INTRODUCTION
Chapter - 1

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The Pteridophytes, which include the ferns and fern-allies, are a group of ancient or primitive land vascular plants with worldwide distribution. They are found in all the continents (except Antarctica) and most islands, favouring moist temperate and tropical regions. They can be found in all but the most frigid and arid environment, and no marine species has been reported so far (Jones, 1987). Recent estimates place their diversity at about 13,000 species in 305 genera (Singh, 2003).

In geological hierarchy, the pteridophytes are of great antiquity. Much before the appearance of modern day flowering plants and man himself, ‘ferns,’ ‘lycopods,’ ‘horsetails’ etc. dominated the surface of earth (Bir et al., 1983). These non-angiosperm vascular plants appear in the fossil record around 400 million years ago (Kendrick and Crane, 1997). They constituted the major forests of the world nearly 240-260×10⁶ years ago and are considered by the geologists to have greatly contributed to the formation of the present day coal reserves (Bir et al., 1983).

Their primitive affinities combined with their obvious continuing ecological success in appropriate habitats worldwide are one of the principal features that make the ferns of considerable interest (Page, 1982). Because of their antiquity, pteridophytes hold a special place in any consideration of evolution of vascular plant groups, since they combine many archaic features with a pointer to traits of evolutionarily advanced ones (Panigrahi, 2003).

From phylogenetic and evolutionary points of view, members of this group are important because these plants not only show the evolution of vascular system, but also vividly reflect the processes that have gone into the emergence of seed habit in plants (Bir et al., 1983). Ferns, representing the highest evolutionary stage
of vascular plants, occupy a middle branch of the vascular plant evolutionary tree (Raven et al., 1992). Like angiosperms, they have true leaves, which is a reflection of their comparatively advanced vascular systems (Rost et al., 1998; Banks, 1999). Despite over millions of years of evolution, ferns still maintain an independent haploid gametophyte generation evolved by their distinct ancestors, and hence, they are evolutionarily quite distinct (Raven et al., 1992).

A fern is a vascular plant that differs from the more primitive lycophytes in having true leaves (megaphylls) and from the more advanced seed plants (gymnosperms and angiosperms) in lacking seeds. Ferns are mostly characterized by feather-shaped leaves (fronds), comprised of many leaflets. They lack flowers and instead produce spores from little circular structures (sori) generally on the underside of leaves. Ferns vary in size from those only a few centimetres high to the 'tree ferns' of tropical regions, which may attain a height of 24 metres (80 ft). Tree ferns have woody trunks without branches, topped with clusters of feathery leaves or fronds. Most ferns, however, have no trunks, and fronds grow directly from a short underground stem (rhizome).

Traditionally, three discrete groups of plants have been considered as ferns: two groups of Eusporangiate Ferns, viz. Families: Ophioglossaceae (Adders tongue, Moonworts and Grape ferns); Marattiaceae, and the Leptosporangiate Ferns. Several other groups of plants were considered 'Fern-allies' the Club mosses, Spike mosses, and Quillworts in the Lycopodiophyta, the Whisk ferns in Psilotaceae, and the Horsetails in the Equisetaceae. One possible means of treating this situation is to consider only the Leptosporangiate Ferns as 'true' ferns, while considering the other three groups as 'Fern-allies.'

The ferns have a popular image of growing in moist shady places (because they do not produce flowers, they require water in order to reproduce, thus restricting their range to relatively damp regions), but the reality is far more complex. Ferns grow in a wide variety of habitats, ranging from remote mountain elevations to dry desert rock faces to bodies of water to open fields. Most grow in damp shady places, although certain species grow on dry ground, soil or rocks. Some ferns, in fact, grow only in rocky places- in fissures and crevices of cliff faces and in boulders. Others grow as epiphytes or air plants on trees. Ferns in general
may be thought of as largely being specialists in marginal habitats, often succeeding in places where various environmental delimiters limit the success of flowering plants. On the other hand, some ferns are among the world’s most serious weed species, such as ‘bracken’ (*Pteridium spp.*) growing in highlands, or ‘mosquito fern’ (*Azolla spp.*) growing in lakes.

Ferns are the plants with a fascinating ecology; they are ecological escapists, growing where they do mainly because their habitats are ones where flowering plants do not succeed well. To do so, they have evolved a range of extraordinary ecological strategies. Such ecology puts many of them in an unusually delicate state of ecological balance, which can be so easily swayed in the direction of their large-scale elimination (Page, 1982).

The economic value of pteridophytes including their medicinal applications has been known to man for more than 2000 years. Theophrastus (c. 327-287 BC) and Dioscorides (c. 50 AD) had referred to medicinal attributes of certain ferns. Sashrutha and Charaka (c. 100 AD) mentioned medicinal uses of *Marsilea minuta* and *Adiantum capillus-veneris* in their Samhitas (Singh, 2003). Since then, more information on various uses of pteridophytes has accumulated.

Although, the ferns have been objects of scientific study since the time of Theophrastus, and besides their rich diversity and ubiquitous presence, this group has not received the desired attention and until date, they continue to remain less explored when compared to other groups of plants. The taxonomy of ferns is poorly known and the biodiversity mostly unknown. An explanation of the fact might be the difficulty that is generally encountered in the identification and nomenclature of the members of this group of plants.

In recent years, the scientific names of some ferns have changed many times. Such name changes cause much confusion and are the unfortunate result of the application of the rules that govern botanical nomenclature, “which were devised in an attempt to produce a stable situation!” As a result of these name changes, most pteridophytes have several synonyms. In case of ferns, the common names are also important and are often more stable and more widely used colloquially than the Latin ones (Page, 1982).
A perusal of various systems of fern classification shows that there are more points of disagreement rather than agreement (Bir *et al.* 1986). The delimitation of families and genera of ferns as well as their phyletic relationships has been very controversial as is clear from a survey of fern classifications given by Pichi Sermolli (1958, 1973, 1977 *etc.*); Nayar (1970, 1974); Jermy *et al.* (1973); Lovis (1977); Kaur (1979); Bir (1982) *etc.* Differences of opinion on family and generic concepts have contributed to a lot of confusion in taxonomy, it is more so because there is a fair multiplication of synonyms for various species.

During the 19th Century, the taxonomic works on ferns in India have mainly come from Beddome (1863-64, 1866-70, 1876, 1883, 1892); Clarke (1880) and Hope (1899-1904). After the compilation of classical taxonomic works in the second half of the 19th Century, there was not much interest in Pteridology in the first half of the 20th Century and the significant works were fragmentary. In the second half of the 20th Century, taxonomic and systematic studies on ferns received a spurt in India because of greater emphasis on vegetational analyses after independence. During the last about 70 years, with the revival of the Botanical Survey of India (BSI), intensive explorations have been made in different parts of the Country by the scientists of the BSI and several other institutions. These expeditions have resulted in several floristic accounts and also some taxonomic revisions. Apart from BSI, work on pteridophytes was also taken up in some institutions of Council of Scientific and Industrial Research (CSIR), like the National Botanical Research Institute (NBRI), Lucknow and some universities. Cytological and cytotaxonomic studies on pteridophytes also received attention of several scientists.

From the Valley of Kashmir, McLeod was among the early fern collectors before 1895 (*fide* Stewart, 1982). Some ferns of Kashmir are included in the works of Clarke (1880); Beddome (1883, 1892) and Hope (1899-1904). A few scattered reports by Bir (1971); Mehra and Khullar (1974); Kapur and Sarin (1977); Khullar and Gupta (1979a); Dixit (1984); Kapur (1985) and Chandra (2000) are available for the ferns of the Valley. Of particular relevance to the pteridophytic flora of Kashmir are the works of R. R. Stewart (1945, 1951, 1957, 1972); Javeid (1965);

Purpose of the work: While the entire gamut of flowering plants constituting c. 250,000 species assigned to c. 13,000 genera and 377 families is grouped into only two classes, the comparatively very small group of c. 305 genera of pteridophytes is grouped into four distinct classes: Psilotopsida, Lycopsida, Equisitopsida and Filicopsida. Such a taxonomic delineation speaks volumes regarding the taxodiversity in extant pteridophytes (Panigrahi, 2003).

As a global community, we are now in the midst of a crisis in loss of biological and cultural diversity. The current ongoing loss of biodiversity is the greatest contraction of life since the end of the Mesozoic Era (Wilson, 1992). According to the 1997 IUCN Red List of Threatened Plants compiled by the World Conservation Union, 13.8% of vascular plants throughout the world are imperilled. The habitat destruction and exploitation due to urbanization, soil erosion, overgrazing of pastures and meadowlands have caused a paradigm change in environment. This change in the environment plus harvesting too much coupled with growing and protecting too little poses a serious threat of extinction to the extant plant diversity and resources.

The characteristic landlocked position of Kashmir gives this region several features of unique interest in the North-Western Himalayas. The prevailing moist westerly winds bring an amelioration effect on the temperature extremes, and the diverse rock types result in an equally diverse topography of lowlands and highlands. In combination, these features serve to make the pteridophytic flora of Kashmir of special botanical significance in India as a whole.

The vegetation, of which the pteridophytes are an intimate part, forms a valuable recourse for research and experiment as well as for teaching and recreation, and a resource, which, at least potentially, is naturally recurring. The continued existence of any such resource depends on its effective care and management, founded on detailed knowledge of the plant species concerned. Today, there seems to be a strong awakening of interest in the environment around us, and the growing awareness of the need to conserve carefully the wildlife that is still left (Page, 1982). Therefore, it is imperative to pay special attention for
locating the pteridophytic habitats, estimating variability in diverse ecosystems in which they thrive, work out their biogeography, and take urgent steps for their conservation as pointed out by Panigrahi (1998).

Though recent ethnobotanical, phytochemical, pharmacological and biological researches have revealed medicinal, pharmaceutical and phytochemical attributes of pteridophytes, which have valuable potential applications for health and industry, still many species of pteridophytes are yet to be explored for their potential applications for future use and to isolate new active principles from them (Singh, 2003).

Since the work on ferns carried out in this part of the world exists in the form of checklists only, it lacks authoritative examination. Further, a comprehensive account of medicinal importance associated with some ferns of Kashmir Valley shall be of immense help to pharmacologists and natural product chemists. The economic utility of pteridophytes, their biochemistry for an assessment of drug value and alkaloid content, if any, are other avenues, which demand most careful consideration.

The present work is intended to provide a comprehensive account and up to date information on the native pteridophyta. The work shall be equally helpful to botanists and plant lovers for multiplication, domestication and improvement of some economically and medicinally important taxa. Besides, it shall also stimulate interest of research in those areas that remain least known- particularly the detailed ecology and biology of the species and hybrids concerned. It shall help in the conservation of some threatened fern species and help in assessment of anthropogenic effect on various pteridophytic habitats. It is in this context that the present study has been undertaken.