

INTRODUCTION

1.1 Status of Pteridophytes in Indian flora

Pteridophytes, the seedless vascular plants, had a very very flourishing past in dominating the vegetation of the earth about 280 - 230 million years ago (Mehra 1967 ; Bir 1976a, 1987a, 1994b ; Khare 1996). Although they are now largely replaced by the seed bearing vascular plants in the extant flora today, yet they constitute a fairly prominent part of the present day vegetation of the world. India with a highly variable climate has a rich diversity of its flora and Pteridophytic flora greatly contributes to its diversity (Kaur 1979, 1980, 1989 ; Bir 1987a, 1987b). Pteridophytes also form an interesting and conspicuous part of our national flora with their distinctive ecological distributional pattern. On a very conservative estimate 500 species of ferns and 100 species of fern-allies are on record from India (Bir 1987a). However, according to a recent census, the Pteridophytic flora of India comprises of 67 families, 191 genera and more than 1,000 species (Dixit 1984 ; Dixit & Vohra, 1984). The vascular flora of our country in general has about 15,000 species (Jain 1984) and as a constituent of Indian flora of vascular plants, the ferns and fern-allies form only five percent part as far as the number of species is concerned (Satija & Bir 1985). But, due to their abundance in individuals as well as their conspicuousness in epiphytic vegetation and in the terrestrial vegetation along forest margins, roadsides, and forest floors, the contribution of ferns and fern-allies to the vegetational pattern in India rank only next to the flowering plants.

1.2 A synoptic account of works done in India on Taxonomy and Systematics of Pteridophytes

In spite of the fact that Pteridophytes form a prominent feature of the native flora of our country, it is until the first quarter of the present century that the sources of information on Indian ferns had been the works of R.H. Beddome (1863 - 1864, 1865 - 1870, 1876, 1883, 1892), C. B. Clarke (1879, 1880), C. W. Hope (1899, 1900, 1901, 1902, 1903a, 1903b, 1904) and a few others. Fern allies, however, were practically left untouched by all of them. Even if the nomenclature of many a species described in these works has become obsolete today, these works still remain as the most important reference works on fern flora of our country.

After the compilation of above classical taxonomic works in the second half of the nineteenth century, it is till about the early sixties of the present century that no significant work has appeared on taxonomy of Indian ferns except for systematic lists of ferns and fern-allies of various regions published from time to time (Schmidt 1857 ; Blanford 1888 ; Macpherson 1890 ; Gamble 1892 ; Prain 1903a, 1903b ; Blatter 1908 ; Stewart 1917, 1938, 1839, 1944, 1945, 1951, 1957 ; Blatter & d'Almeida 1922 ; Haines 1924 ; Majumdar 1933 ; Shingh 1931 ; Mahabale 1938a, 1938b ; Mehra 1939 ; etc.). It is after 1950 that there was a resurgence of researches in Pteridophytes in India in almost all the prominent fields. Comprehensive reviews on works done on Pteridology in India have been provided by Mehra & Chowdhury (1957), Maheswari & Kapil (1963), Chowdhury (1973a) and Bir (1987b), and on different aspects on Indian Pteridophytes by Bir (1976a, 1976b, 1977a, 1977b, 1979, 1983). Kaur & Raza (1983) prepared a detail bibliography of Indian Pteridology till the end of 1980 and this was followed by publications of Vasudeva & Bir (1994a) for the period 1983 - 1993 and Bir (1994a) for the period 1981 - 1994.

The last three decades witness a renewed interest on the study of systematics, distribution, ecology, phytogeography and taxonomy of Indian Pteridophytes and Bir (1976a) has published an account on

taxonomy of Indian Pteridophytes by reviewing in detail the literature till the end of 1973. Nayar & Kaur (1974) provided the nomenclatural equivalents to the species described together with the correct identity to the names used by Beddome in *Handbook to the Ferns of British India, Ceylon and the Malaya Peninsula* and Chandra & Kaur (1987) have published the nomenclatural equivalents of the names used by Beddome for the illustrations of *Ferns of Southern India* and *Ferns of British India* giving correct identity to nearly all the names used therein. Nair & Dixit (1981) published a list of Indian fern taxa not included in Beddome's *Handbook to the Ferns of British India, Ceylon and the Malaya Peninsula* and the supplement to the above work. All these works not only provided a strong basis for workers on Indian Pteridophytes but also rendered relevancy to the works of Beddome even after more than one hundred years of publications of these works.

During the last few decades there have been revival of floristic studies in India and intensive explorations have been made in different parts of our country by the workers of several institutions. These have not only resulted in several floristic / systematic accounts at regional, district or even sub-division level, but also reports of new taxa, new records, and taxonomic and nomenclatural notes have been published (Jain 1984). The compilation of lists of new taxa added to the Indian fern flora were published by Nair & Dixit (1981) and Chandra (1981). With exploration of more and more areas, it is now possible also to workout the status of Indian Pteridophytes. Chandra (1982) enlisted 96 ferns as endemic to India and then Chandra & Kaur (1984) and Kaur & Chandra added 41 and 40 species respectively to the list of endemic ferns of India, while Bir (1987a, 1993) region-wise identified the rare and endangered Pteridophytic elements in India with strategies for their conservation. Dixit (1982) has published a conspectus of the families and genera of Indian Pteridophytes and a census of the Indian Pteridophytes (Dixit 1984) listing 191 genera and more than 1,000 species. Dixit & Vohra (1984) also published a dictionary of Pteridophytes of India embodying relevant information on distribution, use and other information of the taxa.

With the revival of interest in floristics of Pteridophytes in India, a good number of comprehensive works have also appeared for different parts of the country during the last three decades. Of the important floristic accounts, mention can be made of the work(s) of Kachroo (1953, 1975), Panigrahi (1960, 1968), Panigrahi & Patnaik (1961a), Panigrahi & Chowdhury (1961, 1962), Ghose & Biswas (1977), Rao & Hajra (1980), Chandra (1980), Dutta *et al* (1980), Baishya & Rao (1982), Chandra & Chandra (1983), Jamir & Rao (1988), Bir *et al* (1989), Kachroo *et al* (1989) and Vasudeva *et al* (1990) on different parts of North Eastern India ; Mehra & Bir (1964) on Darjeeling and Sikkim ; Bir & Shukla (1966, 1968, 1971), Bir (1968a, 1968b) and Bir *et al* (1986) on Simla hills ; Dhir (1980) on North Western Himalayas ; Dhir & Dutta (1977a, 1977b) on Dharmasala hills ; Chandra (1979) on Kedernath, Madhyamaheswar and Tunganath ; Loyal & Verma (1960) and Verma & Khullar (1980) on Nainital ; Dhir & Sood (1981) on Mussoorie hills ; Bir *et al* (1983) on Garhwal Himalaya ; Pande & Pande (1990, 1994) and Pande (1990) on Kumaun Himalaya ; Mehra & Dhir (1968) on Dalhousiae hills ; Bir & Verma (1961, 1963) on Mt. Abu ; Sharma *et al* (1969) on Gorakhpur, Pande (1973) on Ranikhet and Tiwari (1973) on Lucknow district of Uttar Pradesh ; Mehta (1956) on Parasnath of Bihar ; Chowdhury & Raizada (1961) and Chowdhury (1973b) on Upper Gangetic Plains ; Bir & Vasudeva (1973) and Vasudeva & Bir (1994b, 1994c, 1994d) on Pachmarhi hills of central India ; Agashe (1968) on Kolhapur, Maharashtra ; Subramanyam *et al* (1960), Bir & Basudeva (1971), Manickam & Ninan (1976), Manickam & Irudayaraj (1990, 1992) and Dixit & Mondal (1994) on different parts of South India ; Nayar & Srivastava (1962) on Great Andaman ; and Ellis (1987) on Andaman and Nicobar Islands.

Revisionary and critical taxonomic studies in respect of certain families and genera have already been made as a step towards the compilation of a modern Pteridophytic flora of our country (Nayar 1955,

1956, 1957, 1961a, 1961b, 1961c, 1961d, 1962a, 1962b, 1963, 1964a; Gupta 1962; Panigrahi & Dixit 1966a, 1966b, 1967, 1968, 1969a, 1969b; Dixit & Panigrahi 1969; Nayar & Kazmi 1962, 1963; Nayar & Kaur 1963a, 1963b, 1964a, 1964b; Nayar & Chandra 1965; Nayar & Chandra 1968; Bir & Devi 1968; Bir & Trikha 1968a, 1968b, 1969, 1974; Chandra 1971; Bir *et al* 1974; Dixit & Das 1979, 1981; Dixit 1980, 1981; Panigrahi 1981; Satija *et al* 1983; Bir 1986 and others). In addition to the above works, taxonomic notes and critical studies on nomenclature of certain Indian taxa published during the last three decades have also contributed for a modern Pteridophytic flora of India (Nayar 1954; Nair 1968, 1969; Bir 1962a, 1962b; Bir & Trikha 1973; Panigrahi 1975c; Chakravarty 1981; Dixit & Balkrishna 1993; and others). Basing on the studies on materials in Indian and foreign herbaria, Satija & Bir (1985) have completed an up to date taxonomic account of Polypodiaceous ferns of India. Similarly, Dixit (1988) worked out the family Lycopodiaceae in India.

Of relevance to the Pteridophytic flora of India are the works on revisions, monographs and critical taxonomic interpretations published from time to time (Ching 1931, 1935, 1938; Holttum 1965, 1969, 1971, 1972, 1973a, 1973b, 1974a, 1974b, 1976a, 1976b, 1977, 1983, 1985; Sledge 1967; Nair 1972; Dixit & Nair 1974; Panigrahi 1975a, 1975b, 1975d; Nair & Ghosh 1975; Hennipman 1977; Khullar & Sharma 1980; Ghosh 1983; Khullar *et al* (1983); Stewart 1984; Fraser-Jenkins 1984, 1989, 1991; Fraser-Jenkins & Khullar 1985; and others. The works of Ching (1931, 1935, 1938) on Sino-Himalayan members of *Vittaria*, *Pyrrhosia* and *Dryopteris*, and of Ching *et al* (1983) on *Lepisorus clathratus* complex in the Sino-Himalayan region have greatly clarified the taxonomic confusions about several species of the Indian region. Fraser-Jenkins (1984) provides a chronological review of fern study of the region in addition to the information about the adjoining region.

Of relevance and use in the floristic works in India, particularly in the northeastern India and/or taxonomic revision of Indian members are on Nepal-Darjeeling-Sikkim region (Hara 1966, 1971; Ohashi 1975), on East Himalayas (Wu 1983), Malaysia (Holttum 1954, 1982), and on Thailand (Iwatsuki 1979, 1985). These works give information about the correct nomenclature, synonyms and distribution of a large number of species from eastern region of our country along with vivid descriptions and illustrations.

1.3 Early History of Botanical collections in Assam

A survey of literature on botanical collections in Assam reveals a distinct lacuna in the study of plants in general and Pteridophytes in particular. Francis Buchanan (later, in 1820 Hamilton) was the first to visit Assam in 1808 - 1809 for economic survey of the state and gathered plants in the vicinity of Guwahati. Subsequently, Col. Lister made some collections from Guwahati and foothills of Assam along Arunachal Pradesh border during 1828 - 1832.

N. Wallich and W. Griffith, who were primarily deputed to establish the occurrence of tea in Assam, made deliberate botanical collections in the routes and tracts traversed by them with Sylhet at one end and Mishimi hills at the other end. They left Calcutta on 31st August, 1835 and through Sylhet and Terryaghat entered Khasi Hills and after tracking this hilly terrain, reach Guwahati on 23rd November, 1835. From here they again went upstream by Brahmaputra to reach Sadiya on 16th January, 1836, collecting plants on the way, and also making a short trip to Dibrugarh and Jorhat. Wallich subsequently left back for Calcutta but Griffith stayed at Sadiya till February, 1837, chiefly collecting in the vicinity of Sadiya in Upper Assam before he left back for Calcutta via Burma (Myanmar). On 31st August, 1838, Griffith again left Calcutta for Bhutan traversing and collecting in Khasi Hills and in Kamrup district of Assam. Griffith roughly collected about 1700 specimens during his travel and stay in Assam (Griffith 1836). The next major collection is the contribution of J.D. Hooker and T. Thomson with about 1,000 specimens from the plains of northeastern India in 1850. The collections in the Assam

region were further enriched by many other collectors, principal among them being Francis Jenkins (1834 - 1854), agent to the Governor General at Guwahati, alongwith his collector Charles J. Simons in Mikir Hills (Karbi-Anglong district) and in the Brahmaputra valley, chiefly around Guwahati ; J.W. Masters (1843 - 1873) in Golaghat, Nagaon and Sadiya ; Richard L. Keenan (1872 - 1873) in Cachar ; Watt (1882 - 1883) in Dhansiri valley and Cachar ; S.E. Peal, a tea planter, in Sivasagar district ; King's collector, G.A. Gammie (1894) in Brahmaputra valley ; Meebold (1906 - 1907) in Dhansiri valley and H. G. Carter, Economic Botanist of Botanical Survey of India and his wife D. Carter in Lakhimpur district during March to November, 1915. These collectors, however, did not give due emphasis on collection of Pteridophytes as is evident from publications of some of them (Griffith 1836 ; Masters 1844, 1845, 1846 ; Hannay 1845 ; Gammie 1895 ; Carter & Carter 1921).

Among the early collectors in the state who gave importance in the collection of Pteridophytes were C. B. Clarke and Gustav Mann. C. B. Clarke, who was a mathematician by training seems to be the greatest botanical collector of the country from this area. As Inspector of Schools in Assam between 1883 - 1887, he has surveyed vast areas and made large number of collections, which are now deposited in Kew Herbarium (K) with a duplicate set in Central National Herbarium (CAL) and in these are found some of the earliest gatherings of Pteridophytes of Assam. Gustav Mann, who was posted as Conservator of Forests in Assam during 1863 - 1881, made extensive collection of plants from the whole of Assam. The collections of Mann include a large number of Pteridophytes, which are now deposited in Kanjilal Herbarium of Botanical Survey of India, Shillong (ASSAM) and were used in the study of Pteridophytes by subsequent workers (*cf.* Fraser- Jenkins 1989).

Following G. Mann, U.N. Kanjilal, P.C. Kanjilal, R.N. De, P.R. Dutta, S.R. Sharma, C. Purkayastha, B.B. Syam, A. Das and G.K. Deka, all forest officials in Assam, made extensive collections from the state of Assam with a view to publish a regional flora of Assam during the first half of this century. The collections of these workers contribute greatly to the development of the Kanjilal Herbarium at Shillong. N.L. Bor (1921 - 1936), a British Botanist during the tenure as a Forest officer in Assam, has also made substantial collection, particularly of grasses, from the state.

Publication of the Flora of Assam (Kanjilal *et al* 1934 - 1940) forms a landmark in the history of botanical studies in this region, but this flora itself has an obvious gap in the study of herbaceous flora including Pteridophytes. Subsequent studies largely contribute to fill the gap in respect of herbaceous angiosperms in the flora and Pteridophytes being left out even today from the purview of such studies.

While most of the workers concentrated on collection and study of flowering plants, atleast two persons, R.H. Beddome and C.B. Clarke have made substantial contributions to the ferns of the Indian subcontinent as a whole. The work of Clarke (1880), based on collections for about eleven years from Kashmir to Chittagong and eastwards and those of Beddome (1865 - 1870, 1876, 1883, 1892) included a number of specimens from the present state of Assam also.

With the reorganisation of the Botanical Survey of India in 1956, a separate regional Circle was set up in Shillong for botanical exploration of northeastern India, and although, since then a number of officers of the Servey have made extensive collections from various parts of the region, the state of Assam remains almost unexplored as far as Pteridophytic flora is concerned.

After the monumental publications of Beddome (1865 - 1870, 1876, 1883, 1892) and Clarke (1880) the only worthwhile accounts of the Pteridophytic plants of the earlier Assam (which includes entire northeastern states viz. Assam, Meghalaya, Mizoram, Nagaland and Arunachal Pradesh) are those of Kachroo (1953, 1975), Panigrahi (1960, 1968), Panigrahi and Chowdhury (1961, 1962), Panigrahi & Patnaik (1961a, 1961b), Bir *et al* (1989), Kachroo *et al* (1989) and Vasudeva *et al* (1990).

Recently Handique & Konger (1986) and Barua *et al* (1989) published enumeration lists of ferns and fern-allies from Guwahati and Kamrup district respectively.

A few monographic or revisionary accounts on certain families/genera of Pteridophytes from the Indian subcontinent published during the last few decades also include collections made from Assam.

In addition to the above B.K. Nayar made a substantial collection of ferns in the state in 1951 and P. Chandra in N.C. Hills in 1961. The collections of these two workers have been deposited in the Herbarium of National Botanical Research Institute, Lucknow (NBG). Dutta *et al* (1980) also published an account of pteridophytic flora of N.C. Hills and Barail range, while Panigrahi & Patnaik (1961) worked out the cytology of some genera of the region. Hope (1890a, 1890b) published four *Lastrea* species from Assam.