

CHAPTER - II
REVIEW OF LITERATURE

Bryophytic flora has always been a source of fascination and interest to explorers and botanists. Systematic studies on Hepatic flora of different localities have frequently perused in various parts of the world as well as in India. Bryophytes were collected by British Civil Service officers, doctors, surveyors, travellers, foresters and systematic botanists. Their collections were studied and named by various experts and deposited in Central National herbarium, Howrah and other world herbaria of far off places. The noteworthy earliest contributions of bryophytes were made by the following workers.

Lindenberg and Lehman (1832) have studied some liverworts of India and Nepal. The catalogue of Dr. Wallich, reproduced by Royle (1839) includes a brief note on the hepatics. Lindenberg and Nees (1844, 1847) have been given an account of some of the Indian liverworts collected by Wallich and Wight from the Himalayas. The posthumous memories of Griffith (1849, 1849a) may perhaps be considered as the first noteworthy contribution to Indian bryology in its early days.

Mitten (1860, 1861) published a comprehensive treatment of the liverworts of India. Besides this a diagnoses of several new plants have also been given. During the period 1861-1898 however, a long gap of 37 years ensued and no contributions on Indian hepatics occurred although

liverworts were collected. Schiffener (1899) described the liverworts of British Bhutan. He dealt with 35 species of liverworts of which 10 species and 2 varieties were new to science. Towards the close of the 19th century, Stephani (1900-1924) published the world monograph of liverworts including descriptions of a large number of plants not only from India, Burma and Ceylon but also from such adjoining Indian territories as Nepal, Madura, and the Andaman and Nicobar Islands.

The year 1914 is memorable in the history of Indian bryology as it is only since then that the study of liverworts received serious attention from botanists at home. Kashyap- an enthusiastic explorer, brilliant botanist and the founder of the school of bryology in India, extensively collected liverworts from Western Himalayas. He published an article on the West Himalayan hepatics (Kashyap, 1914) - this being the first publication on bryology by an Indian worker. During his following 20 years or so, his researches (Kashyap, 1914a, 1915, 1915a, 1916, 1917a, 1917b, 1919, 1919a, 1920, 1921, 1923, 1928, 1929, 1932, 1932a; see also R.S. Chopra, 1935) covered the various aspects of Indian hepaticology. The wealth of Indian liverworts described by Kashyap (*loc.cit*) appears so impressive that Prof. Goebel called it a "gold mine in the Western Himalayas." No review of Kashyap's contributions to Indian bryology would be complete without reference to his 2 monographs entitled

“Liverworts of Western Himalayas and Punjab Plain” (1929, 1932) Kashyap’s contributions created a renaissance in bryological research in India. A number of workers started investigation on bryology and through active work at some research centres, they are still contributing to our knowledge on these plants. The following workers not only studied the taxonomy of liverworts but also initiated further research on various other aspects as well such as morphology, cytology, physiology and phylogeny.

Pande (1936) has taken a review of ‘Indian Liverworts’. Pande (1932, 1934); Pande and Mishra (1943, 1943a) have given morphology of *Notothylas* and account of Indian Hepaticae. Pande and Shrivastava (1952) have studied Hepatic vegetation of Pachmari. Pande (1958) in his presidential address stressed importance of vegetational studies of ‘Indian Hepaticology’. Pande, Mahabale, Raje and Shrivastava (1954); Pande and Mishra (1955); Pande and Udar (1957) have given taxonomic status of Indian Metzgerinae. Pande and Srivastava (1957) have given account of progress of science in India in which account of bryology has been emphasized.

Mahabale (1941, 1958), Mahabale and Gorje (1941), Mahabale and Bhate (1945); Mahabale and Deshpande (1947), Mahabale and Mahajan (1955); Mahabale (1971) have studied various aspects of the liverworts.

Mehra and Vashista (1950); Mehra and Khanna (1950); Mehra and Handoo (1953); Mehra and Sokhi (1972) have given developmental account of different genera. Mehra (1957) presented evidence to support the origin of Marchantiales from foliose Jungermanniales. Bapna (1958) studied liverworts from Mount Abu.

Pande (1958) and Kachroo (1969) recognised five geographical units of hepatic flora of India viz., 1) The West Himalayan territory, 2) The East Himalayan territory, 3) Central India and the Gangetic plain and 5) Southern zone consisting a) The West-coast region, b) The East coast region and Deccan plateau.

Kachroo (1951, 1954, 1955, 1955c, 1969, 1970) has given distribution and other aspects of Hepaticae. Udar (1950, 1956, 1957, 1957a, 1957b, 1958, 1959, 1961, 1965, 1970a, 1976, 1980) has given taxonomic account of different genera. Udar and Srivastava (1971), Udar and Singh (1978), Udar and Srivastava (1978) have studied genus *Cyathodium* from Western and Eastern Himalayas. Udar and Nath (1976) Udar, Srivastava and Singh (1978) have studied oil bodies in West Himalayan Liverworts. Udar and Gupta (1981) has given differentiation of genus *Targionia*. Udar and Singh (1981), Udar and Kumar (1981) have published a new species of *Notothylas* and *Jungermannia* respectively.

Udar and Srivastava (1983) studied reproductive biology of some Indian liverworts. Udar R., Srivastava S. and Srivastava G. (1983) have studied endemic liverwort taxa from India. Udar and Srivastava (1984) have studied scanning electron microscopy of spores of some Indian liverworts. Udar and Shaheen (1983) have studied oil-bodies in liverworts of Nainital. Udar and his other students like Udar and Kumar (1982, 1984); Gupta and Udar (1986); Udar and Awasti, (1981, 1983); Kumar and Udar (1985); Awasti and Srinivastava (1987); Kumar (1987); Srivastava and Sharma (1987, 1990) reported new forms (both thalloid and leafy). Recently Mondal et al. (1999) studied biochemical analysis of Twelve Eastern Himalayan species of Riccia. They have also contributed valuable information on morpho-taxonomy, life history, sporeling development, regeneration, gemmaling patterns, enzyme study, palynology, cyt-taxonomy, culture study and scanning electron microscopy of spores.

Some other workers who have also added their contributions to the liverwort flora are : Bir (1970); Bir and Chopra (1972), Kanwal (1977, 1979), Pant and Tewari (1983, 1984, 1988); Tewari and Pant (1983, 1984, 1989); Srivastava (1984); Pant et al. (1986); Tewari and Airi (1988); Gautam and Thakur (1981).

Schuster (1966, 1969, 1974, 1980, 1992, 1992a) has published the account of the Hepaticae and Authocerotae of North America in Vol. I to VI respectively. Campbell (1961) has narrated the problems in the origin and classification of bryophytes with particular reference to liverworts. Fulford (1964) has given contemporary thought in plant morphology of Hepaticae and Authocerofae. Black (1913) have studied morphology of *Riccia frostii*. Hebant (1973, 1977) have studied the conducting tissues of bryophytes. Jarman and Fuhrer (1995) have studied mosses and liverworts in Tasmania and South-Eastern Australia.

Liverworts from Maharashtra are not studied in detail. Some workers like Morajkar (loc.cit) studied liverworts from Nashik. Biradar and Joshi (1984) have given distribution and enumeration of liverworts from Western Ghats. Kalgaonkar (loc.cit) have studied monography and histochemistry of some hepatic members of Maharashtra. Chopra (1938, 1943), Chavan (1937), Apte and Sane (1942), Dabhade (1974), Gupte (1945) have worked on bryophytic flora.

The fascinating ecology of this interesting group of plants has been badly neglected in India. Only a few workers have contributed so far in this field viz. Dudgeon (1923); Maheshwari, et al. (1965); Srinivasan (1968); Pant (1974, 1987); Parihar and Pant (1975, 1982); Tewari et al.

(1985); Shukla (1977); Shukla et al. (1981, 1983); Pant and Tewari (1984, 1988, 1989); Patidar (1988); Vishvakarma and Kaul (1988); Prasad et al. (1989), and their studies too are preliminary ventures in comparison to the sophisticated and detailed investigation of Western workers. Multidimensional aspects of bryophyte ecology that have received attention all over the world in the last forty years include : attempts to recognise and define bryophyte growth forms (Magdefrau, 1982) and life strategies (During, 1979; Layton, 1988; Longton, 1988); quantitative estimation of bryophyte communities, species diversity, correlation with environment and multivariate techniques of numerical classification and ordination (Reviewed by Bates, 1982); other statistical methods including regression, cluster and niche analysis and the use of these (methods) in epiphytic, epilithic, mire, mountain and aquatic bryophyte communities, measurement of bryophyte growth-biomass (harvest) and gas exchange techniques (Slack, 1976, Slack and Glime, 1985; Russel, 1988; Russel and Botha, 1988); a refined study and analysis of the epiphytic habitat (Hale, 1955, 1965; Barkman, 1958; Iwatsuki, 1960; Stringer and Stringer, 1974; Slack, 1976; Rasmussen and Hartig, 1977; Studler, 1982a, 1982b, Pippo, 1984; Ashton, 1986; Palmer, 1986; Tooren and During, 1988; Soderstrom, 1989; Stone, 1989; Frahm, 1990; Schmitt and Slack 1990, Ishiyama and Iwatsuki, 1991); the role of bryophytes on disturbed sites (Pocs, 1982;

Mckendrick, 1987); the post fire community (Southern, 1976; Brown 1982; Duncan and Dalton, 1982; Brasell and Mattay, 1984); and the physiological ecology (Reviewed by Proctor, 1979, 1982, 1984). The subject of mineral nutrition has grown with astounding rapidity in recent years. A great wealth of information is available today from widely scattered parts of the world on bryophytes as monitors or accumulators of minerals or as bio-geo indicators. (Persson, 1948, 1956; Schatz 1956; Noguchi, 1956; Noguchi and Furata, 1956; Schofield, 1959; Shacklette, 1965, 1967, 1984; Whitehead and Brooks, 1969; Brooks 1971, 1983; Coker, 1971; Yeaple, 1972; Crundwell, 1976; Ward et al., 1976, 1977; Wilkins, 1977; Brown and Buck, 1978; Shaklette and Erdman, 1982; Smith, 1982; Glime and Keen, 1984; Wehr and Whitton, 1983; Dyer and Duckett, 1984; Erdman and Modreski, 1984; Satake, 1985; Jones, 1985; Smith, 1986; Shaw 1986; 1987, 1988, 1990; Pentecost, 1981, 1987; Satake et al., 1990; Herrmann, 1990). Extensive literature is available today on the use of bryophytes to assess environmental quality and to monitor heavy metal pollution (Reviewed by Nash and Wirth, 1988).

Recently Tewari and Pant (1994) have presented together an account of ecology of this neglected yet promising group of plants. Daniels (1998) have studied ecological adaptations of some bryophytes of the Western Ghats.

In contrast to such important breakthroughs made elsewhere, our studies in this field appear meagre. In the earlier pages the works on hepatics have been reviewed, special emphasis has been laid on the investigations of liverworts during the last centuries. Since the most of the earlier researches are mainly comprehensive, taxonomic treatises would not permit elaboration within the scope of this review.