Unit–11

FILICALES

Lesson Structure

11.1 Introduction and classification of filicales.

11.2. General Character and Leaf form in filicales.

11.3. Sporangia of filicales and leptosporangiate made of development.

11.4. Origin of Sori in ferns.

11.5. Development of gametangia and sporangia found in leptosporangiate ferns.

11.6. Types of spore and germination.

11.7. Pattern of gametophyte development.

11.8. Embryo development and Types.

11.9. Family wise description with required diagrams including anatomical feature and other details with labeled diagrams.

11.11. Suggested reading.

11.12. Questions for exercise.

11.1 INTRODUCTION & CLASSIFICATION OF FILICALES :

In earlier classification group/class Pteropsia was devided as follows:-

(A) Primofilicas.

1. *Cladoxylales*
2. *Coenopteridales*.

(B) Eusporangiatae

1. *Marattiales*
2. *Ophioglossales*.

(C) Osmundidae.

Osmundales.

(D) Leptosporangiatae

1. *Filicales*
2. *Marsileales*
3. *Salviniales*.

R. F. Holttum (1949-Classification of ferns - Bid. Rev. 24. 267-296) Classified this order as follows:-

1. Sehizaeaceae - ***Senftenbergia, Kenkia, Sehizaea, Lygodium, Mahria, Anenia.***
2. Gleicheniaceae - ***Oligocarpa, Gleichenites, Gleichenia***
3. Hymenophyllaceae - ***Hymenophyllum, Trichomanes***
4. Dicksoniaceae - ***Conioptonis, Dicksonia, Cibotium***
5. Matoniaceae - ***Matonidium, Matonia.***
6. Dipteridaceae - ***Clathropsis, Dictyophyllum, Camptoptoris, Phanerosoms***
7. Cyatheaceae - ***Alsophilites, Alsophila, Hemitelia, Cyatheia.***
8. Dennstaedtiaceae :
9. Dennstaedtioideae - ***Dinnstaedtia, Microplagia***
10. Pteridoideae - ***Pteridium, Pteris, Acrostichum***
11. Davallioideae - ***Davallia.***
12. Oleandraidae - ***Nephrolopis***
13. Onocleoideae - ***Onoclea, Methuecia.***
14. Blechnoideae - ***Blechnum, Woodwardia.***
15. Asplewideae - ***Asplenium, Phylitis.***
16. Athyrioideae - ***Athyrisum***
17. Dryopteridoideae - ***Dryopteris, Polystechum.***
18. Lowariopsidoidae - ***Elaphoglossum***

19. Adiantaceae - ***Adiantum, Cheilanthes, Pellaea, Ceratoptoris, Amogramma***

20. Polypodiaceae - ***Platycarium, Polypodium, Stenochlaena.***

Order filicales is the largest group of Pteridophyta and includes almost 300 genera and about 900 species. There is a considerable range of form and growth habit from tiny annuals to tall-ferns and from protosteles, yet all are alike in the early with stage of development of the sporangium. This together with its stalk, arises from a single cell. The first division of the initial cell is into apical cell and a basal cell. Further divisions take place in each and give rise to primary sporogenous cell.

Commonly the prothallus is either cordate or butterfly shaped ranging from a few mm to 1 cm. or more. The prothallus are one cell thick and are living, green and photosynthetic and there are rhizoids on the under side among which antheridia and archegonia are born. The archegonia are usually concentrated near the growing point or 'apical match'. Departure from this typical form occur in certain families and some have filamentous prothalli, resembling an algal filament, while even substeranean prothalli are known but this habit is extremely rare.

The structure of the antheridium is fairly constant but variation is seen in number of tiers of neck cells at maturity in archegonium. Some families have a slightly more massive antheridium composed of greater number of wall cells and containing more antherozoids, are believed to be more primitive.

The embryology of leptosporangiate ferns are constant. After division the zygote devides at a very early stage into four quadrants, two directed towards the apical notch of the gametophyte and two away from the notch (called poseteriorquadrant). The outer anterior quadrant gives rise to the first leaf, the inner interior to the shoot apex, the outer poseterior to the first root and the inner posterior to the foot. The following list of characters is based on F.O. Bower 1923 (as modified by Holttum, (R.E. Hoetteium, 1961) with addition by Stokey, 1951).

Rhizome - Slender, creeping, dichotomous with fronds in two ranks on its upper side, protostelia, covered with hairs.

Fronds - Large, amply branched, dichosomous and of unlimited growth, the stem or petiole with single leaf trace, the ultimate pinnules narrow with a single vein venation without anatomoses.

Sori - Containing sporangia, few or many grows on terminating veins, marginal, submarginal on the mid view.

Sporangia - Relatively large with stout stalk without a specialized annulus, developing and dehiseing simultaneously to liberate a large number of spores.

Spore genermination - Giving a plate rather than a filament of cells.

Gametophyte - Large, thalloid with a thick midrib, slow to develop.

Autheridium - Containing several hundred antherozoids. Wall cell more than four in numbers.

Archegonium - relatively with long neck.

In advanced forms the dermal appendages are scales instead of hairs. The filicales have been classified by several workers in ways given as below. The external features or morphology shows variation in their pinna structure. Veins, margin, shape and size. This is evidenced by comparing all members of filicales (Chart-1. Showing filicales, Systems of Classification:- 2 - Lweaf form of filicales.

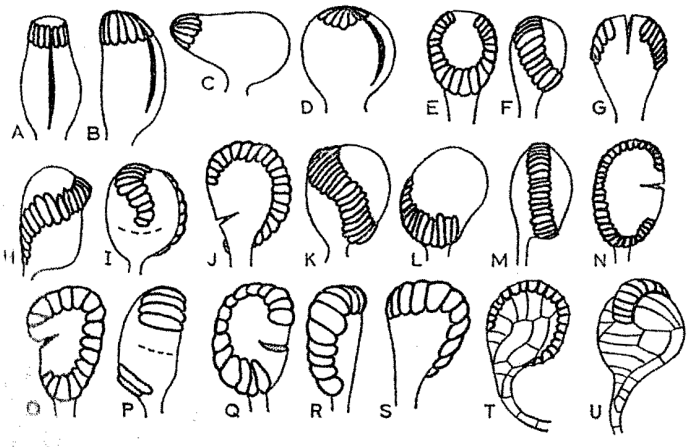
FILICALES, SYSTEMS OF CLASSIFICATION

Bower -1935	**Compeland -1947**	**Halttum -1947**	**Pichi-Sermolli -1958**	**Bierhorst -1971**
Osmundaceae	Osmundaceae	Osmundaceae	Osmundaceae	Psilotaceate
Schizaeaceae	Schizaeaceae	Schizaeaceae	Gleicheniaceae	Stromatopteridaceae
				Gleicheniaceae
Hymenophyllaceae	Hymenophyllaceae	Hymenophyllaceae	Schizaeaceae	Anemiaceae
				Glygodiaceae
Gleicheniaceae	Gleicheniaceae	Gleicheniaceae	Hymenophyllaceae	Osmundaceae
				Hymenophyllaceae
Matoniaceae	Matoniaceae	Matoniaceae	Matoniaceae	Matoniaceae
Disksoniaceae		Dipteridaceae	Platyzomaceae	Platyzomaceae
Polypodiaceae		Cyatheaceae	Dipteridaceae	Dipteridaceae
Pteroids	Pteriodaceae	Dennstedtiaceae	Cheiropleuriaceae	Cheiropleuriaceae
Gymnogrammoids		Dennsteaedtioideae	Grammitidaceae	
Davallioids		Pteridoideae	Polypodiaceae	Polypodiaceae
				Vittariaceae
Aspleniods	Davalliaceae	Davallioideae	Cyatheaceae	

dryopteriods	Aspleniaceae	Oleandroideae	Lophosoriaceae	
woodsioids	Aspleniaceae	Onocleoideae	Dicksoniaceae	Cyatheaceae
onocleoids		Blechnoideae	Dennstaedtiaceae	
blechnoids	Blechnaceae	Asplenioideae	Lindsaeaceae	
dipteroids	Polypodiaceae	Athyrioidiae	Pteridaceae	
Cyatheaceae	Cyatheaceae	ryopteridoideae	Negripteridaceae	
Marsileaceae	Marsileaceae	Lomariopsidoideae	Sinopteridaceae	Pteridaceae
Salviniaceae	Salviniaceae	Adiantaceae	Cryptogrammaceae	
		Polypodiaceae	Gymnogrammaceae	
			Actinopteridaceae	
		Marsileales	Adiantaceae	
		Salviniales	Parkeriaceae	Parkeriaceae
			Vittariaceae	Davalliaceae
			Davalliaceae	
			Oleandraceae	Aspleniaceae
			Aspleniaceae	
			Thelypteridaceae	Aspidiaceae
			Athyriaceae	
			Aspidiaceae	
			Lomariopsidaceae	
			Blechnaceae	Blechnaceae Hymenophyllop
			Loxsomaceae sides	
			Plagiogyriaceae	Loxomaceae
			Hymenophyllop-	
			Sidaceae	
			Marsileaceae	Marsileaceae
			Salviniaceae	Salviniaceae
			Azollaceae	Azollaceae

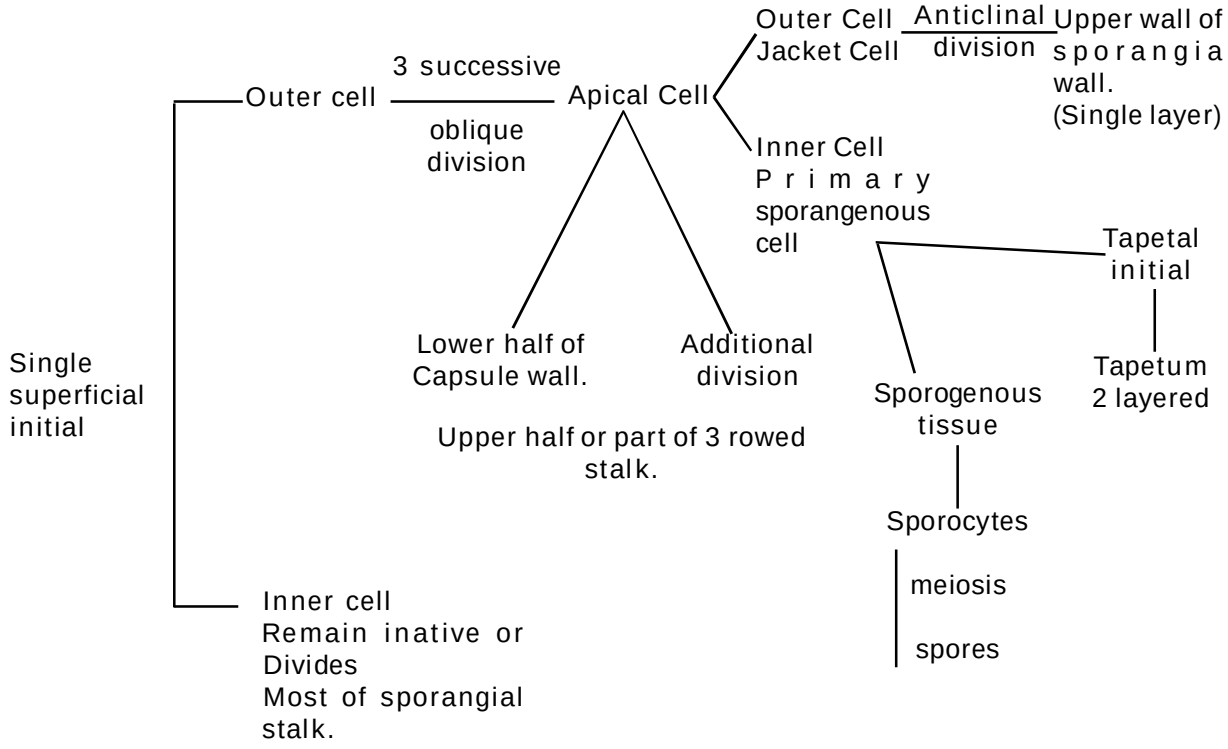
Leaf or pinna possess Sori (Sorus) as spore producing organs. The sorus has variable sorus forms which bear sporangia. Sporangia of some filicales are given as below:–

Leaf form: A, P*hanerosorus sarmentosus:* B, *Matonia pectinata:* C, *Gleichenia Longissima:* D, *G. linearis, var alternans, Sori:* E, *Matonia pectinata;* F, *Trichomanes alotum;* G, *Cinotium Baromet;*



Sporangia of Filicales : A, *Anemia:* B, *Schzaea;* C, *Lygodium;* D, *Mohria;* E, F, G, *Gleichenia;* H, I, *Matonia;* J,K,L, *Hymenophyllum;* M, N, *Cinotium;* O,P, *Hemitelia;* Q, R, S, *Dipteris;* T,U, *Adiantum* (AD, after Prantl; E-S, T,U, Muller)

The Sporangia possess spores, which usually terminates and forms gametophyte or Prothallus. In leprtosporangiate ferns a single Superficial cell forms several cell and their successive stages of development are as follows :-



The sori are most diverse in form but they are circular reniform or linear sori are variable in size and sometimes result due to fusion, the coenosori. Coenosori may be broken up into seqeueuts as in *Blechnum* and woodwardia. The sori occur over a vein or at the end of a vein. The portion of leaf surface bearing sporangia are termed as receptacle. the sporangia originates from superficial cell of receptacle. On the basis of origin the sori are classified as :-

1. MARGINAL SORUS:-

In this type the sporongia originates from the margin of pinnae of pinnule. The indusium is the protective layer of a sorus. The indusium may have thicker adaxial flap or thin leyered part.

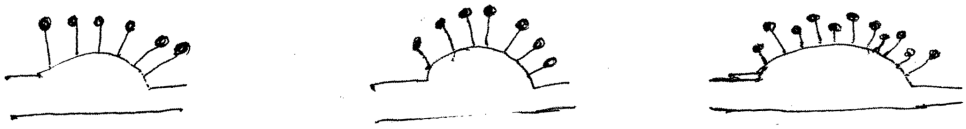
2. INTRAMARGINAL SORUS:-

These are submarginal in origin which becomes Meristematic and form the receptacle or sperogeuous meristem. e.g. Pteris, Cryptogramma, Pellaea and Pteridium. In pteridum, there is also an abaxial indusium.

3. SUPERFICIAL OR ABAXIAL SORUS:-

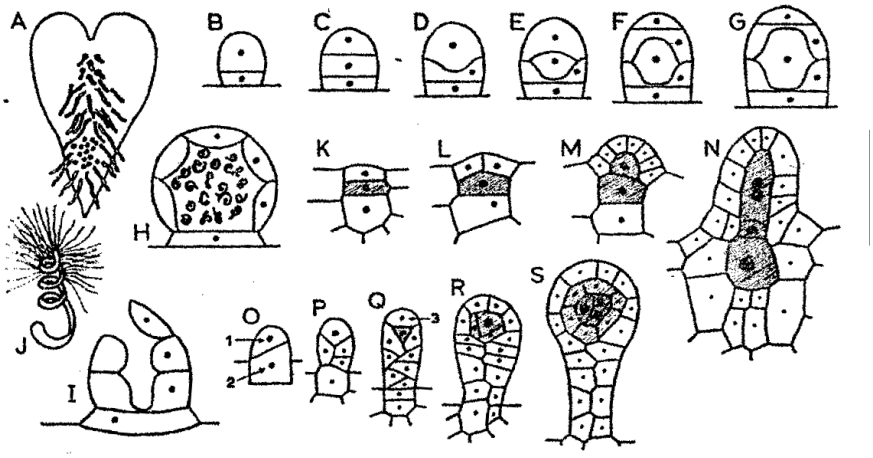
Here the receptacle is submarginal in origin on lower surface but the margin of Lamina remains active and continues to add new tissue shifting the sorus farther away from margin.

A Sorus in which all the sporangia originate, grow and mature at the same time is termed as simple sorus and termed as 'Simplices '. Ancient fossil ferns had this type of development and hence considered as primitive.



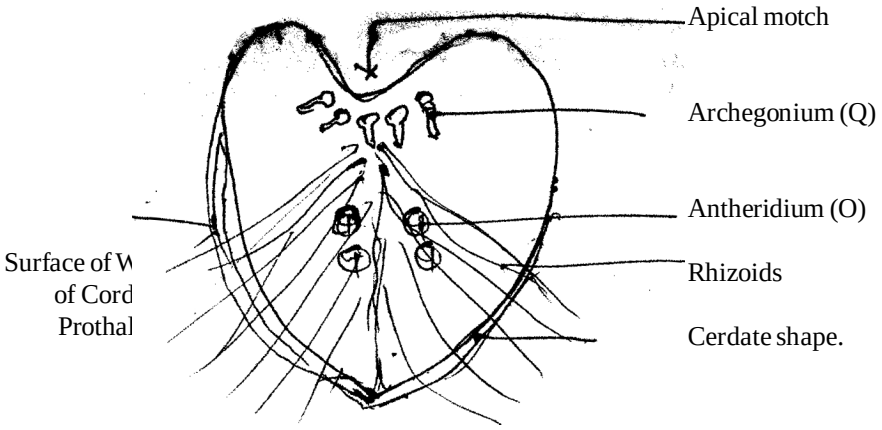
Simplices Gradate Mixed

In leprosporangiate ferns the development of gametangia and sporangia shows the following stages in their development.



Development of gametangia and sporangia as found in leptosporangiate ferns. A, typical gametophyte, B-H, stages in development of antheridium (diagrammatic). I, dehiscing antheridium. j, antherozoid of Ptaridium, K-N, stages in development of archegonium. o-s, stages in development of sporangium of Polypodium (1, apical cell; 2, basal cell; 3, jacket cell) (A,K-N, o-s, after Foster and Gifford; B,H, Dave; J, Sadebeck)

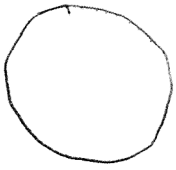
A typical gametophyte is heart-shaped or cordate as germination of spore in fern is a two phase process, spore distension (swelling of spore) and spore extension (formation of germ tube and germ rhizoid). First phase of germination a spore needs adequate moisture for swelling and the period of hydration is variable. Some spore are non-liable but they imbibe water and smell. Merely swollen spores should not be considered to have germinated. The spores of polypodiaceous ferns remain viable for several year, Schrandoef (1986) reported that the spore



of ***Anemia phyllitidis*** remain viable upto 20 years of dry storage. Normally storage of spores leads to decline of viability. Dormancy has been reported in fern spores e.g. ***Alsophilla australis*.** The spores of filicales can germinate in dark e.g. ***osmunda regalis, pteridium aquilinum, polypodium crassifolium*** and ***ceratopteris thalictroides*.** In some genera light inhibit germination. The spores of ***Botychium disectum*** have an obligate requirement of three to four weaks of darkness, and longer period in dark produce better result. The germination is ***Dryopteris filix-mas*** and ***O. cinnamonia*** respond to phytochrome mediated germination. Some fern spore needs cyto-chrome mediated germination. Some fern spore needs cyto-chrome mediated germination e.g. ***Pteris*** and ***Cheilanthes*.** The normal origin of the gametophyte generation is from a haploid spore. The mature wall of the spore has three layers or strata, the intire (endospore), the exine (exopore) and the perine (perispore). The initiative is the innermost layer, adjacent to cell cytoplasm and consist of relatively their cellulose. the exine is massive and usually formed of several layers. The perine or perispore is deposited by tapetum and forms outermost layer in most genera with few exceptions. The filicales or pteridophyta three main types of spores are found such as triletes, monolete and alete. Each of these types may be perinous and non-perinous. Thus there becomes six spore forms trilete perinous, trilete-nonperinous, monolete perinous, monolete-non perinous, alete perinous and alete non-perinous.

Spore with trilete marks

Spores with monolete marks.

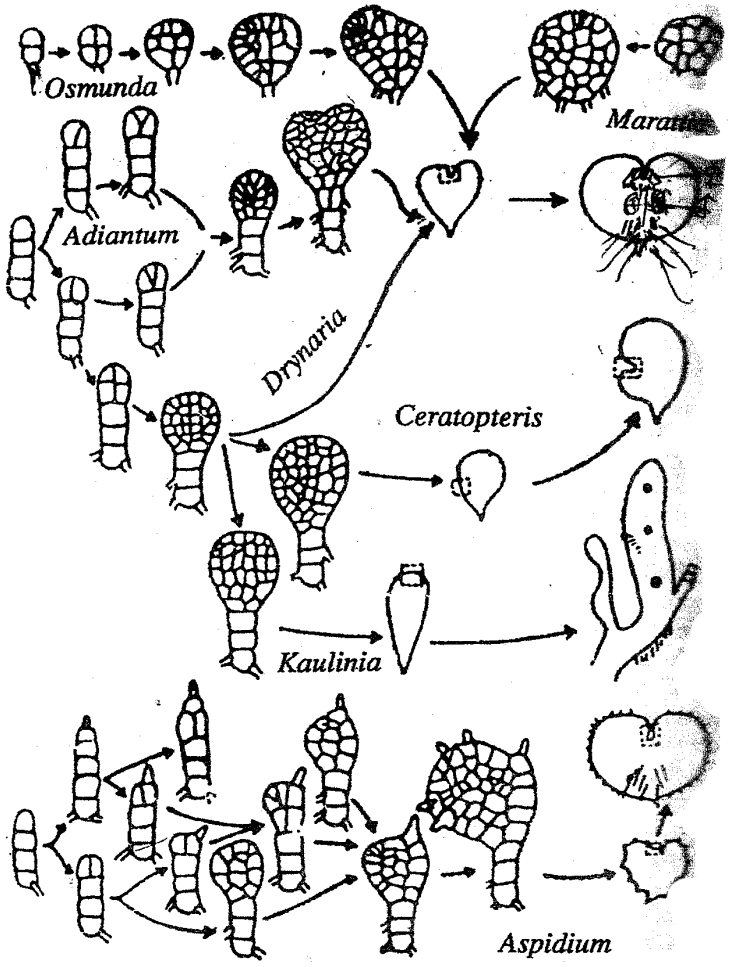


Alete Spore

The gametophyte generation begin with spore germination. This germination is inconspicous and small. The gametophyte may be of two types:-

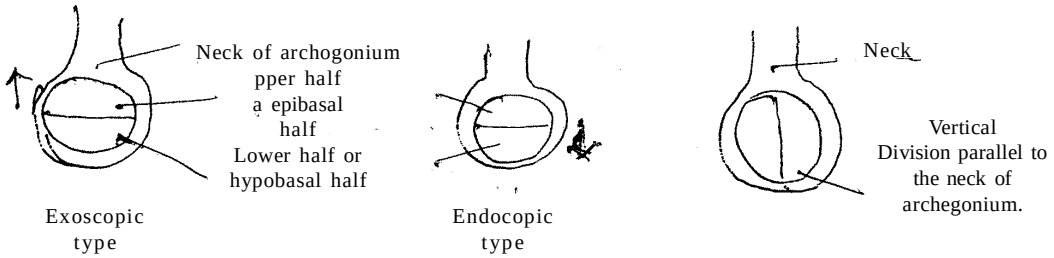
(a) The Endoscoric gametophyte : Found in heterosporous forms e.g. ***Selaginella, Isoetes, Marsilea, Pilularia, Regenelliadium, Salvinia, Azolla*** *and* ***Platyzoma*** and others.

(b) In homosporous pteridophytes the spores are produced in large number in each sporangium and they are morphologically and physiologically indistinguishable. The development of exosporic-gametophyte proceeds along different paths in the various groups of homosporous pteridophytes and the form of mature gametophyte is variable. In homosporous gametophyte the pattern of development can be expressedas follows.



Homosporous Filicales, patterns of gametophyte development (after: Nayar & Kaur, 1971)

The embryo development of filicales or pteridophyta exhibit three types of polarity.



In the primitive spindle shows polarity i.e. the apical pole may be directed towards the neck of archegonium so that the stem apex emerges through the neck of archegonium is known as Exoscopic polarity e.g. ***Equisetum, Tmesipteris, Psilotum, Ophioglossum, Botychium, Lumaria, Azolla*** and ***Salvinia*****.** In endoscopic polarity the apical pole remain directed towards the base of archegonium i.e. away from the archegonial neck. e.g. ***Lycopodium, Selaginella, Danaea, Maroglossum, Helminthospoclys, Maraltia*** and Botrychium obliquum.

In another, when the division takes place at right angle to that of archogonium because the first division wall in the zggote is parallel to the long axis of the archegonium is said to lateral e.g. Marsilea etc.

Besides general discussion of filicales some families have following characters.

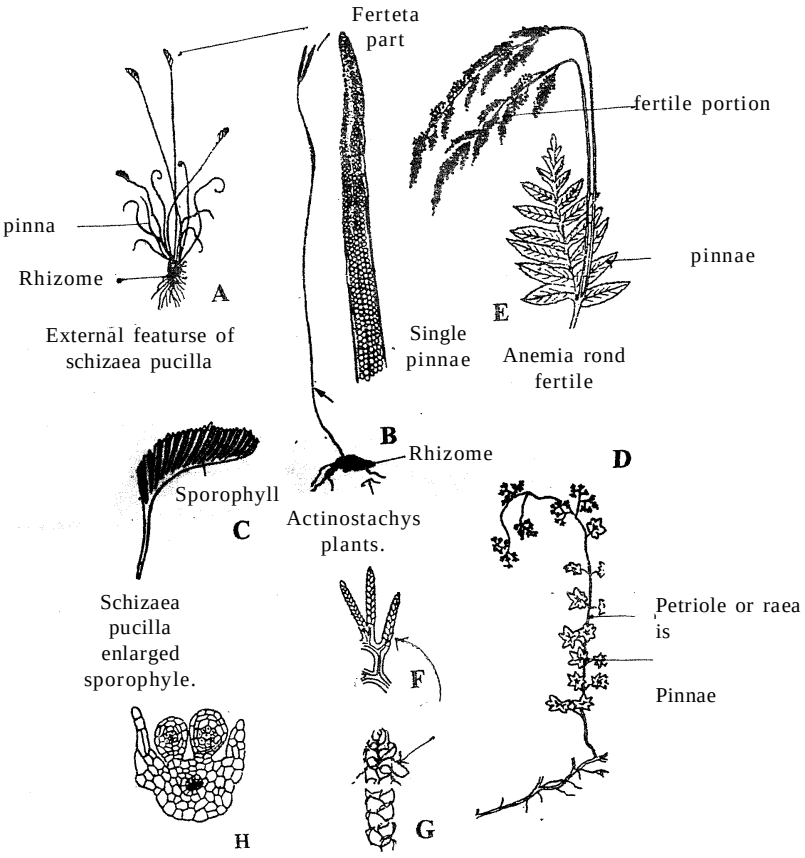


Fig. -1 Schizaeaceae, morphology

A, *Schizaea pusilla*. B. *Actinostachys oligostachys*. C, an enlarged sporophyll of S. *pusila.* D, *Lygodium palmatum;* E, froud of *Anemia mandioccanum.* F, a portion of fertile pinna of *L. palmatum.* G, a portion of F enlarged to show solitary sporangia covered by lobes of leaf tissue. H, *ts* sporophyll of *S. bifida.*

(Figures after: A, C, Smith: B, Bierhorst; D, Losty; E, Bauer; F, G, Eames; H, Bower)

1. FAMILY - SCHIZAEACEAE.

This family is represented by four genera and about 160 species. They grow in tropical and subtropical climate region of the world. This family possess monosporangial sori and their dehiscence mechanism is most primitive. In this family the annulus consist of merely of terminal group of thick walled cells.

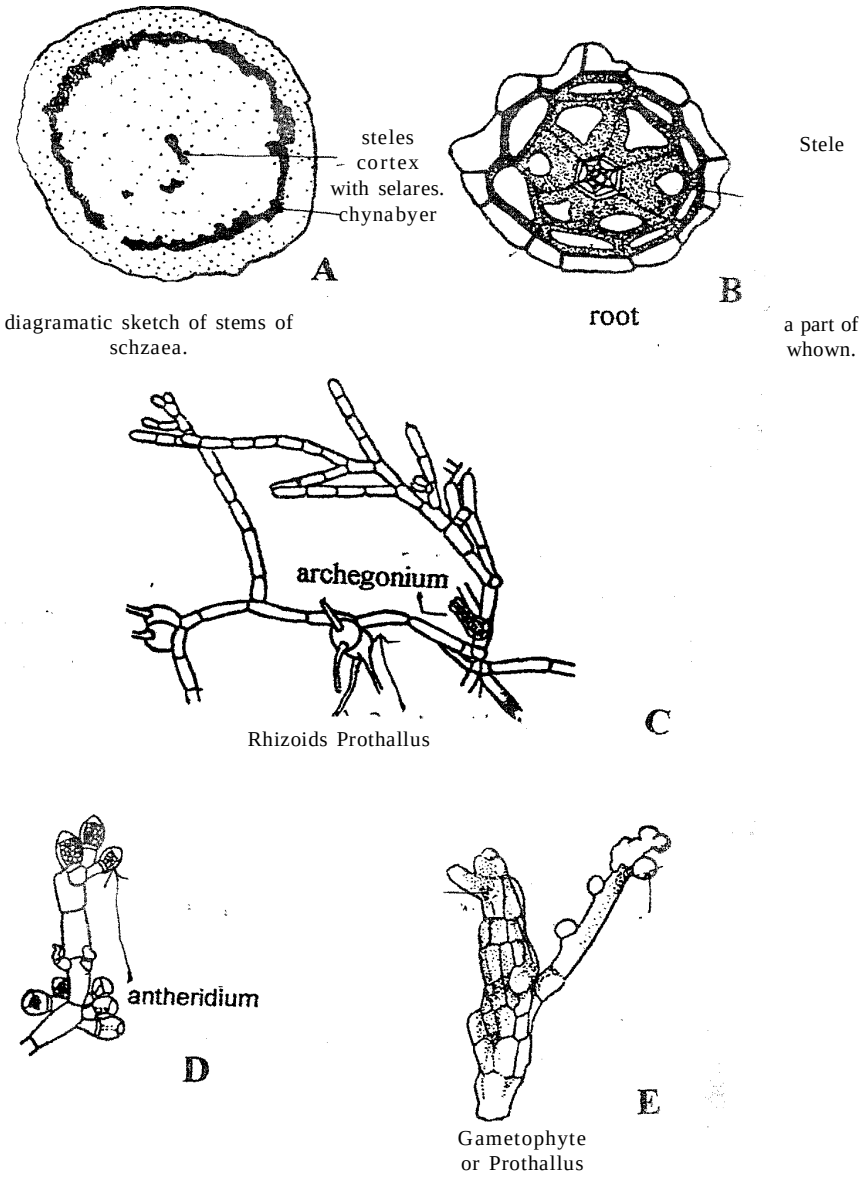


Fig. 2 Schizaeaceae, anatomy of sporophyte and morphology of gametophyte A, B, stem and root of *Schizaea*. C, gametophyte of *S. pusilla,* D, antheridial branch of gametophyte of S. *pusilla.* E, gametophyte of *S. dichotoma.*
(Figures after: A, B, Smith; C, D, Britten & Taylor; E. Bierhorst)

The sporangia arise on the margin of the frond and are unprotected except by enrolling of the margin. **Lygodium** have fronds of unlimited growth forming twning structure 30-meter or more in length. The frond of **Lygodium** is primitive

due the structure of the leaf trace, which shows radial symmetry. **Lygodium** has creeping protostelic rhizome, **Schizaea** has an oblique rhizome with medullate protostele, **Anemia** has creeping or oblique rhizome with solenostelic or dictyostelic condition. **Mohria** is dityostlic, **Mohria** is most advanced in dermal appendages. It has glandular scales and other genera possess hairs. In **Anemia** only the two lowermost pinnae are fertile. The prothalli are flat, thalloid structure but in some species of **Schizaea** the prothale are filamentous with occasional mycorrhizal cells and the gametanga develops at the tip of short lateral flaments. According to F.O. Bower, this filamentous prothalli are simplest among pteridophytes. The antheridial wall of **Lygodium** is complex and produces large number of antherozoids.

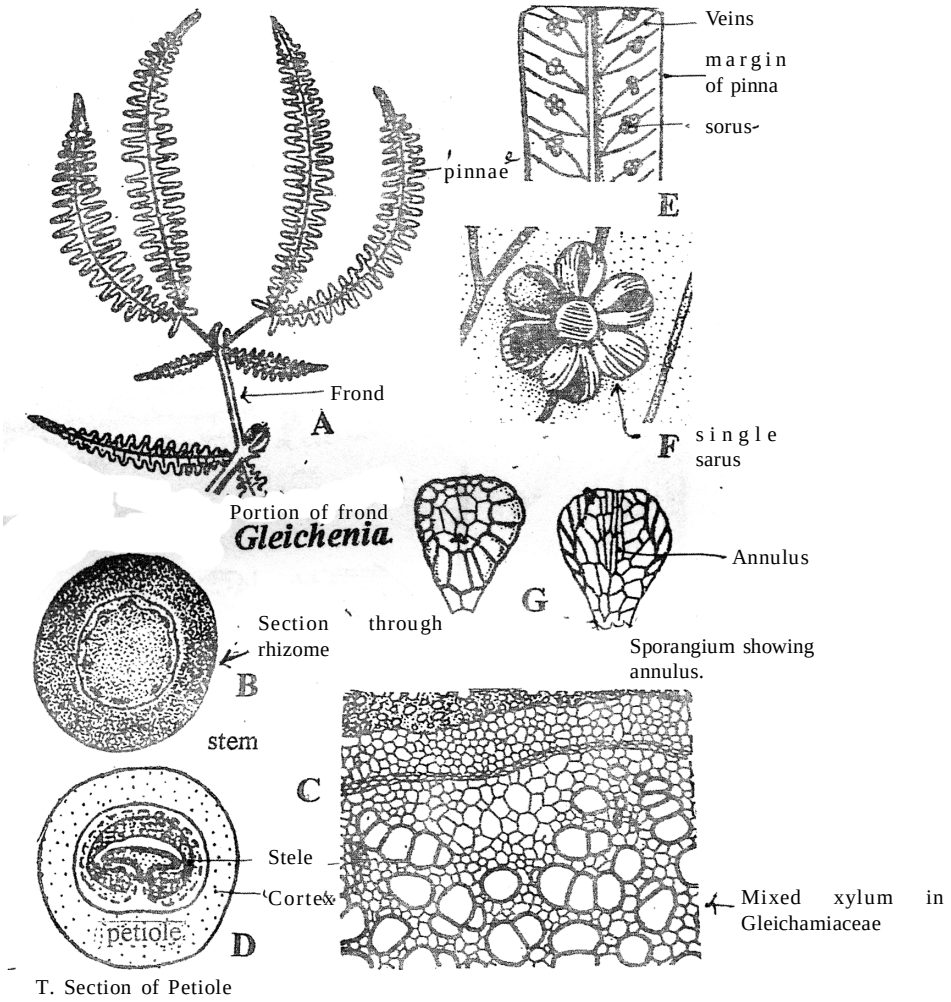


Fig. 3 Gleicheniaceae,Structure and reproduction.

A, *Gleichenia linearis,* portion of frond. B, *G, dichotoma,* transaction of rhizome. C, a portion of innercortex and stele enlarged to show mixed xylem. D, transaction of petiole. E, *G. pubescence,* to show sori. F, *G. pectnata,* a sorus, G. *G. dichotoma,* sorangia to show annulus.

(Figures after: A, Bierhorst; B, C, Smith; E, Eames; F, G Bower)

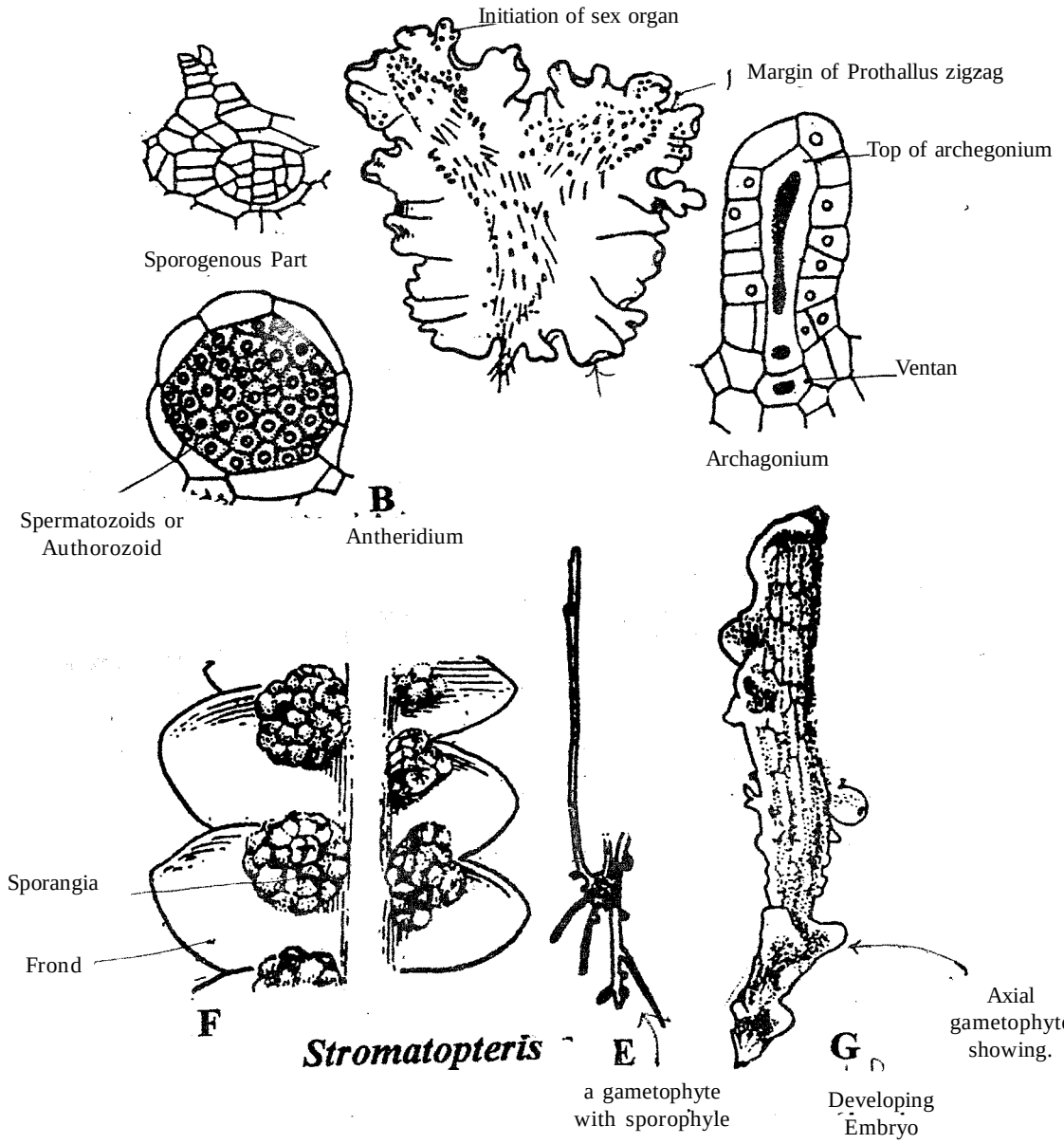


Fig. 4 Gleicheniacea, gametophyte and reproduction.
A, *Gleichenia glauca*, a gametophyte, B, C, D, *G. pectinata*, antheridium, archegonium and a developing embryo. E, *Stromatopteris moniliformis*, a gametophyte with sporophyte. F, abaxial view of a part of frond with fertile pinnae. G, an axial gametophyte.
(Figures after: A, Stokey; B, C, D, Smith; E, F, G, Bierhorst).

FAMILY - GLEICHENIACEAE

This family is represented by 130 species belonging to **Gleichenia.** This possess different type of leaf morphology. Branching is zig-zag in arrangement. The fronds are of indefinite growth and some attain a length of seven meter or more. They arise from a creeping dichotomous rhizome with protestelic condition. In few forms solenostele in found e.g. **G. pectinata,** with large number of sporangia.

The sporangia is strong contrast to sehizaeaceae. Sporangia are born superficially on the abaxial side of the frond. There is no indusium. Each sporangium pear shaped with stout stalk and dehisces by means of apical slit. Large number sporangia are found. The gametophyte primitive. The antheridia are larger than any other leptosporaniate ferns and resemble, them.

FAMILY - GEICHANIACEAE.

3. FAMILY - HYMENOPHYLLACEAE

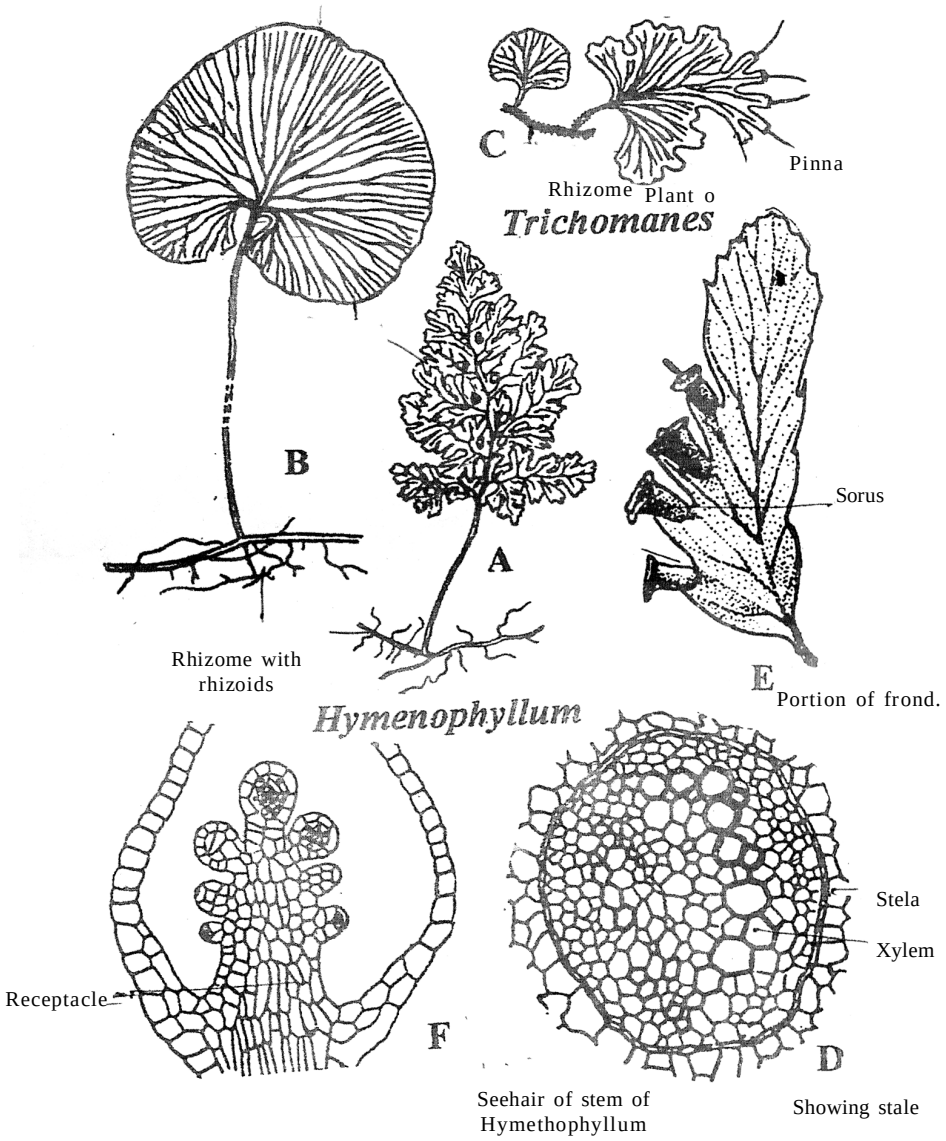
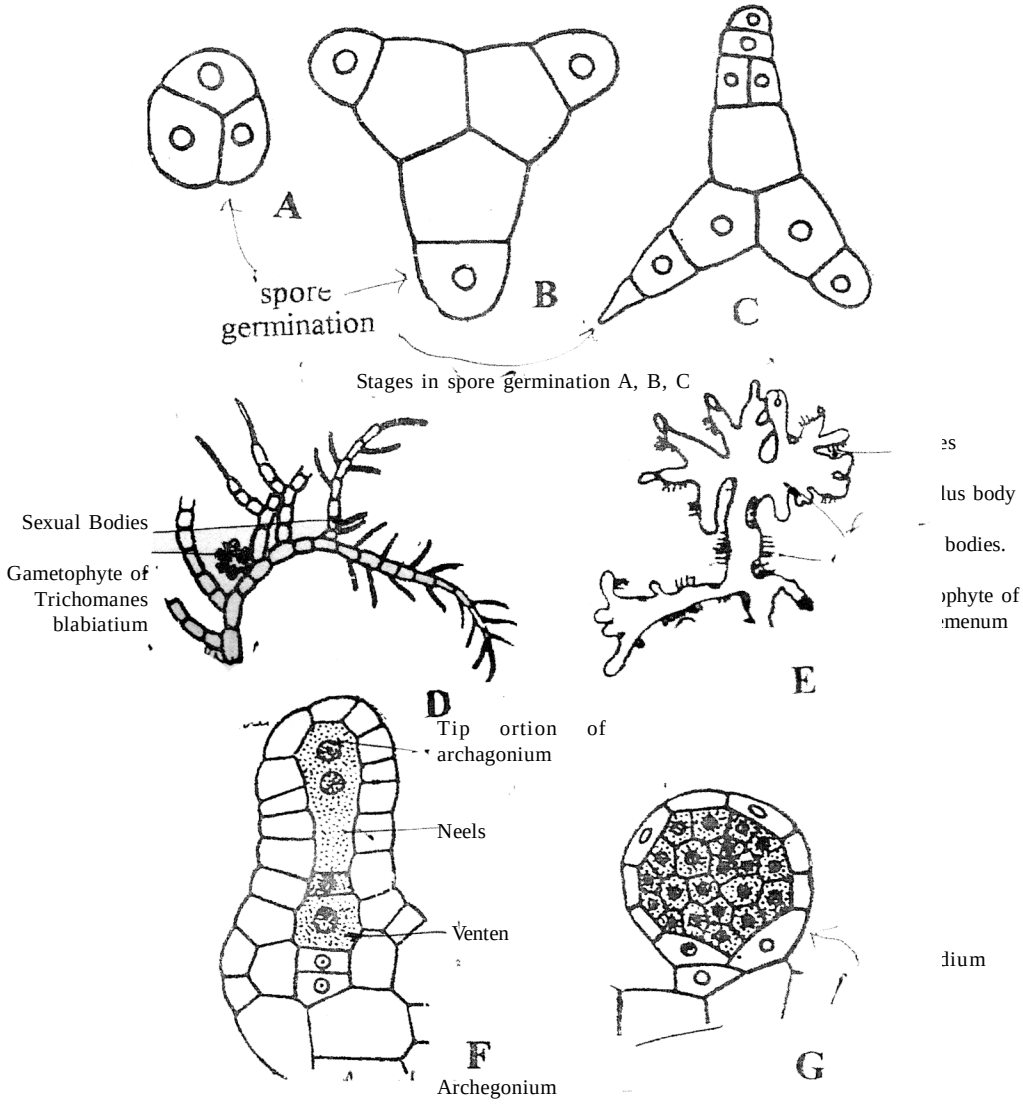


Fig. 5 Hymenophyllaceae, morphology and anatomy. A,B,C *Hymenophyllum multifidum, Trichomanes cuspidatum* and *T. reniforme,* respectively. D, *ts* of stem stele. E, portion of frond of *T. australicum. F* vs receptacle of *H. australe.* (Figure after A, B, Eames; C, Christ; D, F, Smith; E, Bierhorst)



Hymenophyllum acanthoides, stages of spore germination. D, E, gametophyte of *Trichomanes bilabiatum* and *H. bluemeanum.* F, G, *H. kurzii,* archegonium and antheridium. (Figurse after: A-G, Stokey)

This family is referred as 'The Filmy ferns' because of their delicate fronds, the lamina of which is usually one cell thick. Tye genera, **Hymenophyllum** includes abut 300 species and other genera **Trichomaves** with 350 species. They prefer moist habitat and restricted to tropics in distribution. The filmy ferns have thin, wiry creeping, protostelic rhizome from which fronds arise in two rows. Some species are completely without roots. The leaf trace is a single strands. The frond is usually much-branched, each narrow segment have a single vein with various degree of webbing, e.g. **Cardiomanes remiforme** (=**Trichomanes reneifornae).**

The sori are marginal and most species are strictly gradate. **Trichomanes** grow by means of intercalary basal meristem until it forms a slender bristle. The

receptacle of **Hymenophyllum** has limited power of growth. Surrounding the sorus is a cup-shaped indusium in **Trichomanes** and two lipped indusium in **Hymenophyllum.** the sporangium has thin stalk and an oblique annulus and the dehiscence takes place along lateral line. The mechanism of dehiscence is found throughout the more highly evolved members of filicales and results in the forcible ejection of spores. The number of spore varies from 128 cr 256 in **Hymenophyllum** and 32 in **Trichomones.**

The prothallus is strap-shaped.

4. FAMILY - DICKSONIACEAE

The living modern genus **Cibotium** belongs to this family has stout creeping stem or low massive trunk. Fossil member of this family is **Coniopters** from Jurassic rocks of York Shire. Some species of Dicksonia are tall tree ferns **(D. antortica)** with crown of leaves at the summit of tall trunk.

The stems are solenostelic or dictyostelic. There is a single gutter-shapped strong entering the base of stipe. The sporangia marginal in origin and arise in gradate sequence within a purse-like box, formed by two indusia. The spore output per sporangium is sixty four.

5. FAMILY - CYATHEACEAE

All tree ferns were placed in this family but **Dicksonia** have been removed due to marginal sori, where as cyatheaceae has superficial sori. F. O. Bower (1923) recognized three living genera, they are **Alsophila** 300 sps. Hemitellia 100 sps. and **Cyathea** 300 sps. These three genera are distinguished by the characters of the indusium but sori are very similar in gradate development. In **Alsophila,** there is no indusium at all, in **Hemitelia** there is a large scale at one side of the receptacle. Holttum (1954) regarded this distinction between the three genera as artificial and prefers to merge four rowed stalk, an oblique annules and well marked lateral stomium. The number of spore out put ranges from sixty four to sixteen and even eight in some species.

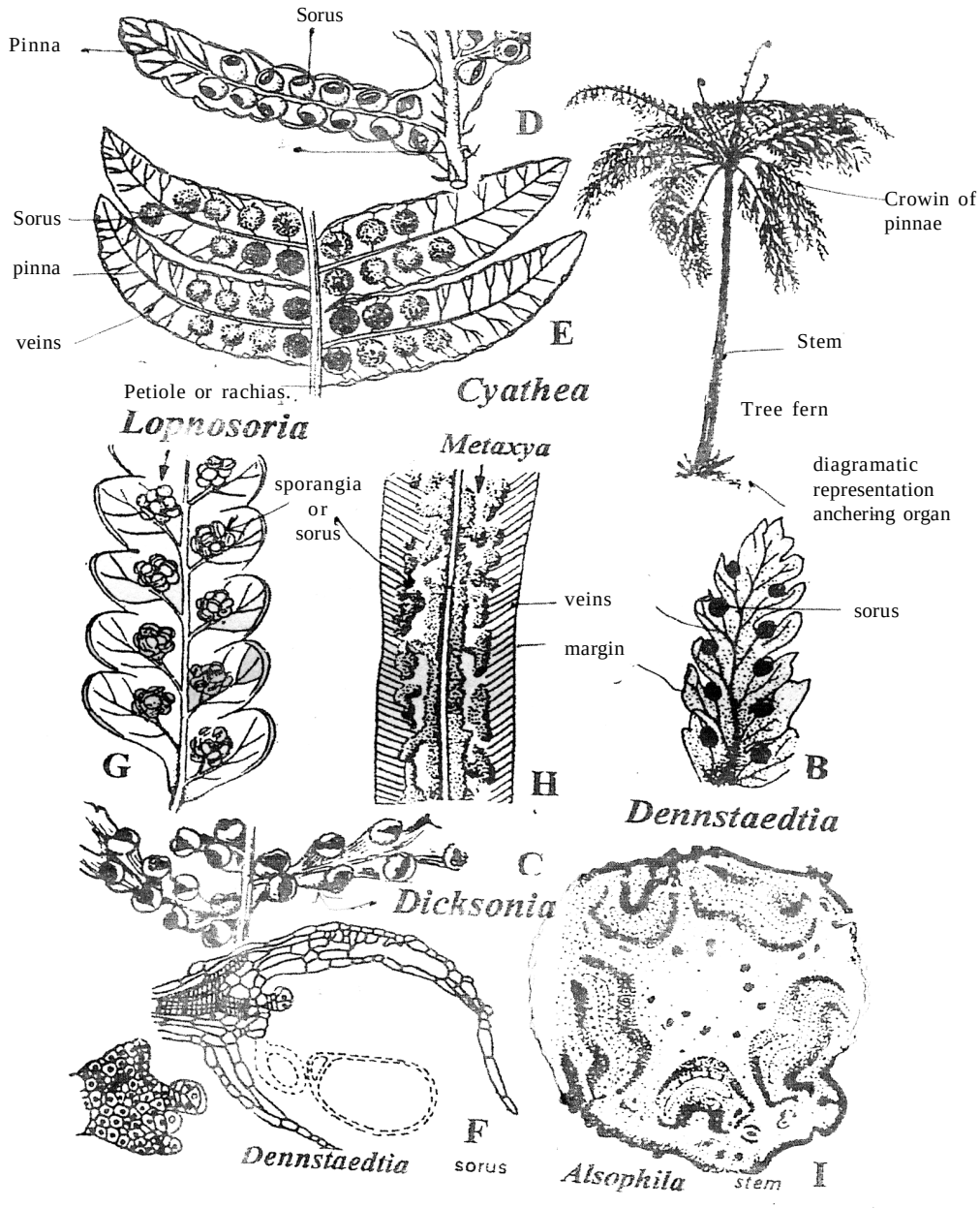


Fig. 7 Cyatheaceae, structure and reproduction.
A, tree fern (diagrammatic representation). B-E, G-H, portions of fertile fronsds of *Dennstaedtia adiantoides, Dicksonia navarrensis, Cyathea medullaris, C, elagans, Lophosoria duinata and Metaxya*. F, young and mature sori of *D. punctilobula* showing marginal origin, gradate arrangement of sporangia and development of dorsal indusial lip as leaf blade. I, *Alsophila,* section of stem.
(Figure after: A, Eames; B, E, F, G, Bierhorst; C, Maxon; D, Smith)

FAMILY - MATONIACEAE

This family includes two genera **Phanerosorus** and **Matonic** and has many fossil representative in the Triassic Each pinna is pinnatifid and there are anastomoses in the veinlets near sori. Phanerosorus has a frond of indefinite growth which is long and slender and bears - dormant buds at the tips of some

its branches. The stem of **Matonia** is creeping and hairy and has polycyclic stellar structure, with two co-axial cylinder surrounding a central solid stele, leaf trace single and gutter-shaped,

The sori are superficial and consist of a small number of sporangia arranged in a ring round the receptacle and continues into the stalk of umbrella-shaped indusium. The spore output is sixty four.

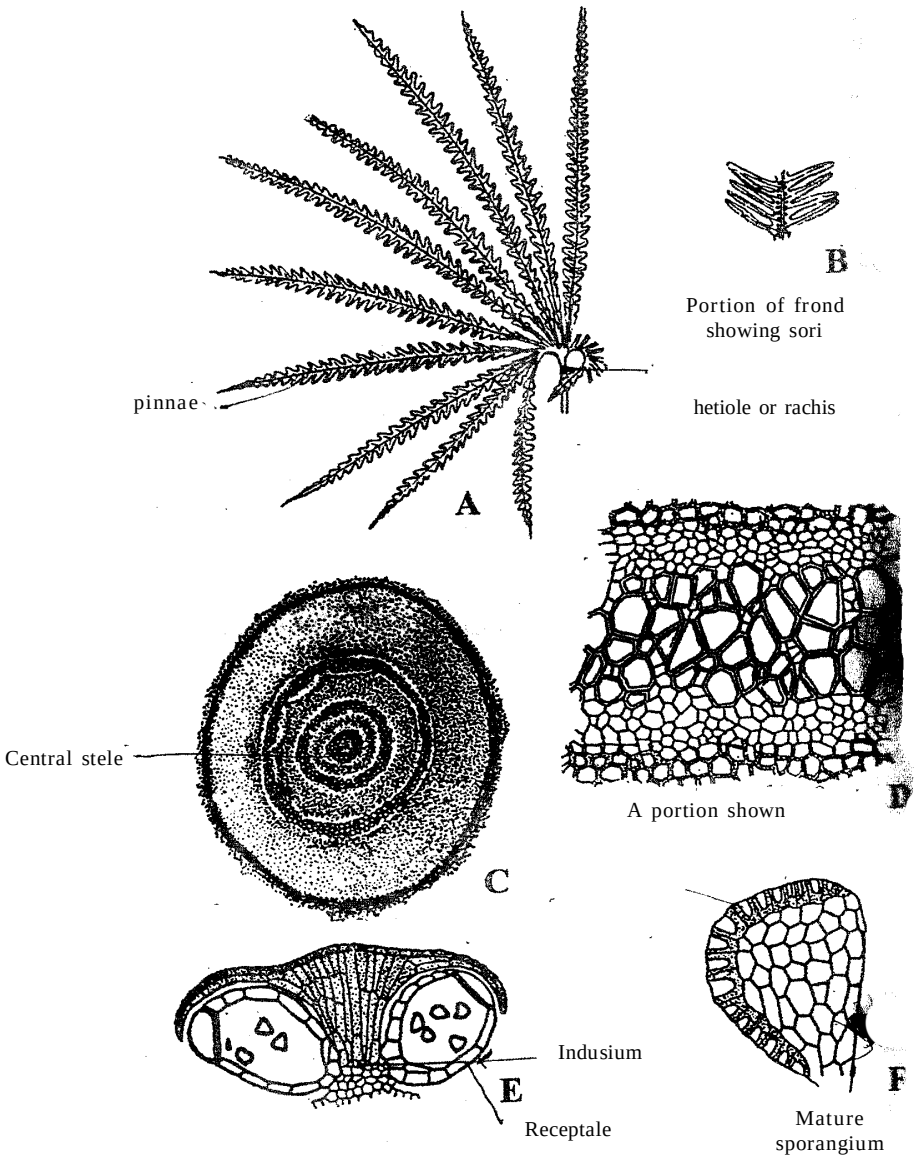


Fig. 10 Matoniacea, structure and reproduction.
A, *Matonia pectinata,* portion of rond. B, portion of rond showing sori. C, rhizome showing tricyclic stele. D, a portion of C enlarged. E, *ts* through recepted and indusium. F, mature sporangium.
(Figurse after: A, C, Bierhorst; D-F, Smith)

FAMILY - DIPTERIDACEAE

This family contains single genus Dipteris with eight species and remain restricted to the Indo-Malayan region. It has fossil records e.g. clathropteri Dictyophyllum and Camptopteris. The leaf architectur is characteristic and frond shows successive unequal dichotomies in an anadromic direction. Fronds arise at distant intervals along creeping hairy rhizome, vascular structure is simple solenostele. Some species have only single leaf-trace, other have two entering the base of the stipe.

The sorus is superficial without an indusicum and the sporangia are interspersed with glandular hairs. This single genus cut across the division of the ferns into simplicas, Gradatae and Mixtae. The spore out put is sixty four.

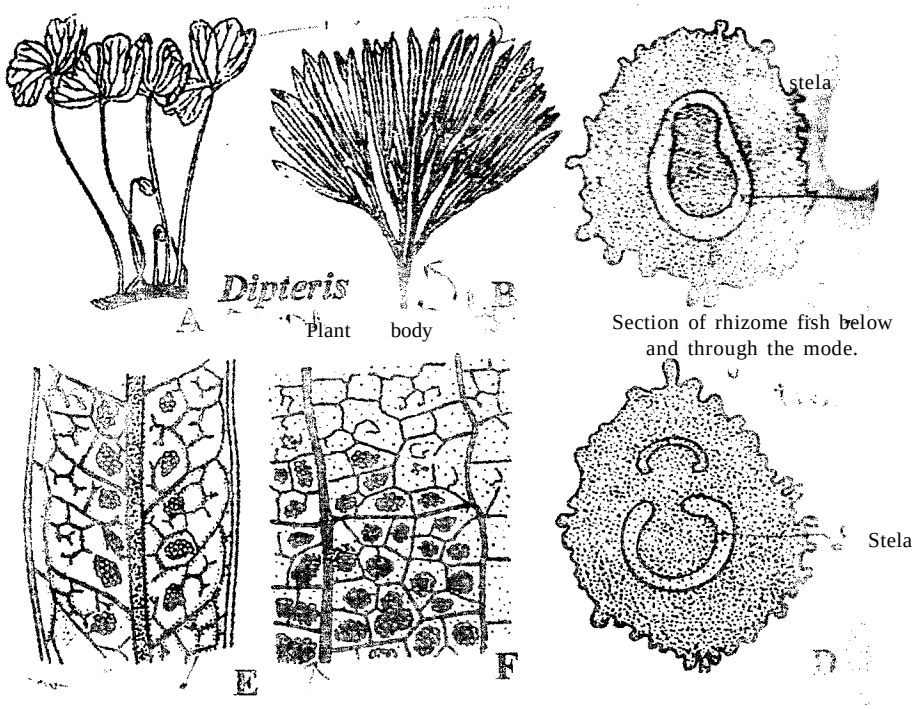


Fig. 11 Dipteridaceae, structure and reproduction.
A, *Dipterisis conjugate*, a plant. B, *D, lobbiana*, a portion of frond. C, D, *D, conjunction* sections of rhizome just below and through the node. E, F, *D. lobbiana* and *D. conjugate*, portions of fertile pinnules.
(Figurse after: A-E, Smith; F, Bierhorst)

FAMILY - DARALLIACEAE AND OLEANDRACEAE

Daralliaceae family includes Davallia and **Seyphularia** and oleandraceae family includes **Nephrologies.**

Davallia has a creeping stem that is covered with scales. The sorus in Davallia and Scyphularia is superficial at maturity with a funnel-shaped

industium. However, it is marginal in origin. The stele is highly dissected solenostele and in the cortex can be seen leaf trace. The stem is creeping in Daralliaceae. Oleandraceae family is repreented by **Nephrolepis.** Its stem is dictyostelic.

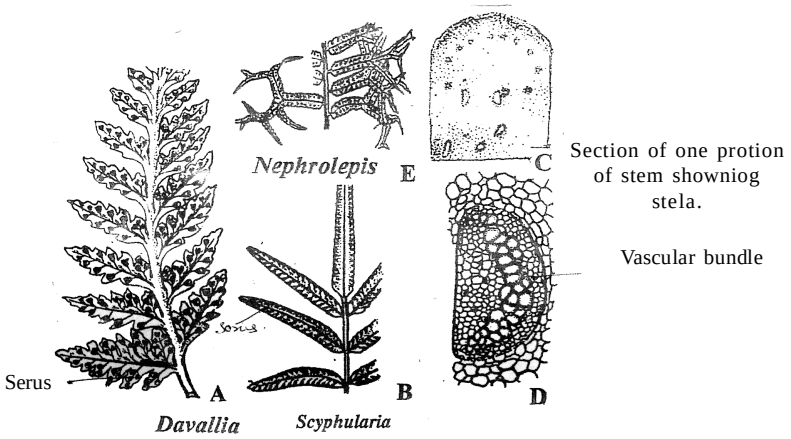
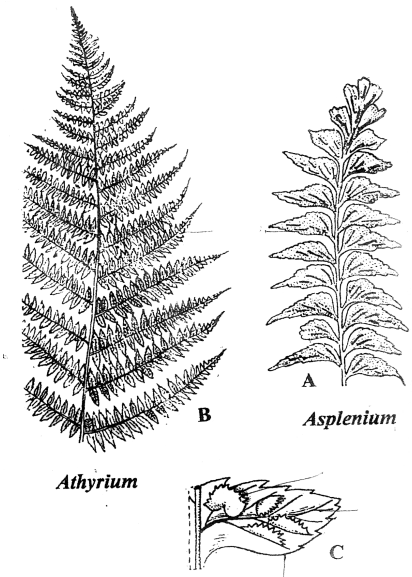


Fig. 12 Davalliaceae and Oleandraceae, structure and reproduction, A, *Davallia*. B, *Scryphularia,* portions of fertile fronds. *C, D. fijiensis,* section of stem, leaf traces are seen outside the cauline bundles. D, a vascular bundle enlarged. E. *Nephrolepis exalata,* a portion of fertile frond.
(Figures after: A, B, Foster & Gifford; C, D, E, Bierhorst)

Vephrolapis is common cultivated fern, often shows abnosmalities. The **N-acuta** and **N. dicksonioides** the adjacent sori are some what fused.

FAMILY - ASPLENIACEAE AND ATHYRIACEAE

The type genus of spleniacea is Asplaniceum which is represented by 700 species e.g. **Asplenium vidus** (bird's nest fern) and **Phyllitis scolopendrium**



Aspleniacea and Athyriacea, structure and reproduction. A, B, portions of fronds of *Asplenium falcatum* and *Athyruim filix-femina,* C, an enlarged portion of B to show shori and indusia.
(Figures after: A, B, Foster & Gifford)

(hart'lstonque fern). The plants are terrestrial or epiphytic with creeping or some what erect rhizome. Leaf or pinna ranges from small to large one. In **Asplenium,** the sori occur singly and the indusium is acroscopic. In this character **Asplenium** resemble **Athyriuml.** O n te Brond (1923) named both genus as Asplenoids.

FAMILY - BLECHNACEAE.

The plants of this family are terrestrial with pinnate or pinnatified fronds. The rhizome shows dictyostelic condition. Sporangia long continuous coenosor on each side of midrib of pinna or segment.

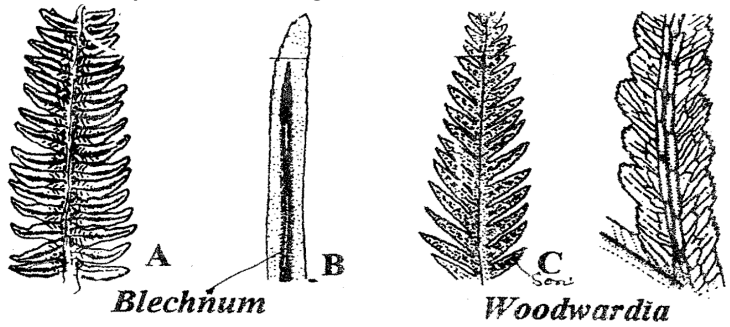


Fig. 13 Blechnacea, structure.
A, B,*Blechnum,* portion of frond and pinna (enlarged) to show two coensori. C, D, *Woodwardia* frond and a portion enlarged to show sori.
(Figures after: A-C, Foster & Gifford)

B, punctilobatum is a possible intermediate between *Phyllitis* and typical *Blechnum* species. On the samefrond and seen sori occurring ni pairs facing each other and some showing fusion forming coensori. n *Woodwardia* the sori form box-like structures on either side of midrib, and indusia are like hinged lids opening towards midrib.

FAMILY - ASPEDIACEAE

This family includes **Aspidium, Woodsia, Onoclea** and Mettusia. Most of the species are terrestrial and some are epiphytes. In *Aspidium,* the pinna are large and pinnatifid and sorus is more or less reniform e.g. Dryopteris. The two genera **Mattencia** and **Onoclea** show leaf dimorphisum i.e. fortile and sterile leaves. The rhizome in **Mattencia** is ascending to erect with leaf bases covered with chaffy scales. Sterile leaves with open venation and pinnalified. Fertile leaf is pinnate and pinna are strongly revolute enclosing the sori.

In monotypic form **Onoclea sensabilis,** the sterile leaves are pinnate with reticulate venation. The sorus is enclosed by an ephemeral indusium.

Woodsia is a small terrestrial xerophytic fern with unipinnale or apinnate leaves. The sori are round with basal indusiuum. The indusium consist of scale-like structure. The spore in higher ferns germinal and produces filamentous protonema.

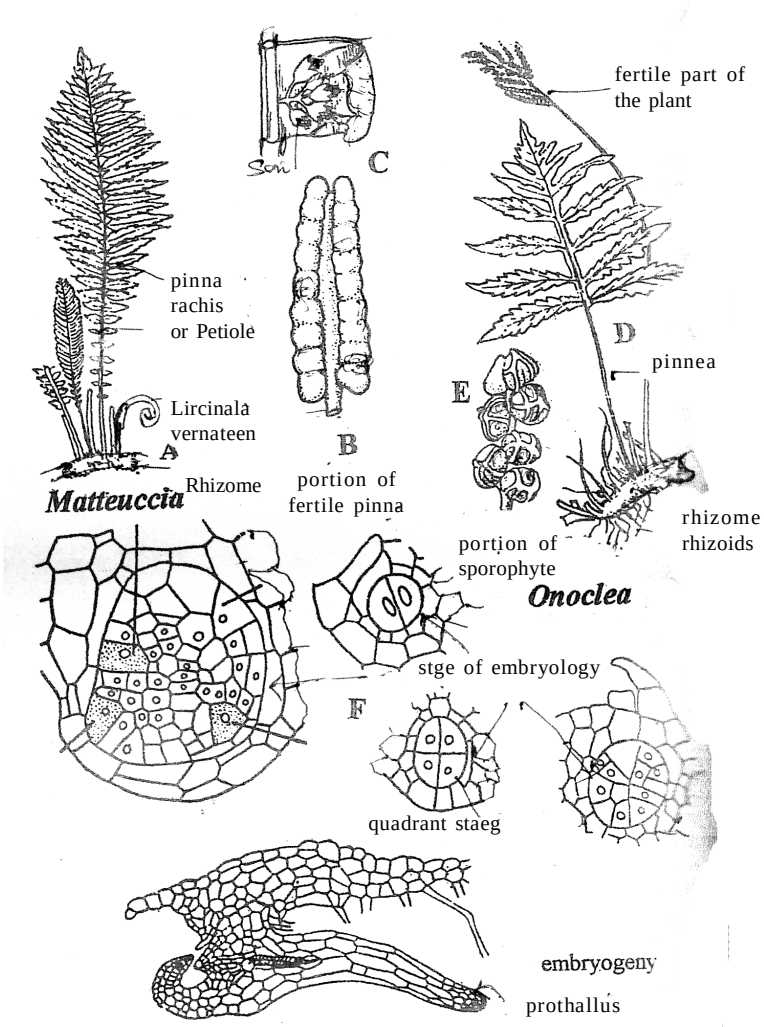


Fig. 12 Aspidiacea, structure and reproduction. A, *Matteuccia structhiopteris*, the plant. B, portion of fertile pinna. C, position of sori on a pinna. D, *Onaclea sensibilis*, morphology. E, a portion of sporophyll. F, O *sensibilis*, stages of embryogeny.
(Figurse after: A, B, C, Bower, D, Diels; E, Bauer; F, Smith)

The gametophyte are green, surface, living condate Apical meristem present in notch region. The antheridia are born on basal region of wings in between rhisoids. The archegonia re confined to.

Family - PTERIDACEAE.

Common member of this family is **Pteris** and **Pteridium Pteris** is represented in India by 49 species. **Pteridium** mark his appearance in Indian only by three species:- **Pteridium aquilinum (L) Kuhu, P. acquilinum** var. **weghtiane** and **P. Capense pteridium quilinum** (Common bracken forn) is common species frond growing in barden and cultivated fields. Rhizome remain clothed with adventitions root. On the upper surface arise leaves. The lamina is trilobed and tripinnate at its lower portion. The sporangia form continuous sori

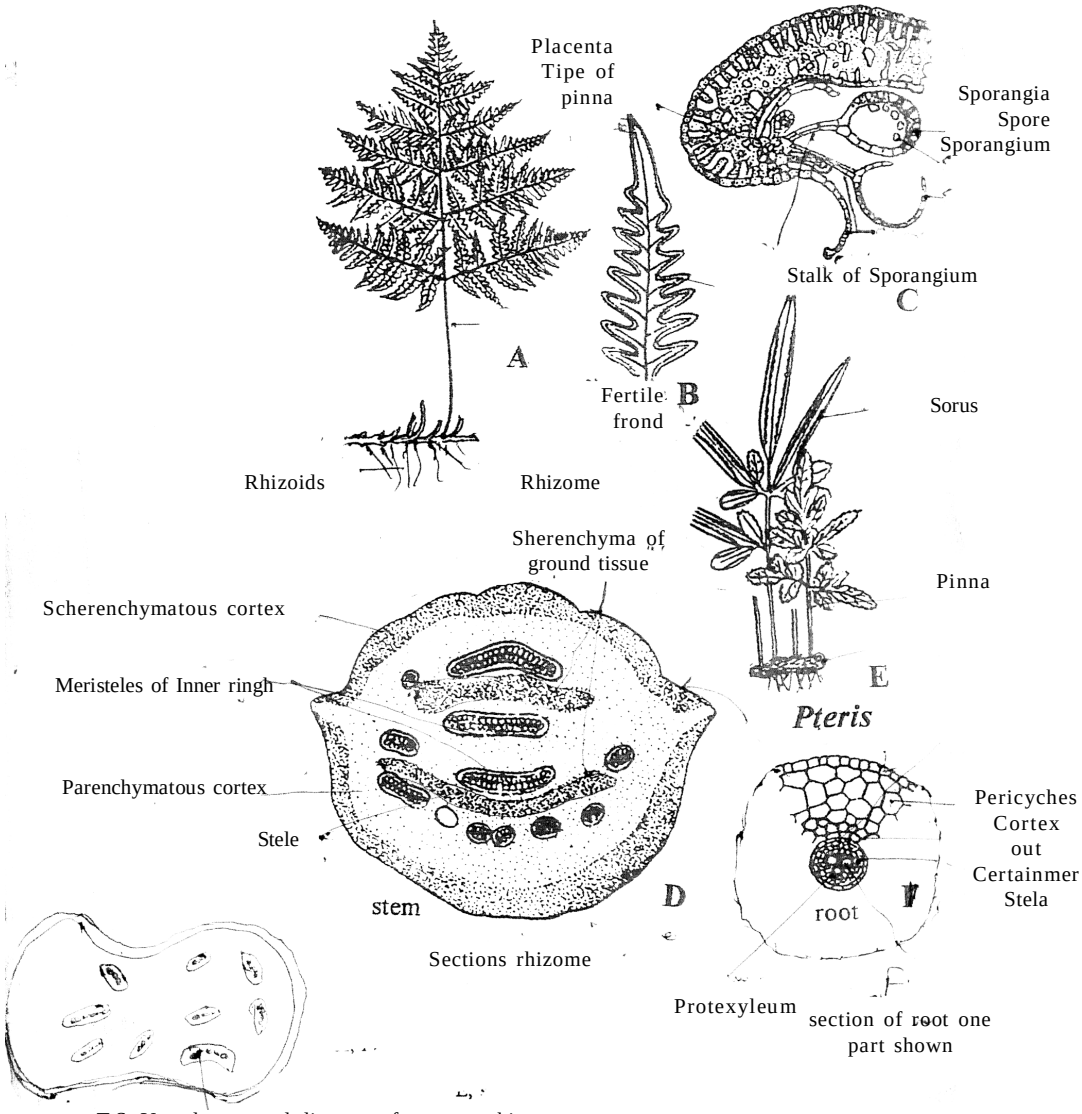


Fig. Pteridaceae, structure and reproduction. A, *Pteridium* aquilinum, morphology. B, a pinnule from fertile frond. C, section of pinnule showing sporangia. D, *Pteridium*, section of rhizome E, section of root. F, *Pteris*, morphology.
(Figures after: A-E, Smith; F, Datta)

along the margins of pinnules and remain surrounded by bilopped indusium. The upper lip is relatively thick and lowe lip is thin. The sorus is marginal in origin. the sori are of mixed type and sporangia are leptosporangiate. The sporangia produces 64 spores and the gamtophyte are heart-shaped. Then shows siphonostelic condition and later becomes dicyclic to polycyclic stele.

Family - DRYOPTERIDACEA.

This family ncludes **Arachniodes** Bl (11 sps), **Dryopteris** (56 sps) and **Nothoperanema** (2 sps) as common species and **Polystichum** 41 sps) from India.

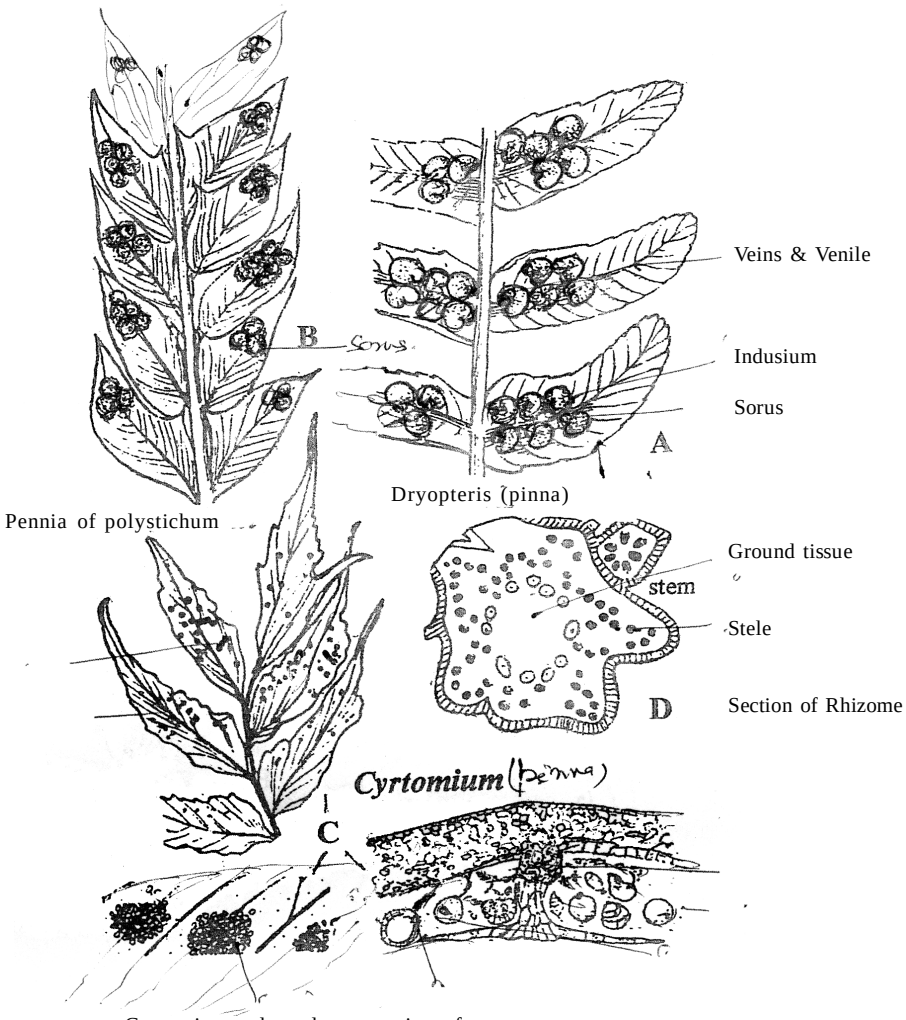


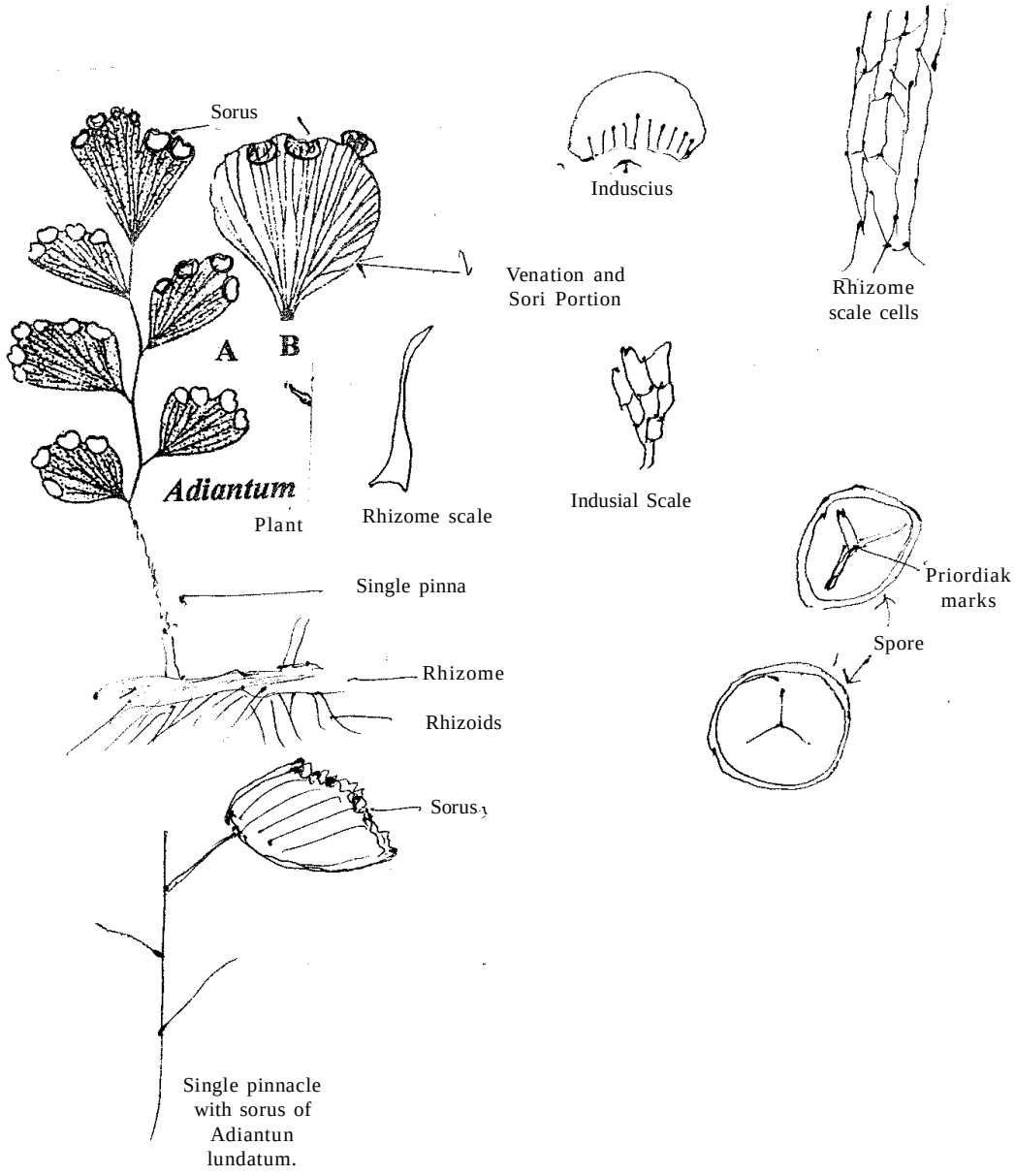
Fig. 16 Dryopteridiacea, structure and reproduction.
A, *Dryopteris,* a portion of fertile frond. B, the same of, *Polystichum.* C, *Cyrtomium,* morphology and a portion enlarged to show arrangement of sori, cross section of sporophyll to show position of indusium. D, *Dryopteris,* section of rhizome.
(Figures after: Bierhorst)

The plant possess short, stout rhizomatous stem covered with rhizoids and scales. The stele is dictyostelic and the stipe receives numerous superficial on the veins or at vein endings andare covered by an indusium which is semiform in **Dryopteris** and peltale in **Polystichum.** Prthallus is heart-shaped.

Family - ADIANTACEA

This family includes singe genus **Adiantum** (maiden hair fern) with about 250 species. In India it is represented by 27 sps. (Dixit 1984). The rhizome and leaves remain coverd with hairs and Palaea. The leaves are pinnate. the sori lack

indusium. The sori are borne on the underiside of special reflexed marginal flap of leaf. Rhizome are solenostelic to dictyostelic.



Family - POLYPODIACEAE.

According to some authors this family includes 63 genera including Polypodium. It is represented in India by Polypodium (2 specise - **Polypodium beddomei** Bak, **P. volgare) Psendodrynaria.** C (one sps - **P. Coronaus). Pyrrosia** (27 species), Thylacopteris (one species - **T. papillosa (Bl) an Tricholepedium ching (**one species **- T. normate).** This family is characterized by an absence of Indusium. The plants are epiphytes and prefers tropical climate some species

occur in temperate zons. The rhizome is dictyostelic pinna simple to once pinnate with anastomosing veins. The sori are round in **Polypodia** anastomosing veins. The sori are round in **Polypodia.** The sporangia are scattered over the entire surface.

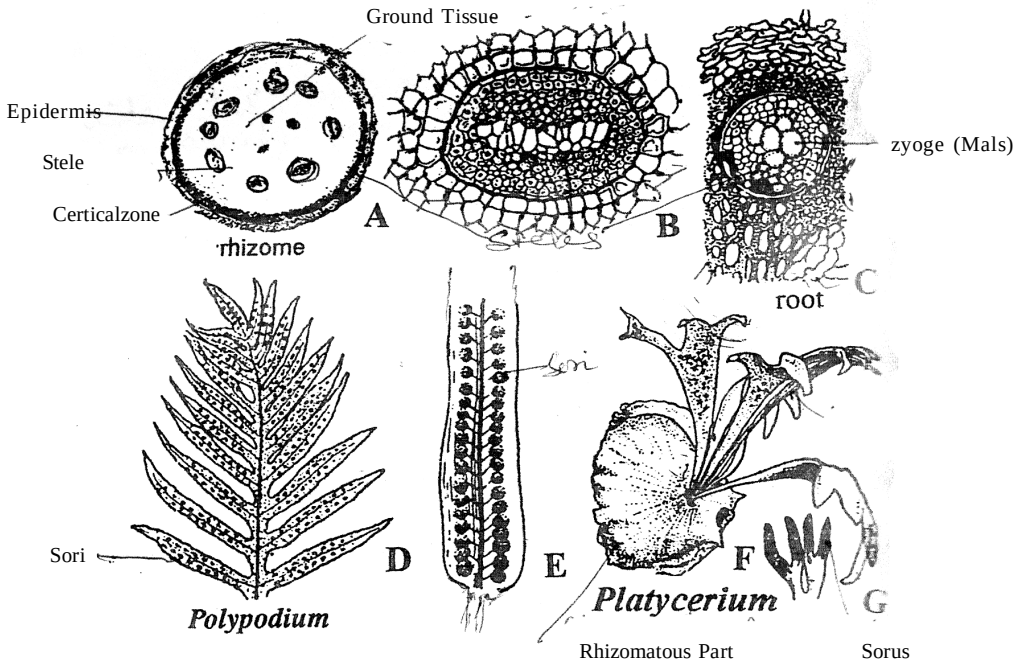


Fig. Polypodiaceae (SL) structure and reproduction. A, *Polypodiu,* section of root. D, *P. vulgaris,* a portion fo frond. E, to showin exindusion sori. F, *Platycerium,* the plant, G, a portion enlarged to show acrostichoid condition. (Figures after: A-C, Bierhorst; D, E, Foster & Gifford; F, Coulter; G, Diels)

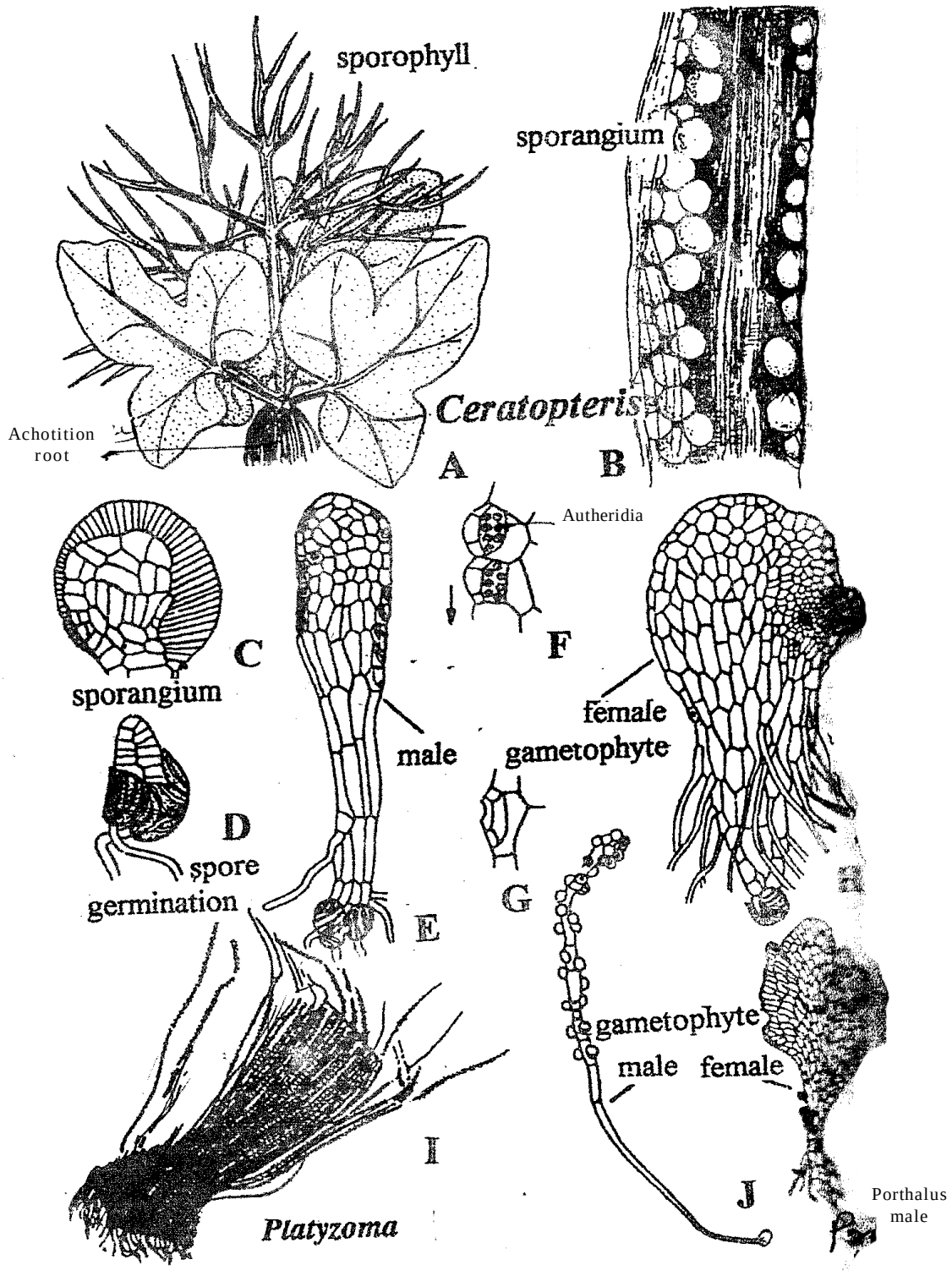
Family - PARKORIACEAE AND PLATYZOMACEAE.

These two families are monogeneric family and gives a live of interest as they are transitional between homosporous and heterosporous leptosporangiate ferns.

Parkeriaceae e.g. **Ceratopteris -** homosporous but reveals incipient heterospory.

Platyzonaceae - e.g. **Platyzoma -** heterosporous with latent homospory.

Ceratopteris thalictroides is a hydrophytic form of world wide distribution. It is free floating or rooted in mud or rarely grows on damp soil. The plant is annual stem small, fleshy with a crown of leaves on its upper surface and from base whorls of adventitious roots emerge. the leaves are dimorphic. The sterile leaves are spreading with broad lamina, which devides three or four times as pinnate or trifoliate. Fertile leaves are erect and devides into narrw segments.


sporophyll
sporangium
Achotition root
Ceratopteris
A
B
C
sporangium
D
spore germination
male
E
Autheridia
F
female gametophyte
G
gametophyte
male female
J
Porthalus male
I
Platyzoma

Vgetative propogation takes place by buds growing on older leaves. The sporophytic plant body shows protostelic condition. Adult stem has polycyclic dictyostele. Roots of **Ceratopteris** are similar to that of **Selizoea** and **Azolla** in characters of pericycle, endodermis, inner cortical layer and no of cells in perimeter. the sporangia are leptosporangiate in development the sporse are alike but germinate and produces gametophytes of two morphological status. The male gametophyte are slow growing small and strap-shaped structure without an apical.

Platyzoma macrophyllum is a monotypic genus of Northern Australia. It is hydrophyte and preers water with mud. The rhizome possess filiform cluoter of levs. The sporangia develops on filiform leaves and are of two types. the swollen sporangia produces 3 spores and larger sporangia produces 16 spore. The microspore germinate to produce filamentous gametophytes and without rhizoids and bear only antheridia,Megaspore germinate forming rhizoids and produces spatulate gametophytes bearing archegonia laterally. The gametophyte are exosporic.

Fig. Parkeriaceae and Platyzomaceae, structure and reproduction. A, *Ceratopteris thalictroids,* the plant showing dimorphc leaves. B, the same, a portion of sporophyll. C, a sporangium. D, a germinating spore. E, male gametophyte antheridia before and after dehiscence. H, female gametophyte. I, *Platyzoma,* the plant. J, K male and female gametophytes.

(Figures after: A, C, Smith; B, Bierhorst; D-H Kny; I-K, Tryon)

11.12 QUESTIONS FOR EXERCISE :

1. Give an account of classification of filicales and mention Indian speciesa of each.
2. Give general account of internal structure of Rhizome/stem mentioning steler variation.
3. Prothallus or gametophyte of filicales.
4. Gametophyle development in filicales.
5. Embryogeny in filicales.
6. Describe the life history of (typical) filicales.
7. Describe leptosporangiate mode of development.

8. Sporangium development in filicales.
9. Habitat and morphological differences of Adiantaceae and Drypteridace.
10. Variation in leaf-forum.
11. Development of gametangia and sporangia in leptosproangiate ferns.
12. Types of spores in filicales and mode of germination.
13. Describe each family of filicales separately.
14. Prepare or list of members of filicales found in Bihar with their ecology.
15. Aquatic ferns, epiphytic ferns and Terrestrial ferns - a brief note with diagrams.

11.13 SUGGESTED READINGS :

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