and individual relative abundance the and low relative abundance was noted for Hesperiidae compared to other families.

Kumar (2014) from Department of Zoology, B.S.N.V. P.G. College Lucknow University carried out a study on Butterfly abundance and species diversity in some urban habitats of

Jhansi and identified 38 species of butterflies and 29 genera belonging to six families. A total of 161 species of butterflies have reported Upper Neora Valley National Park by Sengupta et al. (2014) Department of Zoology, West Bengal State University, Kolkata, and showed that members of family Nymphalidae were maximum and concluded that autumn followed by monsoon showed high species richness due to abundance in vegetation which provides food to the larval forms. Arya & Chaudhary (2014) Department of Zoology, Kumaun University, Nainital, investigated the Species richness and diversity of Butterflies in and around Kumaun University found a total of 897 individuals and 27 species of butterflies were recorded. Family Pieridae was found to be the most dominating family with maximum representation of individuals followed by family Nymphalidae. Rainy season was the most favourable season for the flourishing of butterflies.

Manwar & Wankhade (2014) from the Department of Zoology, Savitribai Phule Pune University, Pune observed and recorded 28 species of butterflies under 5 families. Family Nymphalidae showed maximum representation of species and Monsoon season was found to be the most favoured season as compared to summer and winter seasons. Revathy & Mathew (2014) from the Entomology Department, Forest Health Division, Kerala Forest Research Institute, Peechi, Kerala recorded a total of 50 butterfly species belonging to 5 families and family Nymphalidae was the most dominant one. The highest peak observed during August to November and it declined from February onwards and marked its lowest population during April and May. The result showed that the life cycle was directly dependant on temperature and humidity.

Bhuyan et al. (2014) from Butterfly Research Centre, Jones Estate, Uttarakhand, studied the two typically fruit and sap feeding Indian butterflies shift to flower nectar (Lepidoptera: Nymphalidae). Sharma et al. (2014) from the Department of Zoology & Biotechnology, Devi Ahilya Vishwa Vidyalaya Indore, documented 70 butterfly species in total. Butterflies diversity indicates that the butterfly diversity largely depends upon the flora diversity, so conservation of butterflies' diversity is possible by the enhancement of vegetation, composition of habitat those mostly preferred by butterflies.

Guddeti (2014) Department of Botany, Rayalaseema University, Andhra Pradesh established a coevolutionary relationship of four plants with their butterfly Pollinators and concluded that there is a co evolutionary relationship existing between the plants with their butterfly pollinators. Plant – Pollinator relationships are determined by floral morphology and its

inherent features. Another author Chowdhury (2014) from the Centre for Biodiversity and Ecological Studies, Kolkata, West Bengal During recorded 76 species from Sundarban Biosphere Reserve and they also surveyed taxonomic diversity, ecology and conservation strategies of butterflies.

Ramesh et al. (2013) from Loyola Institute of Frontier Energy, Loyola College, Tamil Nadu have worked and established that butterfly abundance and species diversity were more during wet season than the other periods. The butterfly population was correlated negatively with temperature and positively with relative humidity. Factors such as lacking of larval host plants, nectar plants and dry vegetation, results in less butterfly abundance and lower survival ability of most of the species. An author from Assam University, Assam**,** recorded 294 butterfly species belonging to 156 genera and 5 families from Dibang Valley Gogoi, 2012. A group of investigators from Department of Botany, Andhra University, Visakhapatnam described 38 species of butterflies and their associated larval host plants at Visakhapatnam. Plants belonging to the following families namely Fabaceae, Acanthaceae, Verbenaceae, Annonaceae, Asclepiadaceae, Capparidaceae, Malvaceae, Rhamnaceae and Rutaceae were the most favoured host plants Atluri et al. (2012).

Padhye et al. (2012) Department of Zoology, Abasaheb Garware College, Maharashtra conducted a study on Distribution and composition of butterfly species along the latitudinal and habitat gradients of the Western Ghats of India and found 334 butterfly species, belonging to 6 families and 164 genera. Lycaenidae was the most representative family with 101 species followed by Nymphalidae (97), Hesperiidae (82), Pieridae (34), Papillionidae (19) and Riodinidae (1). Out of 334 species recorded from the Western Ghats, 58 species were found in all latitudinal zones, while 5 species were reported in only one latitudinal zone. Gowda et al. (2011) of Department of Wildlife and Management, Kuvempu University, Karnataka revealed a total 54 species and there is an increase in the number of species during monsoon and winter and the number went to minimum during summer and some of them were observed throughout the year. Nimbalkar et al. (2011) from the Department of Zoology, Vinayakrao Patil Mahavidyalaya, Aurangabad, Maharashtra found 64 species of butterflies and concluded that butterflies were more frequent to visit flowers with tubular corollas than flowers having nontubular corollas. Butterflies also preferred flowers with red, yellow, blue and purple colours than white- or pink-coloured flowers. Species abundance was observed to be at its peak during the months of August to November. Then declined from December to January and continued till May.

Venkata Ramana (2010) of Department of Zoology, Yogi Vemana University conducted a study and identified 70 species of butterflies. Proboscis lengths of different butterfly species were measured in which *Papilio polymnestor* had highest proboscis length and *Leptsotia nina* showed smallest proboscis. Nectar feeding host plants also were recorded and can be listed as *Cosmos sulphureus, Tridax procumbens, Tectona rotundifolia, Carissa carandu, Catharanthus rosens, Nerium odorum, Lantana camara, Tectona grandis, Bougainvilla spectabilis, Jatropha podagria,* majority of butterfly species utilize them as these plants bloomed throughout the year. Some Nymphalids preferred to forage only on white and yellow flowers and Danaids chosen to forage on Red, Green, Yellow flowers, Papilionids forage on all flowers. Lycanids and Hespiriids foraged on flowers of herbs and sherbs. Sharma & Joshi (2009) from Desert Regional Centre, Zoological Survey of India, Jodhpur and documented a total of 41 butterfly species belonging to 5 families from Dholbaha dam (Dist Hoshiarpur) in Punjab Shivalik.

Tiple et al. (2007) from Department of Zoology, Nagpur University, Maharashtra identified 52 butterfly species belonging to 5 families Hesperiidae, Papilionidae, Pieridae, Lycaenidae and Nymphalidae. Species abundance marked a rose from the beginning of the monsoon and reached a peak in early winter. A decline in species abundance was observed from late winter and continued up to the end of summer. Padhye et al. (2006) Department of Zoology, Abasaheb Garware College, Maharashtra recorded 58 species belonging to 5 families. Maximum number of species as well as maximum number of individuals were recorded during early winter and maximum diversity was observed in the partially disturbed areas. Raju et al. (2004) from the Department of Environmental Sciences, Andhra University Andhra Pradesh documented 39 butterfly species belong to 5 families and their associated nectar host plants at Vishakhapatnam. Borkar & Komarpant (2004) Biodiversity Research Cell, Department of Zoology, Carmel College for Women, Goa recorded 91 species representing 5 families. Of which, 71 are habitat generalists and 20 are habitat specialists. Species diversity was significantly higher during post monsoon months compared to other seasons. The higher species richness of butterflies associated with availability and access of food plants. Though an exotic invasive species, *Lantana camara* found to be an important nectar resource for several species of butterflies in degraded as well as urbanized habitat.

Sreekumar & Balakrishnan (2001) of Department of Zoology, University of Kerala worked on Habitat and altitude preferences of butterflies and found that maximum number of species were preferred low and middle elevations. The elevation of the study site was 1145 metre and the entire study site of was divided into 3 on the basis of the elevation of the area. Kunte (1997)

from Life Research Foundation, Pune established that highest species richness occurs during monsoon and early winter in northern Western Ghats.

2.3 Abroad

Shrestha et al. (2018) Department of Zoology, Tribhuvan University, Kathmandu studied the diversity and status of butterflies at different sacred forests of Kathmandu valley, Nepal. A total of 77 butterfly species under 56 genera and six families were recorded. Family Nymphalidae represented the highest butterfly abundance and richness and found dominated in all sacred forest. The status of butterflies was categorized into four categories; very rare, rare, fairly common and common on the basis of number of individuals encountered. A team of researchers Sultana et al. (2017) from Department of Zoology, University of Dhaka, Bangladesh conducted a study on the Butterfly proboscis and their functional relations with the nectar plants in some selected forests and established that butterflies visited flowers with same corolla length or shorter corolla length compared to proboscis length.

Ghazanfar et al. (2016) from the Department of Zoology, University of Gujarat, Pakistan have published a review a paper and concluded that butterflies maintain the ecosystem by acting as pollinator, induce genetic variation in plants, prey, biological pest control, reduce the level of carbon dioxide, and enhance environmental beauty in air.

A team of researchers Serrat et al. (2015) from Centre for Ecological Research and Forestry Applications, Spain conducted a study on Environmental factors influencing butterfly abundance after a severe wildfire in Mediterranean vegetation to evaluate the butterfly assemblage in relation to the surrounding unburned habitat. They discussed that recovery of butterfly population and different parameters such as abundance, diversity, species richness and equitability in burned and unburned areas were influenced by ecological and environmental factors.

Ghazanfar & Raza (2015) Department of Zoology, University of Gujrat, Pakistan established that butterflies play a vital role in the ecosystem and there is a co-evolutionary relationship between butterflies and plants because they are interlinked. Krenn (2015) from the Department of Integrative Zoology, University of Vienna studied the ecological role of extremely long-proboscid Neotropical butterflies (Lepidoptera: Hesperiidae) in plantpollinator networks and found that Neotropical Hesperiidae shows a surprising variation of proboscis length. The results show that skippers with longer proboscis visit plant species with deep-tubed flowers for food,

but do not pollinate them. Skippers with extremely long proboscis rarely visit short-tubed flowers for their diet.

Kocsis & Hufnagel (2011) Department of Management and Marketing, Corvinus University of Budapest, Hungary detailed about the major climatic factors influencing the existence of Lepidoptera including the temperatures, atmospheric CO_2 concentration, drought, etc. and concluded with a view that there are certain adaptable species and also conditions necessary for successful invasion to new territories. Stefanescu & Traveset (2009) from Museu Granollers Ciencies Naturals, Spain studied the Factors Influencing the Degree of Generalization in Flower Use by Mediterranean Butterflies and found that both phylogenetic and ecological correlates with the degree of generalization in flower use.

Duo researchers Bhusal & Khanal (2008) from Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal conducted a study entitled Seasonal and altitudinal diversity of butterflies in eastern Siwalik of Nepal. The result was that butterflies showed a gradual increase in the lower altitudes and species richness was minimum at the higher altitude. Scientists from the Mount Fuji Research Institute, Japan, examined the relationships between the diversities of vegetation, adult nectar plants, and butterflies in and around the Aokigahara primary woodland on Mount Fuji. The results showed that the nectar resource utilization by adult butterflies was significantly favoured to herbaceous plants, especially to perennials. There were greater nectar plant species in sites with greater plant species richness. The results suggested that richness of herbaceous plant species in a habitat plays a central role in supporting its adult butterfly species richness Kitahara et al. (2008).

Kunte (2007) University of Texas at Austin, USA studied Allometry and functional constraints on proboscis lengths in butterflies observed that there was a strong positive relationship between proboscis length in relation to body size and handling time per flower on both nectar plants. Stefanescu et al. (2003) Centre for Ecological Research and Forestry Applications, Barcelona, Spain studied the Effects of climatic change on the phenology of butterflies in the northwest Mediterranean Basin. The study indicates that butterflies are one of the most important popular groups of organisms respond to climatic change. Corbet (2000) Department of Zoology, Cambridge, UK, studied on the Butterfly nectaring flowers: butterfly morphology and flower form. The result of the study revealed that small and short-tongued butterflies do not visit flowers with deep corollas. Flowers with deep corolla and potentially abundant nectar

were frequently visited by butterflies with proboscis length long enough to reach to the base of the flower.