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Pteridophytes: General Characters, Economic Importance

Pteridophytes (pteron - feather, phyton - plants) are the non-flowering vascular plants. Hence they may be defined as 'vascular cryptogams'. They are represented by about 400 genera and about 10,500 species including both the living and fossil plants.

They are the earliest known vascular plants which originated in the Silurian period (400 million years ago) of Palaeozoic Era and subsequently diversified and formed the dominant vegetation on earth during Devonian to Permian period.

Distribution/Habitat of Pteridophyta:

The pteridophytes grow in diverse habitats. Mostly they show terrestrial habits growing in moist, cool and shady places. All pteridophytes require water for transfer of sperms to ovum to complete the process of sexual reproduction.

A few members are aquatic (e.g., *Azolla, Isoetes, Marsilea, Salvinia*) or xerophytic (*Selaginella lepidophylla, S. rupestris, Equisetum arvense*) and many are epiphytic (*Lycopodium phlegmaria, Selaginella oregana, Ophioglossum vulgatum*, ferns like *Polypodium, Drynaria, Pleopeltis*, etc.).

Life Forms:

Pteridophytes range from small herbaceous annual (*Azolla, Salvinia*) to large perennials trees (*Cyathea, Alsophila*). Mostly, pteridophytes are herbaceous in nature.

Plant Body:

i. The major plant body is a nutritionally independent sporophyte which is differentiated into roots, stem and leaves. Some primitive members do not have true roots or leaves (e.g. *Rhynia, Cooksonia, Psilotum*).

ii. The sporophyte develops from the diploid (2n) zygote. The primary roots are ephemeral and subsequently replaced by the adventitious roots.

iii. The stem is generally branched; either dichotomous or monopodial.

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iv. The leaves may be simple, small and sessile (e.g., *Lycopodium, Selaginella*); scale like (e.g., *Equisetum*) or compound, large and petiolate as in ferns (e.g., *Pteris, Marattia*).

Two types of leaves are found in pteridophytes:

(a) Microphylls or Microphyllous Leaves:

The leaves are simple with a single unbranched mid-vein; the leaf trace is not associated with any leaf gap. (Fig. 7.1 A) e.g., *Lycopodium, Selaginella, Isoetes*.

(b) Megaphylls or Megaphyllous Leaves:

The leaves are large, compound with dissected veins, the leaf trace is always associated with leaf gap (pig. 7.1 B), e.g., *Pteris, Marattia, Marsilea*.

i. The leaves and stems, in most of the cases, are provided with filiform trichomes.

ii. A well-developed vascular system, comprising of xylem and phloem, is present. Cambium is generally absent, thus secondary growth does not take place in majority of the pteridophytes except Botrychium *Isoetes*, and arborescent pteridophytes like *Lepidodendron, Catamites*.

iii. The nature of stele varies in different groups. It may be protostele (*Psilotum, Lycopodium, Selaginella*); Siphonostele (*Equisetum, Marsilea, Botrychium*); dictyostele (*Pteris, Polypodium*) or Polycyclic (*Angiopteris, Marattia*).

Diagnostic Characteristics of Pteridophytes:

1. Pteridophytes are non-flowering (seedless) vascular plats.

2. Sporophyte is the predominant plant body, differentiated into root, stem and leaves.

3. There is a regular heteromorphic alternation of generation where both the sporophytic and gametophytic generations are nutritionally independent.

4. The stem is generally branched either dichotomous or monopodial.

5. The primary roots are ephemeral and are soon replaced by adventitious roots.

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6. Pteridophytes are polysporangiate, either homosporous or heterosporous.

7. Pteridophytes are free sporangiate where isospores or micro- and megaspores are released through the dehiscence of sporangia.

8. Presence of multicellular sex organs i.e., antheridia and archegonia.

9. Water is essential for fertilisation where flagellated sperms swim over a thin film of water and are attracted chemotactically towards the archegonium.

10. The zygote undergoes repeated mitotic divisions to form embryo. The first division of the zygote determines the polarity of the sporophyte.

Reproduction in Pteridophyta:

i. The sporophytic plant reproduces by means of spores produced in the sporangia (singular: sporangium).

Sporangium:

i. The position of sporangia may vary in different groups;

ii. They may be borne on the stems i.e., cauline (e.g., *Psilotum; Rhynia*) or on the ventral (adaxial) surface of the leaves i.e., foliar (e.g., *Lycopodium, Selaginella*) or in the axil of the leaves (e.g., *Ophioglossum*).

iii. The sporangia containing leaves are called sporophylls.

iv. The sporophylls may be scattered (e.g., *Lycopodium selago*), uniformly distributed (e.g., *Pteris, Adiantum* and other ferns) or grouped in definite areas to form strobili (*Selaginella, Equisetum*).

v. In some aquatic pteridophytes the sporangia are present within a specialised structure, called sporocarps (e.g., *Azolla, Salvinia, Marsilea*).

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On the basis of mode of development, the sporangia are of two types viz., the Eusporangiate and the Leptosporangiate (Table 7.1). In the eusporangiate type, the sporangia develop from several sporangial initials (e.g., *Psilotum*, *Lycopodium*, *Selaginella*). In leptosporangiate, on the other hand, sporangia develop from a single initial cell (e.g., *Salvinia*, *Pteris*).

In some forms (e.g., ferns) the sporangia are aggregated in clusters termed sori (singular sorus).

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Economic Importance of Pteridophytes

The economic importance of pteridophytes is not well-documented, because due attention has not been given towards their use in human welfare. However, there are many reports on their uses, specially as food plants, medicinal plants and horticultural plants.

Some of the aspects of economic importance of pteridophytes are given:

i. Pteridophytes Used as Food:

The young leaf tips of ferns, the circinate ptyxis or the chroziers are used as vegetable. The young fronds of Ampelopteris prolifera are sold in the market as 'dheki shaak' in India and Bangladesh. The croziers of Matteuccia struthiopters as canned or frozen are served as spring vegetable in USA and Canada. Leaves of *Marsilea*, commonly called 'shushni', are used as vegetable.

The rhizome of many ferns such as *Pteris*, rich in starch, is used as food.

The corm (modified stem) of *Isoetes* is used as food by pigs, ducks and other animals.

ii. Pteridophytes Used as Fodder:

Dry fronds of many ferns form the livestock for catties. The quadrifid lamina of *Marsilea* resembles a clover (Trifolium) has been used as fodder for animals as a substitute for clover.

iii. Pteridophytes Used as Medicine:

The spores of *Lycopodium* have been widely used in pharmacy as protective dusting powder for tender skin and also as water-repellants. The foliages of *Lycopodium* are used as tincture, powder, ointment and cream as a stomachic and diuretic. The foliage decoction is used in homeopathy to treat diarrhoea, bladder irritability, eczema, rheumatism, constipation and inflammation of liver.

Equisetum is rich in silicic acid and silicates. Potassium, aluminium and manganese, along with fifteen types of flavonoid compounds, have been reported from *Equisetum*. The flavonoids and

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saponins are assumed to cause the diuretic effect. The silicon is believed to exert connective tissue-strengthening and anti-arthritic action.

Several ferns have been used as herbal medicine. An oil (5% Filmaron and 5-8% Filicic acid) extracted from the rhizome of *Aspidium* is used as a vermifuge, especially against tapeworm. The decoction of *Asplenium* is used for cough and a good hair wash. The expectorant of *Polypodium* is used as a mild laxative, while the tonic is used for dyspepsia, loss of appetite and hepatic problem.

The root decoction of *Osmunda regalis* is used for treatment of jaundice. The ointment made from its root is used for application to wound. The extraction of *Osmanda vulgaris*, commonly known as 'Green oil charity', is used as remedy for wounds. The chemically active principal 'Marsiline' isolated from *Marsilea* is found to be very effective against sedative and anti-convulsant principal.

The rhizome and frond bases of *Dryopteris* have been used to determine the origin and pathways of dispersed pathogenic insects like corn ear- worm. The preparation of *Ophioglossum vulgatum* as 'Green oil charity' is also used as remedy for wounds.

iv. Pteridophytes Used as Horticultural Plants:

Many species of pteridophytes are cultivated for their aesthetic value. Many variants and cultivars of *Psilotum* have been brought in cultivation in nurseries and greenhouses in the nick-name of 'whisk fern'.

Some epiphytic species of *Lycopodium* (e.g., *L. phlegmaria, L. lucidulum*) are aesthetically more valued and can be grown on hanging baskets.

Several species of *Selaginella* are used as a ground cover in an undisturbed area because of their decent foliage and colour. *Salaginella willdenovii, S. uncinata*, etc., are grown in gardens for their decent blue colour. 5. *lepidophylla, S. bryopteris*, etc., are sold as dried under the name 'resurrection plants' which rejuvenate on contact with water.

Several ferns such as *Angiopteris, Asplenium, Marattia, Microsorium, Nephrolepis, Phymatodes*, etc., have aesthetic values for their beautiful habit, graceful shape of the leaves, and beautiful soral arrangement. Thus, these characteristics make them horticulturally important plants.

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v. Pteridophytes Used as Biofertiliser:

Azolla is a free-floating water fern which can multiply very quickly through vegetative propagation. There are hundreds of moss-like leaves harbouring live colonies of dinitrogen fixer Cyanobacterium - *Anabaena azollae*.

The relationship between the alga and *Azolla* is symbiotic where the alga provides nitrogen to the plant. Thus, *Azolla* in full bloom in the waterlogged rice fields may serve as a green manure. Rice farmers of our country are using *Azolla* as biofertiliser for the better production of their crops.

vi. Pteridophytes Used as Indicator Plants:

Like angiosperms, pteridophytes are being used as indicator plants.

Equisetum accumulates minerals, especially gold, in their stem. The rate of accumulation even reaches up to 4.5 ounce per ton. Equisetum may be referred to as gold indicator plants which help in searching a region for gold ore deposits. Similarly, *Asplenium adulterinum* is an indicator of nickel and *Actinopteris australis* is a cobalt indicator plant. Thus, these plants are found to be valuable in prospecting for new ore deposits.

vii. Pteridophytes Used for Various Purposes:

There are various applications of pteridophytes:

The stem of *Equisetum* was used for polishing wood in ancient times and to clean utensils.

The roots and stems of *Osmunda* are used to make beds for growing orchids. Water boiled with *Lycopodium clavatum* is used for dyeing the woollen clothes which becomes blue when dipped in a bath of Brazil wood.

The powder of *Lycopodium* is highly inflammable and is used in pyrotechny and for artificial lighting. Thus, *Lycopodium* powder finds its wide use in demonstration of artificial lighting on the stage, because it disperses easily in the air and only a small quantity is needed to produce an explosion.

Some of the pteridophyte members are considered to be the obnoxious weeds. *Pteridium aquilinum* is a carcinogenic plant which can rapidly invade the open forest lands, thus elimi-

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nating the other plants of the forest floor. The free-floating water fern, *Salvinia*, quickly propagates vegetatively, and thus occupy the entire water surface of lakes, ponds and irrigation reservoirs preventing free flow of water.

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Diagnostic characters and examples of Psilophyta

i) Psilophyta includes living (Order Psilotales e.g., Psilotum), as well as fossil plants (Order Psilophytales e.g., *Rhynia*).

ii) The members are sporophytic.

iii) Roots are absent.

iv) The organization of the plant body of the members is very simple. It is differentiated into a subterranean (underground) rhizome and an erect aerial portion.

v) Rhizome bears tufts of unicellular Rhizoids.

vi) Aerial portion is sparingly or profusely branched. The branching is usually of dichotomous type.

vii) Aerial axis may be leafless or sometimes may bear scaly appendages (e.g., *Psilotum*) or large foliage leaves (e.g., *Tmesipteris*)

viii) The vascular tissue is of primitive type i.e., simple, cylindrical protostele with annular or spiral racheids.

ix) The reproductive organs are in the form of sac like sporangia.

x) Sporangia are borne at the apex of the aerial shoots. They are either solitary (e.g., *Rhynia*) or in groups and terminal in position. There was nothing like that of sporophyll.

xi) Sporangia always bearing the same type of spores i.e., they are homosporous.

xii) The gametophyte is known only in *Psilotum* and *Tmesipteris* (living genera) while unknown in Psilophytales.

xiii) The gametophyte is cylindrical or branched, subterranean and colourless.

xiv) Sex organs are partially embedded in the prothallus.

xv) Antherozoids are multiciliate in Psilotales.

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Diagnostic characters and examples of Lycophyta

(i) It includes both fossil (e.g., *Lepidodendron*) and living Pteridophytes (five living genera e.g., *Lycopodium, Phylloglossum, Isoetes, Stylites* and *Selaginella*).

(ii) Its history indicates that these Pteridophytes developed during the Devonian period of the Palaeozoic era.

(iii) The plant body is sporophytic and can be differentiated into root, stem and leaves.

(iv) The leaves are small (microphyllous), simple with a single mid vein.

(v) They are usually spirally arranged, sometimes in opposite fashion and or even in whorls.

(vi) In some cases the leaves are ligulate (e.g., *Selaginella, Isoetes*). The ligule is present at the base of each leaf.

(vii) The vascular tissue may be either in the form of plectostele, siphonostele or sometimes even polystele.

(viii) Leaf gaps are absent.

(ix) Sporangia are quite large in size and develop on the adaxial surface of the leaves (sporophylls).

(x) Sporophylls are loosely arranged and form strobilus.

(xi) Some members are homosporous (e.g., *Lycopodium*) while others are heterosporous (e.g., *Selaginella*).

(xii) Antherozoids are biflagellate or multiflagellate.

(xiii) Gametophytes which are in the form of prothalli are formed by the germination of spores.

(xiv) Heterosporous forms have endoscopic gametophytes while in homosporous forms the gametophyte is exoscopic.

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Diagnostic characters and examples of Sphenophyta

(i) It includes both fossil plants (e.g., *Calamophyton, Sphenophyllum*) as well as living plants (e.g., *Equisetum*). It is represented by one living genus Equisetum and 18 fossil forms.

(ii) These Pteridophytes evolved during the Carboniferous period of the Palaeozoic era.

(iii) The plant body is sporophytic and can be differentiated into root, stem and leaves.

(iv) The stem in majority of the forms is long, jointed or articulated and is ribbed i.e., having ridges and grooves.

(v) Stem is divisible into nodes and internodes and is developed as upright aerial branches from the underground creeping rhizome.

(vi) Leaves are thin, small, scaly brown and are arranged in transverse whorls on the nodes of the aerial branches.

(vii) Branches also develop in whorls from the axil of the scaly leaves.

(viii) As the foliage leaves are reduced to scales, the process of photosynthesis is taken up by the stem and hence it becomes green.

(ix) The stem has a solid protostele (e.g., Sphenophyllum) or medullated protostele (e.g., Equisetum).

(x) Secondary thickenings were observed in some extinct forms (e.g., *Sphenophyllum*).

(xi) Sporangia are developed at the apex of the fertile branches in whorls forming compact cone.

(xii) Living members are homosporous but some fossil forms are heterosporous (e.g., *Catamites*).

(xiii) Spores germinate to give rise to gametophytes (prothalli) which may be monoecious or dioecious.

(xiv) Antherozoids are large and multiflagellate.

(xv) Embryo is without suspensor.

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Diagnostic characters and examples of Filicophyta

(i) The plants which are commonly known as 'ferns'. It is represented by about 300 genera and more than 10000 species.

(ii) These Pteridophytes were originated during the Devonian period.

(iii) They occur in all types of habitats. Majority of the ferns are terrestrial and prefer to grow in moist and shady places. Some are aquatic (e.g., *Azolla, Salvinia, Marsilea*), xerophytic (e.g., *Adiantum emarginatum*), epiphytic (e.g., *Asplenium nidus*), halophytic (e.g., *Acrostichum aureum*) or climbing (e.g., *Stenochlaena*).

(iv) Some members are very small while some members are tall tree like (e.g., *Angiopteris*).

(v) Majority of the members (except some tree ferns e.g., *Angiopteris*) have short and stout rhizome. The rhizome may be creeping, upright or growing above the soil.

(vi) Leaves are large, may be simple (e.g., *Ophioglossum*) or compound (majority of the ferns for example, *Pteridium, Marsilea, Adiantum* etc.) and described as fronds.

(vii) Young fronds are circinately coiled.

(viii) Leaves are exstipulate (e.g., Filicales) while stipulate in some other groups.

(ix) The vascular cylinder varies from a protosete to a complicated type of siphonostele.

(x) Vegetative reproduction takes place by fragmentation (e.g., *Adiantum, Pteridium*), stem tubers e.g., *Marsilea*), adventitious buds (e.g., *Asplenium bulbiferum*) or by apogamy (e.g., *Marsilea*).

(xi) Sporangia arise from placenta (a swollen cushion of cells) in groups (sori).

(xii) Sori develop on the margins or abaxial surface of the leaves (sporophylls) or leaflets.

(xiii) Sori are protected by true (e.g., *Marsilea*) or false indusia (e.g., *Adiantum, Pteris*).

(xiv) The sporangial development may be leptosporangiate (e.g., *Osmunda*) or eusporangiate type e.g., *Ophioglossum*).

(xv) The sporangia in most cases have a distinct annulus and stomium.

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(xvi) Members may be homosporous (e.g., *Pteris, Adiantum* etc.) or heterosporous (e.g., *Marsilea, Regnellidium, Azolla, Salvinia* etc.)

(xvii) Spores on germination form autotrophic prothalli (gametophyte).

(xviii) Antheridia and archegonia are partially or completely embedded in the gametophyte.

(xix) Embryo may or may not have suspensor.

Source: Internet Archives