Results presented in Table II would show that UV irradiated leaves aged faster than unirradiated leaves. However, the altered response of irradiated *P. repens* leaves to the two isolates of *Pyricularia* could not be ascribed to UV induced ageing of the leaves. Ageing of unirradiated leaves before inoculation did not alter their typical response to the compatible PR and the incompatible P_1 isolates.

Several suggestions have been made to explain the altered response of UV irradiated leaves to infection by fungi. Buxton *et. al.*[1] speculated that increased infection by *Botrytis fabae* on irradiated broad bean leaves might be due to increased production of foliar exudates that stimulated the pathogen. Others considered that UV irradiation caused injury to the leaf epidermis. It seems unlikely, however, that the above effects of UV could explain the altered response of irradiated *P. repens* leaves to the incompatible P_1 and PR isolates of *Pyricularia.* The effects of UV could not be reproduced with physical injuries to the leaves before inoculation (unpublished observations). In fact, diffusates and extracts of physically injured leaves were less stimulatory to germ tube growth in the compatible PR and more inhibitory to germ tube growth in the incompatible P_1 than those of uninjured leaves[9]. Studying the effects of UV irradiation on resistance of barley (*Hordeum vulgare*) to *Helminthosporium teres* and *H. sativum,* Chakrabarti[10] concluded that increased susceptibility of irradiated leaves was due to partial inactivation of a performed fungal inhibitor present in resistant barley leaves. We have similar evidence to indicate that UV irradiation of *P. repens* leaves before inoculation affects the acccumulation of fungitoxic material in epicuticular waxes. The results of these studies will be published elsewhere.

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EVOLUTION OF STOMATAL COMPLEX IN EMBRYOBIONTA

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ABSTRACT

A survey has been carried out of the stomatal apparatus in the various 'type' taxa of the Embryobionta as suggested in the classification proposed by Cronquist, Takhtajan, and Zimmermann (1966). The study includes not only the true leaves of higher plants but the scaly leaves of *Psilotum, Rhynia, Equisetum,* and *Eqhedra* have also been taken into account. It is seen that the stomatal apparatus is considerably different in its organization among the taxa examined suggesting the polyphyletic origin of the diverse groups of the plant kingdom.

INTRODUCTION

A RECORD of the various characters of the leaves, forms the subject-matter of this, an earlier communication (Paliwal *et al.*, 1976) has been widely employed in studying the history of the group. For example, the analysis of the fossil leaf characters has been important in discussions of the origin of the angiosperms (Sinnott and Bailey, 1914; Axelrod, 1952, 1960, 1970; Scott *et al.*, 1960), their subsequent evolution and diversity (Wolfe and Barghoorn, 1960; Takhtajan, 1969; Delevoryas, 1971), and their distribution through time and space (Cain, 1944) and in paleolimatic interpretations (Wolfe and Hopkins, 1967; Axelrod and Bailey, 1969; MaGinitie, 1969; Wolfe, 1971; Dilcher, 1973).

In the present survey, the variation in the organization of the stomatal apparatus has been considered in the Embryobionta as a whole which has been rather ignored (since studies have been mostly restricted to the familial, generic, or specific levels both in the fossil and living forms), except for a brief attempt in this direction by Porsch (1905).

EXPERIMENTAL

Sources of information.—For the study of the stomatal complex in different taxa, materials and illustrations were collected from different books, publications, herbarium sheets, museum and fresh specimens.

Preparation of the material for microscopic study.—The epidermis was peeled away directly from the leaf surface except in such instances where it was difficult to do so. Consequently, such leaves or stems were placed in a slightly modified mixture of Jeffrey (comprising equal volumes of 10% chromic acid and concentrated nitric acid). The cuticular peels thus obtained were thoroughly washed with distilled water and placed in 50% alcohol, stained with Delafield's hematoxylin and passed through a series of alcohol and xylene and finally mounted in piccolyte.

RESULTS

In *Rhynia gwynnee-vaughani,* occurrence of true anomocytic* stomata has been reported in a well-documented publication by Pant (1960). In *Marchantia polymorpha* the epidermal cells are isodiametric, pentagonally arranged, with straight cell walls. The stomata are absent and only barrel-shaped pores are present. The epidermal cells in *Anthoceros himalayensis* (sporophytic) are rectangular with undulate cell walls arranged in a linear elongate manner with small and large cells alternating each other. The cells are 0·09 mm long and 0·02 mm broad. The anomocytic, kidney-shaped stomata are raised with length and breadth varying from 0·07–0·06 mm. In *Bryum* sp., *Psilotum nudum, Lycopodium selago, Isoetes* sp., *Ophioglossum reticulatum, Polypodium membranaceum, Marsilea minuta, Salvinia natans, Ginkgo biloba,* and Ephedra *distachya* anomocytic (aperigenous) type of stomata are present. *Equisetum* sp., *Welwitschia bainesii,* Gnetum gnemon, *Bennettites* sp., and *Magnolia grandiflora* possess paracytic stomatal apparatus whereas in the taxa like *Marattia* sp., *Cycas circinalis,* and *Pinus roxburghii* the stomatal complex is of cyclocytic type.

In *Anthoceros* the stomata occur on the sporophytic tissue which is also true for *Bryum* where the stomata are present on the capsule. The stomatal frequency per unit area is maximum (37·5) in *Marsilea minuta* and least (3·57) in *Anthoceros himalayensis* and *Isoetes* sp. (3·84). The stomata are placed at the same level as the epidermis in *Marattia, Polypodium,* and *Gnetum*; are raised in *Anthoceros* and *Magnolia,* and sunken in species of *Isoetes, Equisetum, Cycas, Pinus, Ephedra,* and *Welwitschia.* Conspicuous surface ornamentation is seen on the epidermal and guard cell surfaces in the species of *Equisetum* and *Cycas* as well as in *Ephedra* and *Welwitschia* (*see* Paliwal *et al.,* 1974). In *C. circinalis* a peculiar feature is that the sunken guard cells are present only below the subsidiary cells and the ring of encircling cells lies at about the same level as the subsidiary cells. The monocyclic stomata of *Ginkgo biloba* have their guard cells partially overarched by the inner margins of 4–6 subsidiary cells. Normally, they are further protected by the centripetally directed thickened papillae of the subsidiary cells. In *Ephedra distachya* each stomatal apparatus occurring on the stem have two subsidiary cells which are very distinct with a dense protoplasm and a prominent nucleus. Some of these also have more than two (three or four) subsidiary cells. Thus stomata of two types can be made out : (*a*) those having three or four subsidiary cells surrounding the guard cells and (2) those with only two elongated subsidiary cells; the latter being in majority. At high magnification each stoma reveals its sunken position clearly. The inner concave walls of the guard cells surrounding the pore are thicker than the outer ones. In *Gnetum gnemon* at lower magnification, the stomata were found to be irregularly but closely oriented in different planes. Their number is 20 per sq. mm. as compared to 10 on the stem epidermis of *Ephedra* Each stoma is surrounded by two subsidiary cells. The two kidney-shaped guard cells are elongated, giving the stomata an oval outline. The stomata appear to be almost at the same level as the epidermal cells themselves. The stomata of *Welwitschia bainesii* are few and scattered irregularly. The guard cells are kidney-shaped and are positioned sunken in relation to the epidermal and the subsidiary cells. The two subsidiary cells are recognizable from the other epidermal cells by their denser cytoplasmic contents.

We failed to get suitable illustrations for the stomatal complex of the fossil taxa like *Hyenia elegans, Sphenophyllum myriophyllum, Protopteridium minutum, Archaeopteris fimbriata, Noegeratthia* sp., *Lyginopteris oldhamia. Bennettites* sp. However, from the information we could gather, it became apparent that the guard cells are kidney-shaped in most of them. The inner walls of the

* Terminology after Fryns-Claessens and van Cotthem (1973).

guard cells are thick in all the representatives. These are two in number except in *Bryum* sp. where a single oval structure was noticed. The guard cells of *Salvinia* sp. and *Marsilea* sp. are very small as compared to the other taxa studied.

General Comments and Conclusions

Fossil cuticle, as well as cuticle of living leaves, contains a host of characters which may be important in determining relationships at specific, generic and family levels. Workers from all corners have given comprehensive and suggestive accounts on the stomatal types of different monocotyledons, dicotyledons, and gymnosperms (Priestley, 1943; Paliwal, 1965, Stace, 1965; Martin and Juniper, 1970; Sinclair and Sharma, 1971; Dilcher, 1974). Stebbins and Khush (1961) present an account of the stomata of the monocotyledons and considered the stomatal complex systematically in relation to the growth habit, and also the geographic distribution of stomatal types. They suggested that the specialized stomatal complex, once adapted, persisted even though the habitat in which the early evolution of the stomatal complex took place may have changed. Paliwal (1969) and Tomlinson (1974) in their reviews of the usefulness of the stomatal complex development as a taxonomic tool in the monocotyledons disagree with Stebbins and Khush and suggest that it is premature to speculate about the phylogenetic significance of stomatal patterns in the monocotyledons. They further suggest that the stomatal complex has systematic value only when used in combination with several other characters of known taxonomic usefulness.

In this study stomata differ considerably among the taxa studied which suggests the polyphyletic origin of the plant kingdom. For example in *Bryum* sp., *Psilotum nudum, Lycopodium selago, Isoetes* sp., *Ophioglossum reticulatum, Polypodium membranaceum, Marsilea minuta, Salvinia natans, Ginkgo biloba* and *Ephedra distachya* anomocytic (aperigenous) type of stomata are present. *Equisetum* sp., *Welwitschia bainesii, Gnetum gnemon, Bennettites* sp. and *Magnolia grandiflora* possess paracytic stomatal apparatus while in the taxa like *Marattia* sp., *Cycas circinalis*, and *Pinus roxburghii* the stomatal complex is of cyclocytic type. In *Anthoceros*, the stomata occur on the sporophytic tissue which is also true for *Bryum* where the stomata are present on the capsule.

Variation in stomatal frequency (*Anthoceros himalayensis* — 3·57; *Marsilea* — 37·5) and position of guard cells (at the level of epidermis in *Marattia, Polypodium* and *Gnetum*; raised in *Anthoceros* and *Magnolia*; sunken in *Isoetes, Equisetum, Cycas, Pinus, Ephedra* and *Welwitschia* sp.) may all be due to ecological conditions prevailing in the areas where these taxa were growing. Stomata coming in about the epidermal cell level may be due to increasing hydrophytic habits.

Taxa possessing same type of stomata may be due to parallelism or convergence of evolution among them.

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RECENT RESEARCHES IN PLANT SCIENCES

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A NATIONAL symposium on "Recent Researches in Plant Sciences", was held at the Department of Botany, Punjabi University, Patiala, during January 20–22, 1977. Ninety plant scientists representing 30 universities and institutes from all over India took part in the symposium, inaugurated by Mrs. I. K. Sandhu, Vice-Chancellor, Punjabi University. Apart from presentation of papers, special and plenary lectures by eminent botanists constituted the important part of the symposium.

Prof. P. N. Mehra discussed the structural and morphological variability in the Himalayan orchids. Role of the structure and behaviour of chromosomes in relation to the amount of DNA and other constituents in a species was explained by Prof. A. K. Sharma. He formulated a new concept of chromosomal dynamism in evolution and stressed that the flexibility of chromosome behaviour has high potentialities in genetic engineering for crop improvement. Dr. T. N. Khoshoo stressed the need for the improvement of ornamentals in India for earning foreign exchange. Genetical basis of monoecism and dioecism in plants was discussed by Prof. R. P. Roy and he made a strong case for exemplifying indigenous material in teaching of cytogenetics. Prof. V. Puri pleaded for the avoidance of the present practice of forcing fossil specimens into descriptions of modern genera. Prof. T. V. Desikachary pointed out that in spite of fine structure studies in algae, we are still in the beginning of our search for the possible ancestors of land plants from aquatic plants and heterotrichous condition is an important step in this direction. Production of adventitious roots, according to Prof. K. K. Nanda, is controlled by a balance between auxin, IAA oxidase, inhibitors of IAA-oxidase and bound auxins in the system. Prof. C. P. Malik explained the metabolic changes that take place during pollen germination. An elaborate account of the recent palaeobotanical discoveries and their phylogenetic significance was discussed by Prof. D. D. Pant whereas the role of enzymes in *Zizyphus* gall tissues was outlined by Prof. H. C. Arya. A strong plea for adopting an integrated approach in taxonomy by utilizing data from other aspects of plant studies was made by Prof. B. M. Johri.

Nearly 100 research communications dealing with morphology, cytogenetics, biosystematics, anatomy, taxonomy plant functions and diseases covering both basic and applied aspect were presented and discussed during 10 academic sessions of the 3-day symposium.

As a result of panel discussions on the concluding day, the following recommendations with regard to teaching and research in plant sciences have been made :

1. Basic researches should be strengthed in the universities and there should be no strings attached to research.
2. While planning and conducting basic researches, plants of economic importance should be selected. Further there should be an inter-disciplinary approach for finding solutions to problems of plant productivity. This could best be achieved through teacher and scientist exchange programme.
3. Researches on lower groups of plants with particular reference to teridophytes need to be promoted.
4. Local and regional floras of the country must be compiled, and work on plant taxonomy, systematics and phytogeography should be promoted. by U.G.C.
5. Work on preparation of 'Chromosome Atlas' of plants of various regions of the country is urgently needed.
6. Researches on forest biology, environmental botany, pollen physiology, seed treatment, plant nematology and reproductive biology need to be strengthened.