CHAPTER II :

REVIEW OF LITERATURE

INTRODUCTION :

Pteridophytes are predominantly plants of evergreen forests. Ferns in general dominate the pteridophytic flora and they are terrestrial, aquatic as well as epiphytic. They grow luxuriantly in the humus rich soils of forests and also they grow well in garden soils.

A review of literature indicates that much work has been done on the morphology and taxonomy of pteridophytes. Beddome (1873) in his publication entitled 'The ferns of Southern India' has listed the various ferns from southern India. Blatter and d'Almeida (1922) in their book entitled 'The Ferns of Bombay' have described the ferns from the Bombay presidency. Parandekar (1966) in his paper entitled 'Some Ferns from Kolhapur' has described the ferns from Kolhapur and also has briefly mentioned some of the fern localities from Ratnagiri district. Thus, in general, all this work is merely a survey of pteridophytes and also it is the work on morphology of the pteridophytes. Nayar (1961, 1962, 1964) has also done lot of work on the morphological and taxonomical aspects of ferns in his 'Ferns of India'. Agashe (1968, 1969) has described the pteridophyte flora of Kolhapur district. Shetty (1971) has studied the physiology of Acrostichum aureum in saline and nonsaline conditions. Upadhye (1969) has studied the pteridophyte flora of Ratnagiri district (Part I) and also has worked on the morphology and anatomy of Schizoloma heterophylla J. Smith. Patil (1984) has studied the palynology of ferns from Western Ghats.

As compared to morphology, anatomy and cytology etc. very little is known about the biochemistry of pteridophytes. Bohm (1968), Bohm and Tryon (1967), Chatterji et al. (1963), Glass and Bohm (1969), Goswami and Khandelwal (1976), Shankar and Khare (1985), Voirn (1970) and Wallace et al. (1984) have studied secondary metabolites like phenolic compounds, flavonoids, esters and polysaccharides in a number of ferns. Similarly amino acids have been studied in a number of isolated genera of pteridophytes e.g. Goswami and Khandelwal (1967) and Khandelwal and Goswami (1976) studied the occurrence of amino acids in different species of Indian Ophioglossum while Khare and Shankar (1987) studied amino acids and proteins in Psilotum nudum collected from Pachmari (M.P.). Very little work has been done on the phytochemistry of Rajasthan pteridophytes (Kaur et al., 1986). Vyas and Sharma (1988) studied pigments, amino acids, proteins, glucosides, carbohydrates and reducing sugars in different ferns and fern allies of Rajasthan.

Isoetes rajasthanensis and *Isoetes reticulata* are comparatively small sized terrestrial plants found during rainy season at Mount Abu and Atru respectively. During recent years a number of papers have been published on taxonomy (Gena and Bharadvaja, 1984; Sharma *et al.*, 1985), morphology (Singh *et al.*, 1983; Sharma and Singh, 1984), anatomy (Sharma, 1989) and ecological studies (Gena *et al.* 1987) but very little work has been done on the phytochemistry of the species of *Isoetes* found in Rajasthan (Vyas and Sharma, 1988). Very little work has been done on the phytochemistry of Rajasthan pteridophytes (Kaur *et al.*, 1986; Rathore and Sharma, 1988; Vyas and Sharma, 1988). Phenols play an important role in the metabolism of plants and specially during stress.

Vyas, Rathore and Sharma (1989) studied six species of pteridophytes viz. *Athyrium pectinatum* (wall) Presl, *Cheilanthes farinosa* (Forsk) Kuhn, *Pteris vittata* L. and *Tectaria macrodonta* (Fee) C. Chr., from the view point of the change in total phenols during stress. It has been concluded that increase in phenols during stress is comparatively more in drought resistant ferns than the moisture and shade loving ferns.

The flavonoids are derivatives of the parent substance flavone. The flavonoids occur in all vascular plants, some types are more frequently distributed than others, flavones and flavonols are universal while isoflavones and biflavonyls are restricted to a few Gymnospermous plants. Flavonoids occur frequently in pteridophytic plants specially the ferns.

Sharma and Sharma (1992) have studied the flavonoids in seven common ferns viz. Actinopteris radiata, Adiantum lunulatum, A. capillus veneris, Asplenium pumilum, Tectaria macrodonta, Cheilanthes farinosa, Hypodematium crenatum and Cyclosorus dentatus. The flavonoids were identified on the basis of R.F. value.

Rathore and Sharma (1988) have studied proline contents during stress and nonstress conditions in eleven species of ferns from Mount Abu. Drought resistant ferns possess more concentration of proline than the aquatic or moisture loving plants. Proline influences stress probably through its effect on the degradation of chlorophylls and accumulation of carotenoids in ferns.

Accumulation of proline is generally related with the stress (Henson et al., 1977). Recently Kaur et al. (1986) have studied proline contents in vegetative and fertile fronds in four ferns of Rajasthan (Actiniopteris radiata, Adiantum incisum, Asplenium pumilum, and Cheilanthes farinosa) and noticed an increase in free proline during sporangia formation.

GAMETOPHYTE DEVELOPMENT :

The major work on the physiology of ferns is mostly restricted to gametophyte development. The pioneering work of Klebs (1916, 1917) involves analysis of factors controlling the growth of gametophyte. Similar investigations on gametophyte development of Blechnum, Ceratopteris, Polypodium and Gymnogramme were carried out by Perrin (1908) and Czaja (1921). In India, Nayar and Kazmi (1964) have studied in detail the gametophyte development of Acrostichum aureum. Rainer (1968) has studied the effect of chloremphenicol and cycloheximide on chloroplast development and morphogenesis in sporeling of Dryopteris. His study indicates that cycloheximide blocks the growth of gametophyte while the chloroplasts remain functional.

PHOTOSYNTHETIC STUDIES :

Stuart (1960) has studied revival of respiration and photosynthesis in dried leaves of Polypodium polypodioides. It was found by him that the basic photosynthetic apparatus and its mechanism is similar in the fern and the higher plants. Stuart's (1960) work shows that Polypodium polypodioides has remarkable ability to revive its photosynthetic activity when dried leaf is immersed in water. Hatch *et al*. (1966) studied the pattern of photosynthesis and formation of the first stable compound in *Nephrolepis cordifolia*. They found 47% of the radioactivity in 3-phosphoglycerate and 48% in hexose phosphate following the exposure to $14CO_2$ for 4 seconds.

EFFECT OF LIGHT :

Besides the gametophyte development a few attempts to study the effect of light in growth and development in ferns were also made. The earlier work in this field is that of Borodin (1865) who has studied the effect of light on spore germination. He established light dependence of the spore germination, in most species of ferns. However, there are conflicting reports on the ability of spores of certain species to germinate in the dark. Schelting (1875) had earlier stated that spore germination does not occur in the dark. However, in their study of fern spore germination Borodin (1865), Schulz (1902) and Life (1907) were unable to demonstrate the germination of fern spore of *Anemia phyllitidis* in dark. These results indicate that light is essential for fern spore to germinate.

Gibberelic acid stimulation of dark germination reported by Schraudolf (1962) was the first true case of a specific replacement of a light requirement in spore germination. Weinberg and Voeller (1969) have shown a striking pH dependence of Gibberelic acid stimulated dark germination in Acrostichum phyllitidis.

Dring (1965) studied the effect of shaded condition on the fertility of the bracken fern, Pteridium aquilinum. He noticed that when P. aquilinum is grown under shaded area it is less fertile and there is a gradual decrease in fertility with increasing degree of shade. This fertility gradient showed a significant correlation with light intensity, but little or no correlation with other habitat factors measured.

ORGANIC CONSTITUENTS :

There are only a few reports on the biochemical analysis of ferns. Pteridium aquilinum was studied in greater detail for the cellulose, starch and pectin contents (Whistler and Smart, 1953). The unusual sugar, trehelose has been reported from Lycopodiaceae but not from Filicinae (Pigman and Goepp, 1948).

Panvisavas et al. (1968) have reported the distribution of free amino acids in about 39 species of ferns. Their study has indicated that glutamic acid, alanine, aspartic acid are present in 80 percent of ferns investigated. However serine, valine, phenyl-alanine, threonine are present in 45 percent of ferns, while glycine, tryptophan, tyrosine and glutamine are present in only about 3 percent of the ferns examined.

Malic acid appears to be the main acid in pteridophytes. It has been detected in Ophioglossum, Dryopteris, Marsilea and Polypodium species, in greater quantities in Equisetum species and high concentration in the leaves of Isoetes and Platycerium (King and Sperry, 1968).

PIGMENTS :

According to Bucke and Hallway (1965) the plastoquinone C which is generally present in the chloroplasts of higher plants is not detected in ferns. Strain (1966) has reported that the ferns like Adiantum formossum, Blechnum indicum, Pteridium aquilinum contain chlorophyll-a, chlorophyll-b, lutein, neoxanthin, violaxanthin and β-carotene. However, Blechnum indicum and Pteridium aquilinum do not contain α-carotene. He has examined various plants from diverse natural habitats like the mountains, deserts, meadows, sea shores and streams. He is of the opinion that system of chloroplast pigments has originated only once and that minor modifications of this system had been perpetuated in successive generations of plants.

As mentioned earlier (Stuart, 1968) the structure of chloroplasts in Polypodium polypodioides is very similar to that of higher plants. According to

Buy and Nuernberg (1967), the behaviour of the ferns when etiolated does not differ much from that of dicotyledonous plants. In pteridophytes, bracken fern, *P. aquilinum* contains the same carotenoids as green leaves of higher plants although there may be the quantitative differences (Fujita and Ajimaka, 1941). According to Seybold and Egle (1941) carotenoids are also present in the spores of the pteridophyta. The earlier work on ferns for the distribution of Leucoanthocyanidins was undertaken by Bate-Smith (1954). His observation was that Leucoanthocynidins are generally found in ferns but are not present in Selaginellaceae, Psilotaceae and Lycopodiaceae. He has further stated that Leucoanthocynidins are usually present where tannins are recorded. He further attributes properties of tannins to these pigments.

POLYPHENOLS :

Our knowledge on polyphenols in ferns is due to excellent work of Bohm (1968). His work covers caffeic acid derivatives in forty species of ferns. He has shown the presence of rasmarinic acid in *Blechnum brasileense*. He has also isolated blechnic acid, a new caffeic acid ester from *B. spicant*. Glass and Bohm (1969) surveyed several species of ferns for cinnamic and benzoic acids. Their results indicate that P-coumaric and caffeic acids are present in 87 percent of ferns, ferulic acid, P-hydroxy benzoic acid and vanillic acid present in 74 percent of the ferns investigated. Gentisic, salicylic and syringic acids are present in one percent of ferns. Glass and Bohm (1969) also studied the accumulation of cinnamic and benzoic acid derivatives in Pteridium aquilinum and Anthyrium felix-femina. Markham et al. (1969) isolated a new flavonol triglycoside from Ophioglossum vulgatum L. which was shown to be 3-O-methyl quercetin 7-O-diglucoside 4-O-glucoside.

ALKALOIDS :

Panvisavas et al. (1968) investigated 17 species of ferns representing 3 families for the presence of alkaloids and concluded that no alkaloids are present in the fern extracts examined by them. However, Hegnauer (1966) reports that nicotine is present in tracer amounts in other pteridophytes like Lycopodium and Equisetum. Ayer et al. (1968) were able to isolate seven alkaloids from Lycopodium alopecuroides L. These include the known alkaloids like Lycopodine, Lycopodiline and Clavolonine as well as a few unknown ones.

The review of literature clearly indicates that lot of work has been done on the taxonomy and morphology of pteridophytes and comparatively less work on the physiology of pteridophytes. Hence in the present investigation the physiology of some pteridophytes is studied. The typical representatives viz. *Nephrolepis exaltata* Schott. and *Gymnopteris contaminans* Bedd. were selected for this purpose.

N. exaltata and *Gymnopteris contaminans* Bedd. differ from each other. *N. exaltata* Schott. is a garden fern, cultivated in garden and *G. contaminans* Bedd. is growing in natural condition in the evergreen forest where the soil contains more humus and it grows in the shades where there is low light.

Nephrolepis exaltata Schott. has a short erect rhizome giving off numerous wiry creeping stolons. Stipes are tufted and scaly. Frond are 1-3 feet long, 3-6 inches broad, pinnate and pinnae are 2-3 inches in length, 1/4th to 1/2 inch in breadth, acute at the apex, margin is entire or crenate, base is auricled, the upper auricle is larger than the lower one. Rachis and surfaces are scaly when young but naked when old. Texture is almost leathery. Sori are near the margin on the ventral surface. Indusium is firm and kidney shaped. Plate 1 shows *N. exaltata* in its natural habit, while Plate 2 shows the various parts of *N. exaltata* and Plate 3 shows the vegetative leaflets showing forked venation and also the leaflets showing sori in *N. exaltata*.

The *Gymnopteris contaminans* Bedd. is a fern growing naturally in evergreen forest. It has a creeping and scaly rhizome. Stipe is also scaly. Fronds

PLATE 1. : N. exaltata Schott. in its natural habit.

PLATE 2. : The various parts of N. exaltata Schott.

PLATE 3. : The vegetative leaflets showing forked venation (A) and also the leaflets showing sori (B) in N. exaltata Schott.

PLATE 4. : G. contaminans Bedd. in its natural habit.

PLATE 5. : G. contaminans Bedd. in its vegetative stage.

PLATE 6. : G. contaminans Bedd. in its reproductive stage.

PLATE 7. : The various parts of G. contaminans Bedd..

are upto about 1.5 feet in length and dimorphic, pinnate, pinnae of the barren fronds almost sessile, lanceolate, margin entire, slightly crenated or more deeply lobed and serrate segments, terminal pinna more or less elongated, as a rule proliferous, fertile pinnae are much contracted, surfaces are naked. Rachis is scaly. Main veins are conspicuous and two third of the way to the margin, meshes are broad and those abutting of the costa are without any included veinlets. Plate 4 shows G. contaminans in its natural habit. Plate 5 shows G. contaminans in its vegetative stage while Plate 6 shows G. contaminans in its reproductive stage and Plate 7 shows the various parts of G. contaminans.