CHAPTER -II

2.0 REVIEW OF LITERATURE

Recent studies of biodiversity in relation to ecosystem functioning have suggested that species diversity sometimes enhances productivity and stability of ecosystems (Naeem *et al*., 1994; Tilman *et al*., 1996). Positive relationships have been found between butterfly diversity and plant diversity (Thomas and Malorie, 1985; Leps and Spitzer, 1990). This relationship is particularly true in tropical regions where insects show high abundance and species diversity (Price, 1997). Butterflies are highly sensitive to environmental change and are delicate creatures that act as good bio-indicators of the health of an ecosystem. Butterflies are good indicator in term of anthropogenic disturbance and habitat quality (Kocher *et al.*, 2000). Particularly in the forest ecosystem when habitats are fragmented, butterfly that shift from one habitat to other have increased chance of exposure to predicators and are vulnerable to disturbance associated with human activity. The effect of habitat loss can be seen clearly with the declining population of butterfly. Moreover the butterflies that are displaced after habitat loss disappear subsequently. Climatic changes impact the diversity of species and are expected to exacerbate the ecosystem (Scott *et al.*, 2005).

Butterflies are also good pollinators (Thomas JA, 2005). The areas with undisturbed vegetation and high floral diversity support large butterfly communities, as many species are strictly seasonal and prefer only particular set of habitats (Kunte, K, 1997). Butterflies and their caterpillars are dependent on specific host plants for foliage, nectar and pollen as their food. Butterflies are often considered opportunistic foragers, which visit a wide variety of available flowers. Thus butterfly diversity reflects overall plant diversity, especially that of herbs and shrubs in the given area. (Tiple AD.2012, Sparks, T.H., Parish, T., 1995) studied factors influencing nectar plant resource visits by butterflies. The distributions of butterflies are exclusively dependent upon the availability of their food plants. Knowledge about the host plants is crucial to the development of long term conservation strategy, principally for areas in which species of butterflies may be declining (Feltwell, J, 1986). Nectar or flower abundance has been one of the most studied variables that has been shown to have an important impact on abundance and richness of butterfly species and individuals (Munguira and Thomas, 1992; Holl, 1995; Lortscher *et al.,* 1995; Dover, 1996; Dover *et al.*, 1997; Gerell, 1997; Steffan–Dewenter and Tscharntke, 1997; Dover *et al.*, 2000; Clausen *et al.,* 2001).

Butterflies are important natural resources as they help in pollination, a key process in natural propagation, important ecological indicators, as they are closely associated with plants both as adults and larvae and enhance the aesthetic value of the environments by their exquisite wing colours. There is an intimate association between butterflies and plants and their lives are exceptionally interlinked (Feltwell, J, 1986), which leads to different patterns in their distribution depending on the availability of their food plants. In fact, the positive correlation between plant and butterfly diversities has been reported or pointed out in many previous studies (Ehrlich, P.R, Raven, P.H., 1964, Holl, K.D, 1996,).

However, there have been a few studies (Hawkins *et al.,* 2003; Nimbalkar *et al.,* 2011) in which the correlation is weak between butterfly diversity and vegetation community composition or species richness. In another study (Hawkins and Porter, 2003; Gutierrez, D, Mendez, R, 1995) it was pointed out that, although plant and butterfly diversities are positively correlated, plant diversity does not directly influence butterfly diversity but that both are probably responding to similar environmental factors.

Plant communities are groups of plants sharing a common environment that interact with each other, animal population, and the physical environment. As plant communities tend to co-occur on the landscape due to shared environmental requirements, they provide a valuable framework for organizing biological information creating mapable units for land management and conservation planning. Communities are often defined by dominant plant species and these plant associations provide useful habitat information for many animal species and provide an efficient starting point for biological surveys.

The factors such as monitored vegetation and ecological and biogeographically forest disturbance (Hamer *et al.*, 1997); livestock grazing, illegal logging and closing of canopy (Spitzer *et al.*, 1997); unmanaged habitats (Swengel, 1998); habitat quality, soil variables and tillage practices (Peck *et al.*, 1998) and crop management and herbicide application (Wilson *et al.*, 1999) are some of the few renounced biotic factors to influence the distribution of butterfly.

There have been a number of discussions on the effects of abiotic factors on distribution and abundance of lepidopteron insects. In particular, the work of Marks (1977), Adams *et al.*, (1995), Butler *et al.*,(1999) and Tikkanen *et al.*,(1999) are good sources of information for Lepidoptera. Contributions of Wallner (1987) and Khan and Kushwaha (1991) for Homopterous and Irulandi and Balasubramanian (1999) for Coleopteran are appreciable for generalized insect study. Raghuraman and Veeravel (1999) conducted field experiments to study the influence of the abiotic factors in the incidence of spotted leaf beetle, *Henosepilachna vigintioctopunctata* (F.) in brinjal and reported highest population during February and March, observing significant correlations with maximum temperature, relative humidity and wind velocity. Abiotic stress such as spring -summer drought was also reported to generate outbreaks of gypsy moth population (Kultunov and Andreeva, 1999).

In any Eco-system, the population, abundance as well as diversity trend of butterfly species varies from place to place, season to season and even from one minute to the next. Butterfly being exothermal are highly sensitive to climatic variation and a short generation times make them an appropriate model organism to study. Of these, chemical pesticides potentially affect the development of butterfly larva and nectar producing plants which adversely affect the adult butterfly diversity. Adult temperate butterflies feed preliminary on nectar (Scoble, 1992), supplemented to varying extents to mud, dung or carrion (Boggs *et al.*, 2003). Development of agricultural field in forest ecosystem endangers many species throughout the world, at present extinction rate are estimated to be 100 to 1000 times natural rate, depending on the taxonomic groups (Scriber *et al*., 1995). Studies pertaining to the role of temperature and humidity on distribution and abundance of various insects in different ecosystems were well documented by several authors (Chaudry and Alikhan, 1996; Human *et al.,* 1998; Tauber *et al.,* 1998 and Wermelinger and Seifert, 1999).

The relationship between rainfall and wind velocity with the number of insects and their diversity was studied by Ramachandran *et al.,* (1997). Mathew and Rahamathulla (1993), Gunathilagaraj *et al.,* (1997), Asaithambi *et al.,* (1998) studied the seasonal distribution of butterflies and Nasr *et al.,* (1984) and Saha and Raychaudhuri (1998) on the diversity of butterfly communities has been studied in different habitat types in different parts of the world including Indian Great Himalayas Region. Lien van Vu (2009) reported forest edges have greater diversity of butterflies which has more exposure to the open. The gaps in the forest like the stream or river path have higher diversity of butterflies than the closed forest areas (Spitzer *et al.,* 1997; Lien van Vu *et al.,* 2011).

Urbanization is usually considered to impact biodiversity (Blair and Laugner, 1997; Mackinney, 2002, 2006, 2008; Bergerot *et al*., 2011). Cities are generally grown in term of human population size over time (Grimm *et al*., 2008). The growth is accompanied by an expansion of urban areas. Changes in habitat quality and quantity associated with urbanization have negative influences in biodiversity. Plants and animals have frequently experienced local extinction in urban area due to habitat loss, habituated degradation and fragmentation (McKinney, 2002; Clark *et al*., 2007). Adult butterflies are dependent on nectar and pollen as their food while the caterpillars are dependent on specific host plant for foliage (Nimbalkar *et al*., 2011). Butterflies are considered as good indicators of the health of any specific territorial ecosystem (New Delhi: Pollard and Yates, 1993 ; Kunte 2000; Aluri and Rao 2002; Thomas 2005; Bonebrake *et al*., 2010) as well as reflection of human disturbance and habitat feature with great sensitivity than many other taxonomic groups (Thomas *et al*., 2004; Thomas 2005). Butterflies are therefore treated as important model group in ecology and conservation (Watt and Boggs 2003; Ehrlich and Hanski 2004). Studies on the effect on urbanization on biodiversity in urban areas compared with rural areas have shown different species composition and less abundance of organisms: eg. mammals (George and Crooks, 2006); amphibians (Osawa and Kastuno, 2005; Hammer and McDonnell, 2008); birds (Motegi and Yanai, 2005; Ruben and Ian 2009); ground beetles (Niemela *et al*., 2002 ;Lee and Ishii, 2009 ; Lee and Kown, 2013), ants (Lee and kown, 2013) and butterflies (Imai 2004; Lee and Kown, 2012 and Bergerot *et al*., 2011)

Extending this view, study of species diversity in ecosystem is necessary to understand the effect of anthropocentric development in the integrity and substances of ecosystem. Diversity of insects has been emphasized in many studies owing to their dominance in the terrestrial and aquatic ecosystem and provision of ecosystem service such as pollination, pest control, nutrient decomposition, and maintenance of ecosystem species (Losey and Vaughan, 2006). Among insects, butterfly performs prominent role in pollination and herbivores (Kunte, 2000; Tiple *et al*., 2006) bearing a history of long term co evolution with plants (Ehrlich and Raven, 1964).

2.1. Butterfly distribution and North Eastern India

Due to richness in vegetation, the northeastern region of India is home to a rich diversity of butterflies, among other insects (Kunte, 1997; Alfred *et al*., 2002) and it is also part of one of the mega biodiversity hotspots of the world (Myers *et al*., 2000). A review of literature suggests that 76 species of butterfly were previously recorded from the state of Tripura (10,490 sq km), northeast India (Mandal *et al*., 2002; Agarwala *et al*., 2010; Majumder *et al*., 2011). Among other northeastern states, 104 species of butterfly from Meghalaya (22,429 sq. km), 695 species from Sikkim (7,096 sq. km), and 962 species from Assam (78,438 sq. km) have been recorded (Evans 1932; Talbot 1939; Wynter-Blyth, 1957; Haribal, 1998). Evidently, the knowledge base on lepidopteron fauna and their distribution in different habitats is uneven and still scanty from this part of India.

The northeastern region of India, south of the Brahmaputra River, is part of the globally recognized Indo-Myanmar biodiversity hotspot and is host to a remarkable biodiversity that includes a high proportion of endemic, rare and endangered species http://www. biodiversityhotspots. org/xp/ hotspots / indo_burma/Pages/default.aspx). The Garo Hills of the northeastern state of Meghalaya (previously part of Assam) form the north-westernmost limit of the Indo-Myanmar Biodiversity Hotspot. From there the hotspot extends south eastwards to cover the Khasi, Jaintia, Naga, Manipur and Mizo Hills (together encompassing the Patkai Hills) in northeastern India and the entire Indo-Chinese sub region. The high species richness and endemism make this an especially important region for butterfly diversity and conservation in India. Early European lepidopterists extensively explored this biodiversity hotspot between 1840 and 1950 and described hundreds of butterfly species and subspecies (summarized in Moore,1890–1892, 1893–1896, 1896– 1899, 1899–1900, 1901–1903, 1903–1905; Swinhoe,1905–1910, 1910–1911, 1911–1912, 1912–1913; Evans,1932; Parsons & Cantlie,1948; Cantlie, 1952, 1956). The major taxonomic and natural history work in this region was done in the Khasi and Jaintia Hills in eastern Meghalaya (Swinhoe 1893, 1896; Parsons & Cantlie 1948; Cantlie 1952, 1956), in Cachar Hills in southern Assam and Bangladesh (Butler, 1879) and in the Naga-Manipur Hills (Tytler 1911, 1912, 1914, 1915a,b, 1926a,b). The pace of species discovery and accumulation of bionomic information on butterflies of this region has subsequently slowed down as the region has received less attention from lepidopterists with a few notable exceptions (Radhakrishnan *et al*., 1989; Larsen, 2004; Kunte, 2009, 2010). Nevertheless, some areas have historically remained practically unexplored. .

Few scientists in North eastern region had studied on the butterfly species diversity, species composition and its distribution patterns. Gupta & Sukla (1988) have studied the distribution and taxonomy of Nympahlidae and Lycaenidae butterflies in Arunachal Pradesh and its adjoining areas. However, most of the information was based on the butterfly specimen"s collections of past workers. Betts (1950) had studied butterfly diversity in the northern bank of Brahmaputra River, starting from earlier Balipara Frontier Tract (now Chariduar and Balipara of Assam), from Bhalukpung to Tawang and Subansiri district of Arunachal Pradesh. Several workers during British period also had been studied the butterfly diversity in northeastern region, of which, the works of Butler, (1879); Marshall & DE Niceville, (1882); WoodMason, (1882); DE Niceville (1886); Wood-Mason & DE Niceville (1887); Swinhoe (1893, 1910, 1913); Tytler,(1911, 1914) and Cantlie (1952) were worth mentioning.

Most of the pieridae groups of species utilize medicinal plants as food plants which has been studied by Baruah, (1988). The small white butterfiy *Pieris canidia* (Sparrman) is an important phytophagus insect, which is well known for the damage it causes to cruciferous oil seeds and vegetables and to ornamentals like nasturtium. The pest was first recorded in India by Bingham, (1905-07). According to him, this pest is distributed in the Himalayas from Chitral to Kashmir to Sikkim and Bhutan, from 2,000 to 11,000 feet elevation; the hills of Southern India; Assam and Upper Burma extending to China. In Assam, *Pieris canidia* is a commonly occurring pest in the fields of rapeseeds, mustard and Brassica vegetables.

2.2 Butterfly abundance

Details of the theoretical studies with suitable examples of fieldwork and methodology of computing indices are well defined by several workers (Taylor and Brown, 1972; Janzen, 1973; Krebs, 1972; Wolda, 1981; Ludwig and Reynolds, 1988; Oliver and Beattie, 1996; Edwin, 1997; Bartlett *et al.,* 1999; South Wood and Henderson, 2000). Fluctuations in abundance and species richness have been well documented for a number of insect groups by several authors (Wolda, 1978; Smythe, 1982; Wolda and Wong, 1988). Devries *et al.,* (1997) observed that both species richness and abundance of nymphalid butterflies in a lowland forest in Ecuador are depressed during the dry season and increased during the beginning of the rainy season. This seasonal pattern recurs in many other insect groups such as Coleoptera, Hymenoptera, Homoptera, Lepidoptera, Orthoptera (Brown *et al.*, 2001; Wolda, 1992; Wolda and Wong, 1988). However, the magnitude of intra- and inter annual variation in species richness and abundance of tropical insects remains poorly known.

Two important measures of diversity are species richness and relative abundance of individuals (Hammond and Miller, 1998). Species richness is a critical variable in conservation planning and natural resource management. Kerr (2001) suggested that the predictability of butterfly richness improved with quadrat size and butterfly richness may be less predictable as quadrat size declines.

Butterflies (Lepidoptera: Papilionidae) are among the best studied insect groups in south-east Asia in terms of taxonomy and biogeography (Abrera, 1982, 1985, 1986; Corbet and Pendlebury, 1992; Igarashi and Fukuda, 2000). Schulze *et al.,* (2004) and Veddeler *et al.,* (2005) showed that undisturbed mature forests had significantly higher species richness than selectively logged forest and plantations. Lepidopteran species richness increases with potential evapo-transpiration (PET) within individual biomass independently of habitat heterogeneity measures (Kerr *et al.,* 1998).