

III REVIEW OF LITERATURE

Review of literature

Though Pteridophytes are not as a dominant part, of the present day vegetation, as they were in the historic past, they form a conspicuous part of the world's vegetation particularly in the tropics. Because they occupy a crucial central position in the evolutionary history of the vegetable kingdom, they have attracted the particular attention of botanists to Pteridophyte morphology.

A brief review of the work so far done on the taxonomical, floristic, cytological, biochemical, palynological, anatomical and gametophytes of the ferns abroad and in India is attempted here.

Taxonomical work :

During the last 75 years, there has been a tremendous upsurge in the history of taxonomy of fern leading to overcoming of the impediments imposed by the Hookerian concepts mainly through the classical work of two great Pteridologists of the current century, Carl Christensen and F. O. Bower.

Bower (1923) was essentially a morphologist, and through his extensive comparative studies established morphological concepts without which major phyletic sequences can neither be detected nor interpreted.

Carl Christensen was a herbarium botanist. Based on his experience with the genera of ferns, he proposed a scheme for a natural classification of ferns (1938).

The credit for the modern concept that the Polypodiaceae is polyphyletic, goes to the Chinese botanist R. C. Ching (1940) who for the first time classified the polypodiaceous complex into 33 families.

Following the lead given by Ching seven other systems of classification for the Polypodiaceae were published, differing substantially from each other in grouping of genera and interpreting phylogeny of the various groups. These were proposed by Dickason (1946), Holttum (1947), Copeland (1947), Reimers (1952), Alston (1956), Pichi Sermolli (1958) and Nayar (1970).

In recent years the morphological, anatomical, biochemical, cytological and gametophytic studies are largely used in fern taxonomy. Bierhorst (1968) based on morphological characteristics raised Psilotum to ferns and placed Psilotaceae in the order Filicales. Van Cotthem's (1970) study on structure of stomata of ferns has shown its utility in fern taxonomy, Voeller (1971) published a phylogenetic scheme for the ferns based on developmental studies. Voirin's research (1970) on the flavonoids of the Pteridophytes is an example of the importance of Phytochemical studies in the classification of ferns.

Floristic work :

"Since more than 90 percent of the ferns are restricted to the tropics, it is but natural that the floristic study of ferns given from time to time is by different botanist working in asian tropics." Thus to name a few of them, the following could be mentioned :-
 Ching in China (1940), Copeland in Philippines (1947), Holttum in Malaya (1947), Dickason in Burma (1946) and Nayar in India (1970). Like Christensen, Alston (1950) and Pichi-Sermolli (1950) worked mostly on the various European herbaria.

In addition to above floristic studies, recently many workers have described the fern floras from the different regions of world. For example Ferns of Ottawa district described by Cody, W. J. (1956). Flora of Goose Bay by Gillett, J. M. (1963), Flora of Alberta by Moss, E. H. (1959), Packer, J. G. & M. G. Dumais (1972) made some additions to the flora of Alberta. Porsild, A. F. (1964) described flora of the Canadian Arctic Archipelago. Roland, A. E. and E. C. Smith (1963) described the flora of Nova Scotia. Soper, J. E. (1963) described the ferns of Manitoulin Island. Taylor, R. L. & G. A. Mulligan (1968) described the flora of the Queen Charlotte Islands. Taylor, T.M.C. (1970) described the Pacific Northwest Ferns and their allies.

Alston, A.H.G. (1959) described the ferns and fern allies of West Tropical Africa, and Sledge, W. A. (1972) described the Tectarioid ferns of Ceylon. Adams, C. D. (1957) observed the fern flora of Fernando.

Morphological and anatomical work :

Systematists, taxonomists and phylogeneticists commonly use morphological characters in identifying the possible interrelationships between different groups of plants. This is reflected in the earlier systems of classification of ferns which are purely based on morphological characters of ferns. A classical work in the comparative morphology of ferns was done by Bower, F.O 1923-28. He published his valuable book "The Ferns" in which he condensed the knowledge attained in more than 30 years of morphologic, morphogenetic and anatomical research. His book is an endless source of information and probably no other Pteridologist have been contributed in such a large measure as Bower to our knowledge of the phylogeny of ferns. Since then many Pteridologist have added to the knowledge of morphology and anatomy of different ferns. Holttum, R. E. (1957) described the morphology of the family Gleicheniaceae and he also studied the evolution of vascular systems in ferns with special reference to dorsiventral rhizomes in 1955. Bobrov, A. E. 1964 described the morphology of Polypodium sps. The frond

articulation in various species of Polypodiaceae and Davalliaceae is described by Phillips & White in 1964. Keating (1968) described the trend of specialization in the stipe anatomy of Dennstaedtia and related genera. The morphological and anatomical investigations of some of the Thelypteroid ferns were described by Wood (1971). Davis & Heywood (1963) also stressed the function of anatomy in taxonomy of the ferns.

The usefulness of the stomatal types, either the morphological or the ontogenetic one, as a valuable character in plant taxonomy is shown by multitude of authors. For Ex. Kondo (1962), Kondo & Toda (1956), Thurston (1969) & Van Cotthem (1968, 1970).

The exhaustive morphological and anatomical as well as gametophytic studies of some of the fern genera have resulted in the presentation of monographs: on different genera of ferns. For Ex. Brown, D.F.M. (1964) has described the fern genus Woodsia, Blasdell (1963) described the monographic study on the genus Cystopteris. Tryon A. F. (1970) published a monograph on the fern genus Eriosorus, Hennipman, E. (1977) published a book on the monographic studies of the fern genus Bolbitis.

Biochemical work :

Information on the biochemical studies of ferns

upto 1961 was comprehensively surveyed by Hegnauer (1962), who pointed out that, except for the polypodiaceae, there was very little biochemical information. A review of chemical constituents of ferns, covering the literature upto 1967 was published by Berti & Bottari (1968). Since then, with the vastly increased interest in phytochemistry and the burgeoning of powerful new analytical techniques, a number of more comprehensive chemical surveys of ferns has been carried out. These include the distribution of hydroxy aromatic acids in about 120 sps. (Bohm 1968, Bohm & Tryon 1967, Glass & Bohm 1969), a survey of flavonoids in 136 fern species (Voirin 1970) and a study of the mannose containing polysaccharides in over 100 NewZealand sps. (Bailey & Pain 1971). In spite of this our knowledge of fern chemistry is still uneven and some families have been completely ignored.

Cytological Work :

Modern fern cytology was initiated by the publication in 1950 of Prof. Manton's book "Problems of cytology and evolution in the Pteridophyta" in which cytological data was presented for 90 sps of ferns distributed among 27 genera. This classic work stimulated a great upsurge of research and there has grown-up a considerable literature on the subject. The ferns probably represent the only large assemblage of predominantly tropical organisms for which

cytological data are available over so much of the total range. Thus coverage has been given to a greater or lesser extent to fern floras from Europe, North America, Mexico (Mickel, Wagner & Chen 1966, Smith 1971), Jamaica (Walker, 1966), Trinidad (Walker), West Africa, the Indian Sub-continent (Bir & Shukla, 1969, Roy, Sinha & Sakya 1971), Ceylon, Malaya, New Guinea (Walker), New Zealand, Japan (Mitui 1966, a,b, 1970; Kurita 1967, a,b, 1968,1972). Taiwan (Mitui 1968), Madeira (Manton, Lovis), the canary Islands, Galapagos (Jarrett, Manton and Roy, 1968), Hawaii, New Caledonia and Thruston da cunha (Manton & Vida 1968).

Palynological work :

Today, perhaps the ferns represent one of the best palynologically studied groups of plants. Significant contributions on the morphology of spores of ferns from different countries of world has been given by many botanists. Japan (Nayar & Devi 1963, Kawasaki 1968, Mitui 1971, 1972), Africa (Nayar et al. 1964, Welman 1970) New Zealand (Harris 1955), England (Knox 1951; Jermy & Harper 1971), North America (Alston 1955, Blasdell 1963, Crane 1953, 1955, 1956, 1960, Devi et al. 1971, Gastony 1974, a,b, Hagenah, 1961, Knobloch, 1969, Knobloch et al. 1971, Mc vaugh 1935, Reed 1954; A. F. Tryon 1971, Tryon & Tryon 1973, 74, Tryon, R. M. Jr. & A. F. Tryon 1973, Wagner (1955) Hawaii (Selling 1946) U.S.S.R. (Slodkoy 1955,1959, 1962).

Gametophytic work :

That not all gametophytes were alike had been demonstrated by turn of the century, especially by the botanist of (1870's and 1880's like Campbell (1886), Goeble (1877, 1888), Banke (1878), Bower (1888) etc.

By 1951 Stokey has been observing gametophytes for some time and has come to the conclusion that indeed the gametophyte can contribute to the question of relationships. She indicated where useful information might be found; in the germination pattern, in the manner of development of the cell plate and the meristematic regions in the form of mature and old thallus, in the type, position and time of appearance of hairs when present and in the sex organs, especially in the form of the antheridium. Stockey and Atkinson 1951-1958 studied the gametophytes of many homosporous ferns. For example Stenochlaena palustris, Blechnum spicant, Blaechnum bunctienii, 5 sps of Platynerium, Acrostichum speciosum, Didymochlaena sinuata, Loxsonia cunninghami, Loxsonopsis costaricensis, Elaphoglossum, and Rhipidopteris and the gametophyte of the Grammitidaceae.

Atkinson 1960-1973 published many papers on gametophytic studies mainly on the following genera : genera of the family Hymenophyllaceae, Mohria, Anemia, Cystodium, Diplazium, Taenitis, Pinnata, Taenitis blechnoides,

Syngramma alismifolia, Pleocnemia conjugata, Arcypteris irrigularis.

These studies indicate: the usefulness of gametophytic characters in taxonomy of ferns.

Work on Ferns from India :

Nearly 600 sps are recorded from tropical, sub-tropical and warm temperate forests of the country. But not many species are recorded from the low hill, thorny or high altitude scrub forests. In several localities certain ferns are dominant and thus lend a physiognomic characteristic to the landscape.

The classic taxonomic account of the Indian ferns is presented by R. H. Beddome (1865-1870, 1876, 1883, 1892, 1893, 1908) and Roxburgh (1894). Album of the Indian ferns as compiled by Baynes (1887) is quite interesting. Fern allies were described by J. B. Baker (1887) N. P. Chowdhury (1937) and A. H. G. Alston (1941). These are still used by taxonomists of today as the main source of information on Indian ferns. With the developments made in the field of technology, new data have accumulated on number of fern genera. Hence these works by earlier authors need revision. But unfortunately for several reasons this significant group of plants remained almost neglected from a taxonomic point of view, as in the case with other cryptogamic plants. A

brief review of the work so far done on the systematics, ecology, phytogeography, taxonomy, morphology and anatomy, cytology, palynology and gametophyte of ferns is attempted here.

Systematics :

Except for the classical works referred above most of the workers particularly during the last three decades or so concerned themselves only with compilation of systematic list for the various regions of the country as :

- a) Eastern Himalayas : Assam (Kachroo 1953, 1975; Panigrahi, 1960) and Darjeeling-Sikkim state (Mehra and Bir, 1964).
- b) Eastern India : Orisa and Bihar (Panigrahi 1960).
- c) Western Himalayas : Nainital (Strachey 1918, Loyal & Verma (1960), Mussoorie (Mehra 1939; Stewart, 1942), Simla (Blanford 1886, 1888, Hope, 1921, Bir, 1963, 1968, Bir & Shukla 1966, 1968, 1971). Kangra (Schelpe, 1954) Dalhousie (Mehra & Dhir 1968) Dharamsala (Dhir & Dutta, 1976, a, b, Dhir & Sheera, 1975) and Kashmir (Stewart 1945, 1951, 1957).
- d) Nicobar & Andaman Islands : Car Nicobar and Nancoury Islands (Thothathri 1960 a), Andman Islands (Thothathri 1960 b, Nayar and Srivastava 1962).
- e) Western India : Mt. Abu (Bir & Verma 1963, Sharma & Bohra 1977), Rajasthan (Mittal 1968 a, b,)
- f) Central India and A

f) Central India and adjoining regions : Madhya Pradesh (Tiwari, 1964, Panigrahi & Dixit 1966 a), Pachmarhi (Gamble 1892, Bir & Vasudeva, 1972, 1973) and Maharashtra Bombay (Carstensen 1891, Blatter 1909, Blatter & d'Almeida (1922), Mahabaleshwar and Matheran (Birdwood 1886, 1887, 1897) and Kanara (Mac pherson 1890).

g) South India : Kodai kanal - Palni Hills (Bir & Vasudega, 1971, 1978, Manickum & Ninan 1976) Shevaroy Hills (Subramanian et al. 1960) Cumbum valley and Pachku-Matchi hills (Subramanyam et al. 1961).

Taxonomy : A comprehensive review on the subject has been given by Bir, 1976 where in literature upto the end of 1973 was included. Very useful information about 40 new taxa of Indian ferns published after 1960 was included their in. Latest nomenclature along with Synonymy as provided by Mehra & Bir (1964) and Nayar & Kaur (1974) have gone a long way in the compilation of revised lists of ferns of restricted areas.

So far, on country-wide basis, taxonomic revision of genera, namely, Selaginella (Alston, 1945; Panigrahi & Dixit 1966 b, 1967, 1968 a), Ophioglossum (d'Almeida, 1922; Chakravarty, 1951; Balakrishnan et al. 1960; Mahabale, 1962; Panigrahi & Dixit 1969 a, Mittal, 1968 a), Botrychium (Panigrahi and Dixit, 1969 a), Osmunda (Panigrahi & Dixit, 1969 b), Plagiogyra (Nayar 1962), Adiantum (Nayar 1961 a).

Pityrogramma (Chandra 1963), Vittaria (Bir 1962),
Gleichenia (Panigrahi & Dixit 1968 b, 1969 c, 1971),
Cystopteris (Bir & Trikha 1972), Lepisorus (1968 b, 1969,
1974), Microsorium (Nayar 1961 c, Bir & Trikha 1968 a),
Phymatodes (Bir & Devi, 1968), Polypodium and Goniophlebium
(Bir et al. 1974), Drynaria and Pseudodrynaria (Nayar 1961 b)
and Marsilea (Gupta, 1962, Gupta & Bhardwaja, 1956, 1957,
1958) has been taken up. As a result of such generic
revisions the number of species in India has far exceeded
the previous estimates as in the case of Lepisorus where, as
many as 20 sps are now known from the country against the
earlier record of 10-12 sps.

Ecology & Phytogeography :

The ecological and phytogeographical studies on
Indian ferns are very limited. Ecological and distributional
notes have been provided by Kachroo (1953), Loyal & Verma
(1960), Mehra & Dhir (1968), Bir (1963), Bir & Vashdeva
(1971, 1972) and Dhir & Sheera (1975). Out of these, the
most detailed account pertaining to the forest types and
various habitats and ecological adaptations about the Ferns
of Darjeeling and Sikkim Himalayas is given by Mehra and Bir
(1964). These studies reveals that the ferns constitute a
prominant element of the epiphytic growth in dense forests.

Phytogeographical distribution of the ferns and fern
allies have been discussed in detail only for Pachmarhi

(Bir & Vasudeva 1972), Assam (Kachroo 1975) and Dharamsala (Dhir & Sheera 1975). The fern flora of the Western Himalayas exhibits similarities with the European flora while on the other hand Eastern Himalayas abound in Malayan and Chinese elements. Further, the fern vegetation of Sikkim state is quite conspicuous in having close similarities with that of Yunnan province of the Chinese mainland. Although Pachmarhi in Central India shares the characteristic species of the Himalayas and South Indian mountains yet its Pteridophytic vegetation is more kin to South India and Ceylon. The occurrence of the Asplenium pumilum var. hymenophylloides an abyssinian element, at Mt. Abu in Rajasthan is noteworthy.

Cytological work :

The work on the cytology of Indian ferns began almost simultaneously at the Universities of Punjab and Kerala around 1953. Investigations on the Himalayan members were carried out mainly by P. N. Mehra, S. S. Bir, S. C. Verma, D. S. Loyal, G. Panigrahi and S. N. Patnaik, whereas the South Indian ones were studied by A. Abraham; C. A. Ninan, P. I. Kuriachan and S. S. Bir. A few papers were also contributed by B. K. Nayar, N. Pal and S. Pal. Similar work was also started at Patna University by R. P. Roy and B. M. B. Sinha and more recently at Banaras University by S. K. Roy.

A perusal of the cytological literature on Indian ferns has revealed that 81% of ferns and 35% of fern allies have been investigated so far.

Palynology :

The "Spores", the connecting link between the two generations (the free living sporophytic and gametophytic) in the life cycle of ferns, have attracted attention of botanists ever since alternation of generation became known. The fern spores are recognised as an important criterion in the classification and also from phylogenetic point of view and to analyse cytologically the species complexes.

Significant contributions on the morphology of spores of ferns from India is by Bir, et al. (1966-74), Chandra (1973), Mahabale (1960), Nayar & his associates (1960-1968), Pal & Pal (1970) and Verma (1966-67) etc.

Gametophyte :

The gametophytic phase is always ignored by the workers but recently it is realised that gametophyte of ferns is not an overly plastic, taxonomically useless body and may be an entity of considerable value in the study of relationship among ferns.

In India the work on the gametophytes of eusporangiate ferns by Javalgekar, S. R. & Mahabale T. S. (1959),

Mahabale, T. S. (1949-1953) is noteworthy. On Letosporangiate homosporous ferns the work of Prof. B. K. Nayar & his associates is noteworthy.

Work on Pteris :

Although the genus Pteris is abundantly found in the different localities of world as well as in India, except the comparative morphological and anatomical details on Pteris, as given by Bower (1923) in his book "The Ferns", ~~no~~ other detail studies have been done on this genus. N. C. Nair and Anjali Das described the venation pattern in P. vittata. The structure and development of phloem in the rachis of P. vittata is described by Shah & Fotedar (1974), Kshirasgar & Mehta (1978) described the growth and differentiation in rhizome callus of P. vittata. The pharmacognostic studies on the rhizome is also described by Kapur S. K. (1982). In 1985 Murakami et al. described the chemical and chemotaxonomical studies on several species of genus Pteris. The cytological work on Pteris in India reveals that several taxa of Pteris in India are apogamous and the highest grade of polyploidy at hexaploid level is attained in P. vittata Abraham et. al. (1962). Kuriachan (1968), Verma and Khullar (1965 c), and Palta & Mehra (1984) also described the cytological aspects on Pteris. Gametophytic studies on Pteris vittata are described

by different authors on the various aspects. For Ex. Bell (1982) described the tubular elements in Plastids in the female gamete of P. ensiformis, Khare & Surjit Kaur (1983) described the gametophyte differentiation of pentaploid P. vittata. Yukio Kato 1969, 1970 described the development of gametophyte of P. vittata in aseptic culture.