

Chapter - 2

**GENERAL LITERATURE
REVIEW**

Lepidoptera (butterflies and moths) is a major insect order which is divided amongst four sub-orders (Zeugloptera, Aglossata, Heterobathmiina, and Glossata). The representatives of order Lepidoptera found in all terrestrial regions of the earth (except the Antarctic continent and extreme Arctic), and appear to have evolved at least as early as the Mesozoic era. Their biology is dominated by the ecology of the early stages (mainly feeding on or within plant tissues), and the mate-location strategies and dispersal abilities of the adults.

The butterflies (sub-order Rhopalocera) include about 17,200 species (Ackery 1984); belong to the Ditrysia, a major sub-group of the Glossata. The two major subgroups, super-families Hesperioidea (with the single family Hesperidae) and Papilionoidea (with five families – Papilionidae, Pieridae, Lycaenidae, Riodinidae, and Nymphalidae) are cosmopolitan and well-represented in the Oriental Region (Scoble 1986, Weller and Pashley 1995, de Jong *et al.* 1996). The oldest known fossil considered to be a hesperioid butterfly was from the Upper Paleocene (Kristensen and Skalski 1999). Butterfly diversification is generally considered to have come about through co-evolution with flowering plants, or more probably by adaptive radiation onto flowering plants, coupled with geographical isolation. Mate location in butterflies is typically initiated by visually guided male activity (in contrast to moths, in which mate location is normally initiated by controlled release of female pheromones).

In India, butterflies were more or less overlooked in the period prior to the invasion of Europeans. Peter Smetacek (2000), in one of his article on ‘The study of butterflies’ summarized that: “Work on Indian butterflies began, in a rather haphazard manner, during the first half of the 18th century. During this period, the opening up of trade routes from Europe to many parts of the world, and the consequent increase in trade had resulted in the collection of many life-forms curious and unfamiliar to Europeans. Some of these were economically important, while other served merely to enhance the growing curiosity of Europeans. They sold these creations under fanciful names to credulous buyers who ranged from competent naturalists to society hostesses, whose only interest was filling their ‘cabinet of curiosities’ with more unusual creatures than possessed by their social rivals”.

Carolus Linnaeus, who originated the binomial system of nomenclature, was the first person to describe one Indian butterfly *Papilio hector* (= *Atrophaneura hector*) commonly known as Crimson Rose on the basis of the previous illustration. From 1775 onwards, J.C. Fabricius and Pieter Cramer described a number of Indian butterflies. The former described the Indian collections of Johan Gerhard Koenig (1728-1789), a Danish medical doctor who came to South India in 1767.

The 19th century saw vast progress in every field of science, and the study of butterflies was no exception. The East India Company's Museum at London contained a number of Indian butterflies which were described by Thomas Horsfield and Frederick Moore between 1828 and 1859 in their 'Catalogue of the Lepidoptera in the Museum of the Honourable East India Company' (Talbot 1939, Smetacek 2000). Butterflies were collected even from the remotest parts of India by army personnel and other civilians. Large number of scientific papers and books describing Indian butterflies were also published during this period. Although important, these information were fragmentary in nature and scattered. A strict morphological approach was adopted; every population that differed visibly from population of similar species was considered a distinct species. There was little understanding of polymorphism, seasonal variation, and variation within a species. Wet and dry season forms were often described as different species. The classification and nomenclature is not easily understood by today's workers. At least a hundred genera are now synonymized, as are hundreds of species (Larsen 2004).

One of the oldest accounts on Indian butterflies was published by Moore (1865) on the 'Lepidopterous Insects of Bengal'. He reported as many as 389 species of butterflies under nine families. Most of the collections were made from different localities around Calcutta and Darjeeling which are well within the political boundary of the State West Bengal. However, a handful of them were from Dacca (Bangladesh), Cuttak (Orissa) and Silhet (Bangladesh).

Lionel de Nicéville (1881, 1882, 1883a, 1885b) wrote a series of papers on butterflies taken in Sikkim. The butterflies were taken on the road between Siligori (Siliguri) and Chunabatti, between Chunabatti and Kurseong, between Kurseong and Darjeeling and also from the valley of Great Ranjeet (Rangit) and from the hills

and valleys near the station of Darjeeling. All these areas fall under present day boundary of West Bengal. He mentioned a total of 313 species of butterflies from his four visits. Nicéville (1885a) prepared a comprehensive list of butterflies of Calcutta and its neighbourhood, with additional notes on habits, seasonal dimorphism and food-plants. He provided a list of 163 species under five families including those of 98 species mentioned by Rothney (1882) in his paper on butterflies captured in Barrackpore Park. Wood-Mason and Nicéville (1882) published a comprehensive list of the diurnal Lepidoptera inhabiting the Nicobar Islands. At the same time, Wood-Mason (1880, 1881a, 1881b, 1882) described new butterflies from north-eastern India and made useful revisions of various genera. Later Nicéville (1886a) described life-history of certain species of Satyrinae from Calcutta, with special reference to their seasonal variations. This was one of the oldest literatures on early life-cycle stages of any Indian Lepidoptera. Later Nicéville (1883b, 1885c, 1886b, 1887, 1888, 1889a, 1889b, 1890a, 1890b) in a series of papers described many genera and species of butterflies from Indian region. Mackinnon and Nicéville (1897, 1898a, 1898b) published a list of 322 butterfly species of Mussoorie in the Western Himalaya and neighbouring regions through a series of papers.

Marshall and Nicéville (1883) published the first volume of a work titled 'The Butterflies of India, Burma and Ceylon'. The following second and third volumes were published by Nicéville (1886c, 1890c) alone. These three volumes are the first systematic work on Indian butterflies and although three families, Papilionidae, Pieridae and Hesperidae are not included.

Forsayeth (1884) published one article on life history of Lepidoptera observed during his stay at Mhow, Central India. This article dealt with very useful information on early life-cycle stages of sixty Lepidopteran insects (both butterfly and moth).

An article on butterflies of Kumaon, Garhwal district was written by Doherty (1886). His collection records include low valleys at 2500 ft. and even at great height of 18000 ft. above the sea in the Western Himalayas. He also published notes on Assam butterflies (Doherty 1889).

Elwes (1888) wrote a paper entitled 'A catalogue of the Lepidoptera of Sikkim' in which a total tally of 537 species was mentioned. Although a catalogue of Sikkim butterflies, however, most of the collections were made from Darjeeling district [namely Terai, Birch Hill, Tonglo, Sinchul (Senchal), Singalila range, Peshoke, Mongpo, north-east Bengal, Sivoke (=Sevoke)] and even from Maldah, Calcutta, Barrackpore. All these areas were part of undivided Bengal.

Watson (1888, 1890, 1894, 1895, 1896) published a series of papers based on butterfly collection records from Burma, Mysore, and a key to the Asiatic genera of HesperIIDae, as well as useful revisions of genera of Indian Pieridae. At the same time Watson (1891) compiled description of Indian HesperIIDae which were scattered over a large number of periodicals in a single-volume of 'HesperIIDae Indicae'. Descriptions of total 230 species are provided including notes on their distribution and synonymy.

Davidson and Aitken (1890a, 1890b) published a paper on some of the larvae and pupae of the butterflies of the Bombay Presidency, in which they described 94 species which they had reared. Later Davidson *et al.* (1896a, 1896b, 1897a, 1897b) published a series of papers on the list of butterflies of North Canara District of the Bombay Presidency, including information regarding their habits and transformations.

Betham (1890a, 1890b, 1890c, 1891a, 1891b, 1892) published a comprehensive list of Central Provinces (consisting of 19 districts, situated almost in the centre of Indian Peninsula) through a series of papers. He reported as many as 147 species of butterflies.

The ten volumes of 'Lepidoptera Indica' was published between 1890-1913, first six volumes written by Moore (1890-1892, 1893-1896, 1896-1899, 1899-1900, 1901-1903, 1903-1905) and the rest by Swinhoe (1905-1910, 1910-1911, 1911-1912, 1912-1913). These are all lavishly illustrated (835 hand-coloured plates with some 4000 individual illustrations) and contain descriptions and figures on every known butterfly species (during that period) of Indian subcontinent including notes on their habitats and distribution. Swinhoe (1890, 1893, 1896) also published articles on new species of Indian butterflies and comprehensive list of Lepidopteran insects from Khasia Hills.

Young (1905, 1906, 1907) wrote a series of articles on the common butterflies of India to encourage those who have a genuine desire to collect insects. Later the series was continued by T.R. Bell (1909a, 1909b, 1909c, 1910a, 1910b, 1911, 1912a, 1912b, 1912c, 1913a, 1913b, 1913c, 1914, 1915, 1916, 1918a, 1918b, 1918c, 1919a, 1919b, 1920a, 1920b, 1920c, 1921a, 1921b, 1923a, 1923b, 1924a, 1924b, 1925a, 1925b, 1925c, 1926a, 1926b, 1927). To make the publication widely useful, he incorporated 238 species of butterflies from the plains of India along with those inhabit the hill-stations of Bombay Presidency. Those papers contain very detailed descriptions of the early stages, probably the most elaborate accounts of larvae and pupae ever written.

Bingham (1905, 1907) published two volumes on butterflies in the 'Fauna of British India' series. Families like Danaidae, Satyridae, Amathusiidae, Nymphalidae, Riodinidae, Papilionidae, Pieridae and Lycaenidae (part) were only included.

Hannington (1910a, 1910b, 1911a, 1915) wrote a serial paper on the butterflies of the Kumaon (comprising the districts of Almora, Nainital and Garhwal). Distribution and seasonal occurrence of 378 butterflies were mentioned here. Hannington (1911b, 1911c) also published articles on early life-cycle stages of few Indian butterfly species. His publication also includes papers on Coorg butterflies with detailed list of the Hesperidae and life history notes (Hannington 1916, 1919).

Evans (1910) provided a list of 191 butterflies from Palni Hills, South India along with descriptions of two new species. Evans (1913, 1914a, 1914b, 1920a, 1920b, 1921, 1924a, 1926a) wrote a series of papers on 'Notes on Indian butterflies'. The main objective was to give brief notices of any information published regarding Indian butterflies' along with author's own observations. Evans' (1912a, 1912b) publication on 'A list of Indian butterflies' was a result of 13 years of continuous collection from nearly every part of India. He also consulted available literature of that time. Evans' (1922a) article on 'Butterfly collection in India' provides short descriptions on characteristics of Indian butterflies and techniques to catch and preserve them. Later on Evans (1922b, 1923a, 1923b, 1923c, 1924b, 1924c, 1925a, 1925b, 1925c, 1926b, 1926c, 1926d) wrote a series of articles entitled 'The identification of Indian butterflies' to explain in simple

language how butterflies are to be identified. These were later compiled and published as a book (Evans 1927). A second edition with minor updates and corrections of this valuable handbook was published further (Evans 1932). In the second edition he had identified actually 312 genera, 1466 species, 918 races, and altogether 2384 taxa. This is the only comprehensive account of Indian sub-region butterflies in a single compact book (Ghorpadé and Kunte 2010). With a bit of effort and experience, anyone could now identify at least 95% of any butterfly material from India (Larsen 2004). However, data regarding habits and habitats are lacking in this book.

Tytler (1911, 1912) wrote a paper on butterflies from the Naga Hills and provided a list of 423 butterflies belonging to six families. His other contributions included a series of papers on butterflies from Manipur and the Naga Hills (Tytler 1914, 1915a, 1915b).

Annandale (1912) published notes on the fauna of Paresnath Hills, West Bengal, in which species account of 56 butterflies under four families was mentioned.

Antram's (1924) single volume work on the butterflies of India covers only a part of the Indian area, and many species including all the Lycaenidae and HesperIIDae were not incorporated in this book. Peile (1937) wrote a guide book on collecting butterflies in India, which gave details of over 600 forms, with ample information on the habits of the respective butterflies.

Many species of butterflies and moths make regular movements in the adult stage, over distances which frequently exceed a thousand miles. In India directional flights of butterflies have, however, been known to occur from South India (William 1927, 1930, 1938). Larsen (1978, 1986a, 1986b) wrote detailed articles on seasonal movements of migrant butterflies from the Nilgiri Hills and plains of India. Kunte's (2005) article on movement patterns in Danainae butterfly migrations in Southern India was also very informative.

Talbot (1939, 1947) wrote two new volumes on butterflies in the 'Fauna of British India' series with updated taxonomy and nomenclature followed by L. de Nicéville and F. Moore. However, he did not incorporate further available

information on the distribution and ecology. Species accounts of only 451 butterflies are included.

The splendid work of T.R. Bell was followed by detailed descriptions of early stages published by D.G. Sevastopulo (1938, 1939a, 1939b, 1939c, 1940b, 1941a, 1941b, 1941c, 1942, 1943, 1944c, 1945c, 1946b, 1946c, 1947a, 1947b, 1947c, 1948) in a series of papers. He also made very important contribution in the list of butterflies of West Bengal and neighbouring region. His contributions include butterflies of Calcutta (164 species, nine families), Rhopalocera of Peshoke (89 species, eight families), Lepidoptera of Gopalpur (district Ganjam) (23 species), Rhopalocera of Tukdah (94 species, eight families), Lepidoptera of a trip to Phalut (52 species, eight families), Lepidoptera of Darjiling and Tukdah etc. (Sevastopulo 1933, 1937, 1940a, 1944a, 1944b, 1945a, 1945b, 1946a, 1946d, 1951-1952, 1956a, 1956b). He also published one article on food-plant of Indian Rhopalocera (Sevastopulo 1973).

Sanders (1944) published a paper on list and notes on butterflies of Calcutta. A total of 135 butterflies, eight families were mentioned. Maude (1949a, 1949b, 1949c, 1949d) provided a list of 262 butterflies under 10 families from his four visits at Darjeeling district.

Wynter-Blyth's (1940) publication on butterflies of Simla (Shimla) hills included 278 different species which were collected from low valleys to high up in the Himalayas (from 2000 to 20000 ft.). He also provided a list of the butterflies of the Nilgiris (Wynter-Blyth 1944a, 1944b) in which a total 195 species were mentioned.

The classification of butterflies has undergone major changes over a period of 100 years. Earlier the concept of sub-species was not recognized and virtually any population that differed (intra-specific variations) was described as a species. Numerous sub-families were described. Today these may not even be dignified as tribes. The number of full families was much higher than today. As a result, interpreting a checklist written 100 years back is quite difficult to understand. Gradually, the concept of sub-species was introduced during the 20th century and consolidation began to take place. The numbers of recognized species decreased sharply as previous species were rearranged as sub-species.

Parsons and Cantlie (1948) wrote a paper on butterflies of Khasia and Jaintia Hills, Assam. There was a mention of total 272 species and sub-species with information regarding localities and abundance. An additional list of 206 butterflies was provided by Cantlie (1952). Later he (Cantlie 1956) published a list on Hesperidae of Khasi and Jaintia Hills to fulfill the gap in Evans' Catalogue of Hesperidae. Total 144 species were being mentioned there.

Ferrar (1948) published an article on the butterflies of Andamans and Nicobars based on his collection records from 1923 to 1931. A total of 268 butterfly species was mentioned in the list.

Evans (1949) published a catalogue with keys to the Hesperidae from Europe, Asia and Australia, which were in possession of the British Museum (Natural History). This included all Indian species and remains an invaluable tool for taxonomic identification.

Wynter-Blyth (1957) published a very useful book on butterflies of Indian region. Each species is well described with information on its habits, habitats, abundance and seasonal occurrence. However, only 843 species were described fully.

Cantlie (1963) made taxonomic revisions of the Lycaenidae group (except the *Arhopala* group) of Evans' 'The identification Indian butterflies' and published it as a formal book.

In the year 1997, Director, Zoological Survey of India had edited a comprehensive list of butterflies of the State of West Bengal in 'Fauna of West Bengal (Part 7) - State Fauna Series 3'. This includes a total of 326 species of butterflies under nine families (Bhattacharya 1997, Ghosh and Chaudhury 1997a, 1997b, Gupta 1997a, 1997b, Mandal and Maulik 1997). In the recent past, Dasgupta (2006) prepared a checklist of 450 butterfly species of West Bengal by consulting only few of the available literature.

Varshney (1979, 1985, 1990) wrote a series of articles on the revised nomenclature for taxa in Wynter-Blyth's book on the 'Butterflies of Indian Region' (Wynter-Blyth 1957). His other important publications include 'Index Rhopalocera Indica' and 'Genera of Indian butterflies' (Varshney 1977, 1983, 1993, 1994, 1997,

2010). He estimated the numbers of butterfly species in the Indian region through one of his publication (Varshney 2006). Varshney and Nandi (1976, 1980) published articles on butterfly fauna of Gangetic plains of Bihar.

The Wild Life (Protection) Act, 1972 of India was the first, modern legal step at the national level that ensures protection at various levels of animals including butterflies, plants and their habitats (Anonymous 2007a). Once it was properly implemented throughout India many studies in respect to butterflies (diversity, seasonal occurrence etc.) of Protected Areas (National Parks, Sanctuaries, Reserve Forests etc.) have been performed by various workers. However, it is not possible to discuss all those in detail. Saha and Raychaudhuri (1998, 1999a, 1999b, 1999c, 2001, 2002a, 2002b) in a series of articles produced a checklist of 102 species of butterflies under seven families from Buxa Tiger Reserve, Jalpaiguri district, West Bengal. Das *et al.* (2012) published a systematic list of butterflies' along with habitat preference data from Gorumara National Park, Jalpaiguri district, West Bengal. They presented a list of 170 butterflies belonging to five families. Some other important works in Indian perspective were those of Trishna Wildlife Sanctuary, Tripura (Majumder *et al.* 2012), Rani-Garbhanga Reserve Forest, Assam (Saikia *et al.* 2010), Ratanmahal Wildlife Sanctuary, Gujarat (Bhalodia *et al.* 2002), Bondla Wildlife Sanctuary, Goa (Borkar and Komarpant 2004), Pench Tiger Reserve and National Park, Madhya Pradesh (Chandra *et al.* 2002, Sharma and Radhakrishnan 2005), Ripu-Chirang Wildlife Sanctuary, Assam (Choudhury 2010), Mudialy Ecological Park, Kolkata (Chowdhury and Chowdhury 2007), Chintamani Kar Bird Sanctuary, West Bengal (Chowdhury 2010, Chowdhury and Chowdhury 2006a, 2006b), Indian Botanical Garden, West Bengal (Chowdhury and Das 2007), East Calcutta Wetland, West Bengal (Chowdhury and Sarkar 2007, Chowdhury and Soren 2011), Kalakad-Mundanthurai Tiger Reserve (Devy and Priya 2001), Indian Tiger Reserves (Ghosh *et al.* 1993), Rajaji National Park, Uttaranchal (Joshi 2007), Guindy National Park, Madras (Rajasekhar, 1995), Lonar Wildlife Sanctuary (Sharma 2008), Melghat Tiger Reserve, Maharashtra (Sharma and Radhakrishnan 2004), Tadoba Andhari Tiger Reserve, Maharashtra (Sharma and Radhakrishnan 2006), Kedarnath Musk Deer Reserve, Uttaranchal (Singh 2009), Ankua Reserve Forest, Jharkhand (Singh 2010), Aralam Wildlife Sanctuary, Kerala (Sreekumar and

Balakrishnan 2001), Dalma Wildlife Sanctuary, Jharkhand (Verma 2009), Shendurny Wildlife Sanctuary, Kerala (Shamsudeen and Mathew 2010).

There are also a good number of articles published in recent times in various journal on butterfly diversity of different states/ and or biodiversity hotspots (both inventory and new records). The review includes some of the important works: Arunachal Pradesh (Arora and Mandal 1981), New Delhi (Ashton 1973), Madhya Pradesh and Chattisgarh (Chandra *et al.* 2007), Nilgiri Mountains (Larsen 1987a, 1987b, 1987c, 1988), Delhi (Larsen 2002), Goa (Rangnekar and Dharwadkar 2009), Dehradun valley (Singh and Bhandari 2003), Vidarbha region, Maharashtra (Tiple 2011), Sriniketan, West Bengal (Sukul and Jana 1972), Western Ghats (Murugesan and Muthusamy 2011, Kunte 1997, 2008, Kunte *et al.* 1999), Eastern Ghats (Ramana 2010, Raju *et al.* 2011), Garo Hills (Kunte 2010), Mizoram (Kunte 2009), Simlipal Hills (Nair 2011), Pune, Maharashtra (Nimbalkar *et al.* 2011), Western Himalaya (Singh 2003, 2005a, 2005b). Smetacek (2006, 2007) published comprehensive checklist of South Asian skipper (Hesperiidae) butterflies.

In recent times, many photographic guides were published to make identification easy. However, no such book is available covering all butterfly fauna of India and also lack further information after Wynter-Blyth's book. Some of the important publications are on – Butterflies of Shillong (Anonymous 1989), South Indian butterflies (Gunathilagaraj *et al.* 1998), Common Butterflies of Bengal Plains (Roy *et al.* 2007), Treasures on Tiger Tracks (Ganesh *et al.* 2009), butterflies of Western Ghats (Gaonkar 1996), Butterflies of India (Gay *et al.* 2008), Butterflies of Sikkim Himalaya (Haribal 1992), The Book of Indian Butterflies (Kehimkar 2008), Butterflies of Peninsular India (Kunte 2000), Butterflies of the Himalaya (Mani 1986), Butterflies of India (Singh 2011), Guide to butterflies of Goa (Rangnekar 2007), Butterflies and Wild Flowers of Tolly Club (Roy 2011), Butterflies of Mumbai (Rodrigues 2012), Butterflies of the Garo Hills (Sondhi *et al.* 2013).

Key general works on butterflies in recent past (international scenario) includes: Ehrlich (1958), Eliot (1961, 1973, 1986, 1990), Hemming (1967), Ackery (1975, 1984), Vane-Wright (1978, 1993), Hancock (1983), Ackery and Vane-Wright (1984), Brakefield (1984), Bridges (1888), Yata (1989), Vane-Wright and Ackery (1989), Heppner (1991), Pollard and Yates (1993), Weller and Pashley (1995), de

Jong *et al.* (1996), Ackery *et al.* (1999), Braby (2005), Warren *et al.* (2009). Factors which determine the distribution of butterflies were elaborately discussed in research articles by Hodgson (1993), Dennis and Shreeve (1996, 1997), Dover 1997, Dennis *et al.* (2000), Cowley *et al.* (2001a), Dennis *et al.* 2003, Dennis 2004, Dennis *et al.* 2004, Dennis *et al.* 2006 . The resourceful works of Thomas *et al.* (1988), Hanski *et al.* (1993), Gutiérrez and Menéndez (1995), Hughes (2000), Cowley *et al.* (2001b), Päävinen *et al.* (2005) showed that distribution and density of butterflies are not related.

Recent literature on neighbouring countries in the region (South and South-East Asia) which are most useful were those of Bangladesh (Larsen 2004), Nepal (Smith 1994, 2006), Ceylon (D'Abrera 1998), Pakistan (Roberts 2001), Thailand (Pinratana 1977, 1979, 1981, 1983, 1985, 1988), Malay Peninsula (Corbet and Pendlebury 1992), Hong Kong (Bascombe *et al.* 1999). The three volumes of 'Butterflies of Oriental Region' are one of the finest guides with coloured illustrations of all listed butterflies in this region (excluding the Hesperiiidae) (D'Abrera 1982, 1985, 1986).

Information on feeding and foraging behaviour of adult butterflies were furnished in research articles by Norris (1936), Arms *et al.* (1974), Gilbert and Singer (1975), Adler and Pearson (1982), Brakefield (1982, 1994), Tumlner (1885), Boggs (1987), Pivnick and McNeil (1987), Braby and Jones (1995), Sculley and Boggs (1996), Miller (1997), Beck *et al.* (1999), Hall and Willmott (2000), Dennis (2004), Tudor *et al.* (2004), Boggs and Dau (2004).

Studies on different aspects of mate-acquisition strategies by Tinbergen *et al.* (1942), Obara (1964), Baker (1972), Scott (1974), Bitzer and Shaw (1979, 1983), Boggs (1981, 1987, 1990, 1995), Rutowski *et al.* (1983), Thornhill and Alcock (1983), Wickman and Wiklund (1983), Wiklund and Forsberg (1985), Wickman (1986, 1992), Pivnick and McNeil (1987), Rutowski and Gilchrist (1987), Forsberg and Wiklund (1989), Cordero and Soberón (1990), Rutowski (1991, 1978a, 1978b, 2003), Kaitala and Wiklund (1994) are very resourceful.

Articles by Ilse (1937), Rausher *et al.* (1981), Courtney (1982, 1986), Kolb and Scherer (1982), Dennis (1983), Stanton (1984), Wiklund (1984), Forsberg (1987), Jordano *et al.* (1990), Jones (1991), Thomas *et al.* (1991), Kelber (1991a,

1991b), Porter (1992), Shreeve (1992), Dennis (1995), Figurny and Woyciechowski (1998), Dolek *et al.* (1998), Gutiérrez *et al.* (1999), Meyer-Hozak (2000), Kelber *et al.* (2001), Janz (2002, 2003), Anthes *et al.* (2003a, 2003b), Heinz and Feeny (2005), Nylin *et al.* (2005), Küer and Fartmann (2005), Rabasa *et al.* (2005), Stefanescu *et al.* (2006), Eichel and Fartmann (2008) enlighten topics like host plant selection and ovipositing behaviour of female butterflies.

Whereas, Hinton (1981), Courtney (1984a), Davies and Gilbert (1985), Pullin (1986), Vulinec (1990), Porter (1992), Fitzgerald (1993), Clark and Faeth (1997), Nieminen *et al.* (2001), Singer (2004), Saastamoinen (2007) elaborately discussed the egg-laying behaviour of butterflies.

Literature available on larval ecology and food plant use are of plenty and only a few of them are mentioned here, like Wiklund (1975), Cates (1980), Mattson (1980), Courtney (1984b), Slansky and Scriber (1985), Boggs (1986), Wheeler (1996), Mevi-Schütz and Erhardt (2005). For the early stages and life histories the works of Igarashi and Fukuda (1997, 2000) is an excellent resource. Chou (1990, 1998) provides illustrations of all Chinese butterflies, many of which are Oriental in distribution. The series on Chinese butterflies produced by Satoshi Koiwaya (1996) and Hong Kong butterflies (Bascombe *et al.* 1999) are other remarkable resources on life history studies. Key works by Indian contributors are those of Atluri *et al.* (2002, 2004a, 2004b, 2010), Ramana *et al.* (2004), Raju *et al.* (2011), Lakshmi and Raju (2011). The publication of Robinson *et al.* (2001) on hostplants of the moth and butterfly caterpillars of the Oriental regions is a remarkable resource.

Information on basking and daily activity patterns of butterflies are available in articles by Parry (1951), Digby (1955), Vielmetter (1958), Church (1960), Clench (1966), Porter and Gates (1969), Kammer (1970), May (1979), Magnuson *et al.* (1979), Rawlins (1980), Willmer and Unwin (1981), Willmer (1982), Findlay *et al.* (1983), Willmer (1983, 1991), Boggs (1986), Kingsolver (1985), Stevenson (1985), Heinrich (1986), Tracy and Christian (1986), Srygley (1994), Kemp and Krockenberger (2004).

Factors which determine the distribution of butterflies were elaborately discussed in research articles by Hodgson (1993), Dennis and Shreeve (1996, 1997), Dennis *et al.* (2000), Cowley *et al.* (2001a), Päivinen *et al.* (2005). Whereas,

studies by Hanski *et al.* (1993), Hodgson (1993), Gutiérrez and Menéndez (1995), Thomas *et al.* (1988), Dennis *et al.* (2000), Hughes (2000), Cowley *et al.* (2001a, 2001b), Päävinen *et al.* (2005) showed that distribution and density of butterflies are not related.

In global conservation perspective, butterfly parks and breeding centers are widely adopted as integrated management practices. Different aspects of butterfly conservation were discussed in various articles by Boppré and Vane-Wright (2012), Collins (1987), Collins and Morris (1885), Kendrick (2011), Morris *et al.* (1991), New (2010, 2011a, 2011b), New and Collins (1991), New *et al.* (2000). However, this concept has not been attempted in many tropical and sub-tropical countries including India. Few publications which could be useful are those by Bahuguna (1998, 1999), Hutton (1985), Khatri (1993), Kunte (2008), Gupta and Mondal (2005), Hanfee (1998), Sidhu (2011).