Laboratories 4 & 5: Leptosporangiate Ferns

These two labs cover some of the major families of leptosporangiate ferns (see Lab #3 for a chart that distinguishes between eusporangiate and leptosporangiate ferns), sometimes called the "higher ferns" or "true ferns." This is a group that contains 30-50 families and ~10,000 extant species. After the leptosporangiate fern labs you should be familiar with the common types of **indusia** (**peltate, reniform, tubular, laterally attached, false**, etc.), the two major categories of spores (**trilete** and **monolete**), **annulus** types (**patch, apical, oblique, vertical**, etc.), and other features that help distinguish the major groups of leptosporangiate ferns. *See p. 87-92 in the Simpson text for more information*.

PTERIDOPHYTES: Part II – Leptosporangiate Ferns

Osmundaceae – 3 genera, ~25 spp., temperate and tropical, terrestrial
Homosporous; **fertile and sterile fronds present (dimorphic fronds) or frond divided into sterile and fertile regions**; stipules often present at base of stipe; indusia lacking; no distinct or well-developed annulus; **many spores** per sporangium (>128), sporangia spherical; **spores green**, trilete
Osmunda
Todea

Hymenophyllaceae – 2-34 genera (depending on circumscription), ~600 spp., tropical, epiphytic or terrestrial
Homosporous; **leaves only one or two cell layers thick**; indusia present (**cup-like or tubular**); stomata lacking; **sori located at the margin of the leaves**; annulus oblique; **spores green,** trilete
Hymenophyllum
Trichomanes

Schizaeaceae – 4 genera, ~175 spp., tropical, terrestrial, commonly climbing vines
Homosporous; leaves indeterminate and climbing in *Lygodium*; **dichotomous branching and venation**; sporangia occur singly (*i.e.* not grouped into sori), marginal, **on stalks at blade tips or on pinnae lobes**; indusia absent (except in *Lygodium*); annulus apical; spores monolete
Lygodium
Schizaea

Marsileaceae – 3 genera, ~80 spp., tropical and temperate
Heterosporous; sori are enclosed within a **sporocarp** (microsporangia and megasporangia within the same sporocarp), which is stalked and arises from the rhizome or petiole; **rooted-aquatic** (often with floating leaves) **or terrestrial**; spores trilete
Marsilea
Pilularia

Salviniaceae – 2 genera, ~13 spp. tropical
Heterosporous; sori are enclosed within a **sporocarp** (microsporangia and megasporangia are in different sporocarps); in *Salvinia*, **leaves in whorls of three**, one of the three leaves resembles a submerged "root"; in *Azolla*, leaves divided into two lobes, one photosynthetic (with cavities that house the nitrogen-fixing cyanobacteria *Anabaena*), the other submersed and non-photosynthetic; **all are free-floating aquatic**, spores trilete
Salvinia
Azolla

• *Families below this point have 64 or fewer spores per sporangium*

Cyatheaceae – 4 genera, ~650 spp., tropical "Tree Ferns"
Homosporous; generally arborescent; numerous **scales** and sometimes hairs present at leaf bases; indusia various or lacking, but not as in Dicksoniaceae; spores trilete
Cyathea
Alsophila

Dicksoniaceae – 6 genera, ~20 spp., tropical "Tree Ferns"
Homosporous; arborescent; **lacking scales** but with hairs at leaf bases; **indusium present**, **bivalvate**, usually half composed by a reflexed portion of the margin (often colored differently), sometimes cup-shaped; spores trilete
Dicksonia

Pteridaceae – ~40 genera, ~1000 spp., temperate to tropical, also in arid regions
Homosporous; sporangia typically aggregated in lines along the veins or near the leaf margin; **no indusium or a "false" indusium present**, formed by reflexed margin; scales or glandular hairs often present; annulus typically vertical, interrupted; trilete spores; few spores per sporangium (usu. 32-64); spores dark in color (*i.e.* black, brown or gray), not green, trilete
Adiantum
Cheilanthes
Pellaea

Aspleniaceae – ~8 genera, ~700 spp., temperate and tropical
Homosporous; stems typically covered with scales; **sporangia located on veins and are covered by laterally-attached indusia**; **sori usually linear, oblique to costa, typically open away from costa**; spores monolete
Asplenium

Blechnaceae – ~10 genera, ~300 spp., terrestrial or epipetric
Homosporous; blades often reddish in color when young; **sori linear, or clustered so as to form "chains"**, **parallel to costa**; **indusia present, opening inward** (*i.e.* toward the costa); spores monolete
Blechnum
Woodwardia

Dryopteridaceae – ~40 genera, ~1500 spp., temperate and tropical
Homosporous; **scales** present on stems; indusia usually present, **reniform** (kidney-shaped) **or peltate,** sometimes lacking or "acrostichoid" (spread densely over abaxial surface); sori generally not located along the leaf margin; leaves often highly dissected, **annulus vertical**, spores monolete
Dryopteris
Polystichum

Polypodiaceae - homosporous; **sori round** (sometimes elongate or acrostichoid) **and lacking an indusium**; annulus vertical and interrupted; net-like venation pattern; **leaves generally simple or pinnatifid**; plants often epiphytic, **annulus vertical**; spores monolete, usually yellow
Lecanopteris
Polypodium

Family	Annulus	Indusium	Spore
Osmundaceae	Patch/Not Distinct	None	Trilete, Green
Hymenophyllaceae	Oblique	Cup-Shaped or tubular	Trilete, Green
Schizaeaceae	Apical	None (except in *Lygodium*)	Monolete
Marsileaceae	N/A – In sporocarp	N/A	Trilete, Heterosporous
Salviniaceae	N/A – In sporocarp	N/A	Trilete, Heterosporous
Cyatheaceae	Oblique	Various (including lacking), but not as Dicksoniaceae	Trilete
Dicksoniaceae	Oblique	Bivalvate or cup-shaped	Trilete
Pteridaceae	Vertical	False or none, (some acrostichoid)	Trilete
Aspleniaceae	Vertical	Laterally-attached, usually linear, typically opening away from costa	Monolete
Blechnaceae	Vertical	Laterally-attached, linear, opening towards costa	Monolete
Dryopteridaceae	Vertical	Reniform or peltate, occasionally laterally attached, (rarely lacking)	Monolete
Polypodiaceae	Vertical	None	Monolete

OSMUNDACEAE. OSMUNDA FAMILY

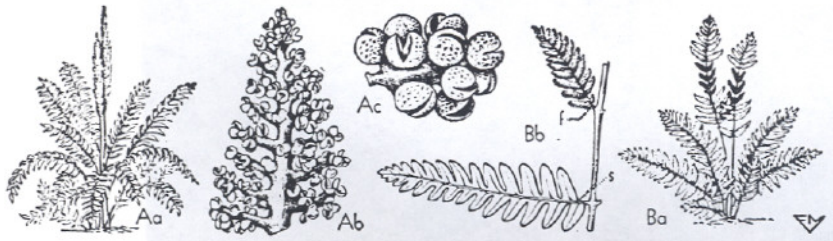


Fig. 46. OSMUNDACEAE. A, *Osmunda cinnamomea*: Aa, habit, much reduced; Ab, segments of fertile frond, × 3; Ac, sporangia, × 10. B, *Osmunda Claytoniana*: Ba, habit, much reduced; Bb, portion of frond with sterile (s) and fertile (f) segments, × ½. (From L. H. Bailey, *Manual of cultivated plants*, The Macmillan Company, 1949. Copyright 1924 and 1949 by Liberty H. Bailey.)

HYMENOPHYLLACEAE. FILMY FERN FAMILY

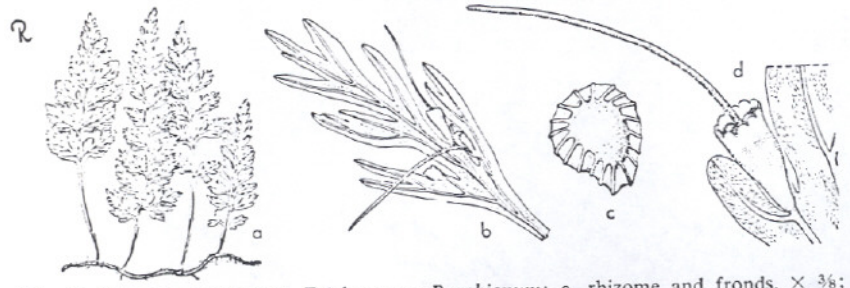


Fig. 49. HYMENOPHYLLACEAE. *Trichomanes Boschianum*: a, rhizome and fronds. × ⅜; b, fertile pinna, × 3; sporangium, × 50; d, fertile segment with sorus and indusium, × 6.

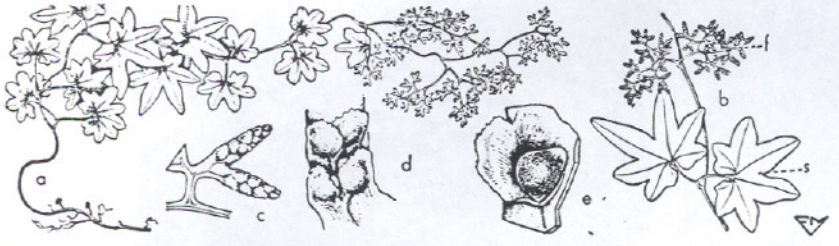


Fig. 47. SCHIZAEACEAE. *Lygodium palmatum*: a, plant, × ¼; b, section of frond showing sterile (s) and fertile (f) pinnae, × ½; c, fertile segments, × 2; d, sporangia covered by indusia, × 5; e, sporangium with indusium cut and opened back, × 10. (From L. H. Bailey, *Manual of cultivated plants*, The Macmillan Company, 1949. Copyright 1924 and 1949 by Liberty H. Bailey.)

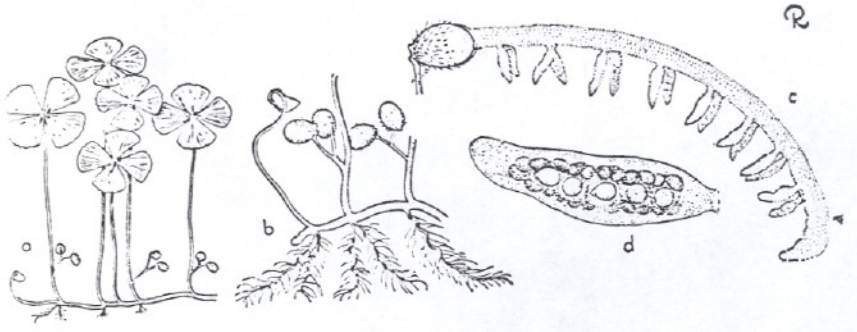


Fig. 53. MARSILEACEAE. *Marsilea quadrifolia*: a, portion of plant, × ⅓; b, sporocarps, × 1; c, germinating sporocarp, sori pendent from gelatinous tissue, × 1½; d, sorus, seen from below, showing large megaspores surrounded by smaller microspores, × 8.

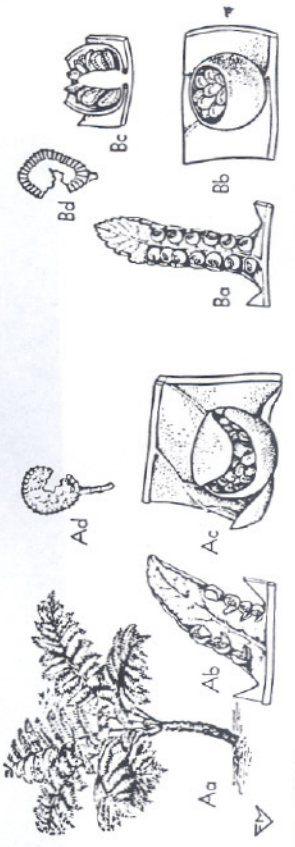


Fig. 50. DICKSONIACEAE. A, *Cibotium Schiedei*: Aa, plant, much reduced; Ab, frond segment with sori, × 2; Ac, sorus, × 10; Ad, sporangium, × 25. CYATHEACEAE. B, *Alsophila australis*: Ba, frond segment with sori, × 2; Bb, sorus, × 10; Bc, sorus, vertical section, × 10; Bd, sporangium, × 25. (From L. H. Bailey, *Manual of cultivated plants*, The Macmillan Company, 1949. Copyright 1924 and 1949 by Liberty H. Bailey.)

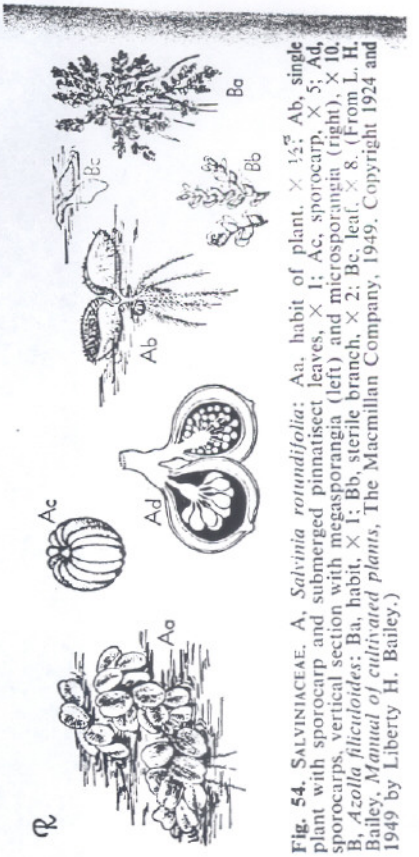
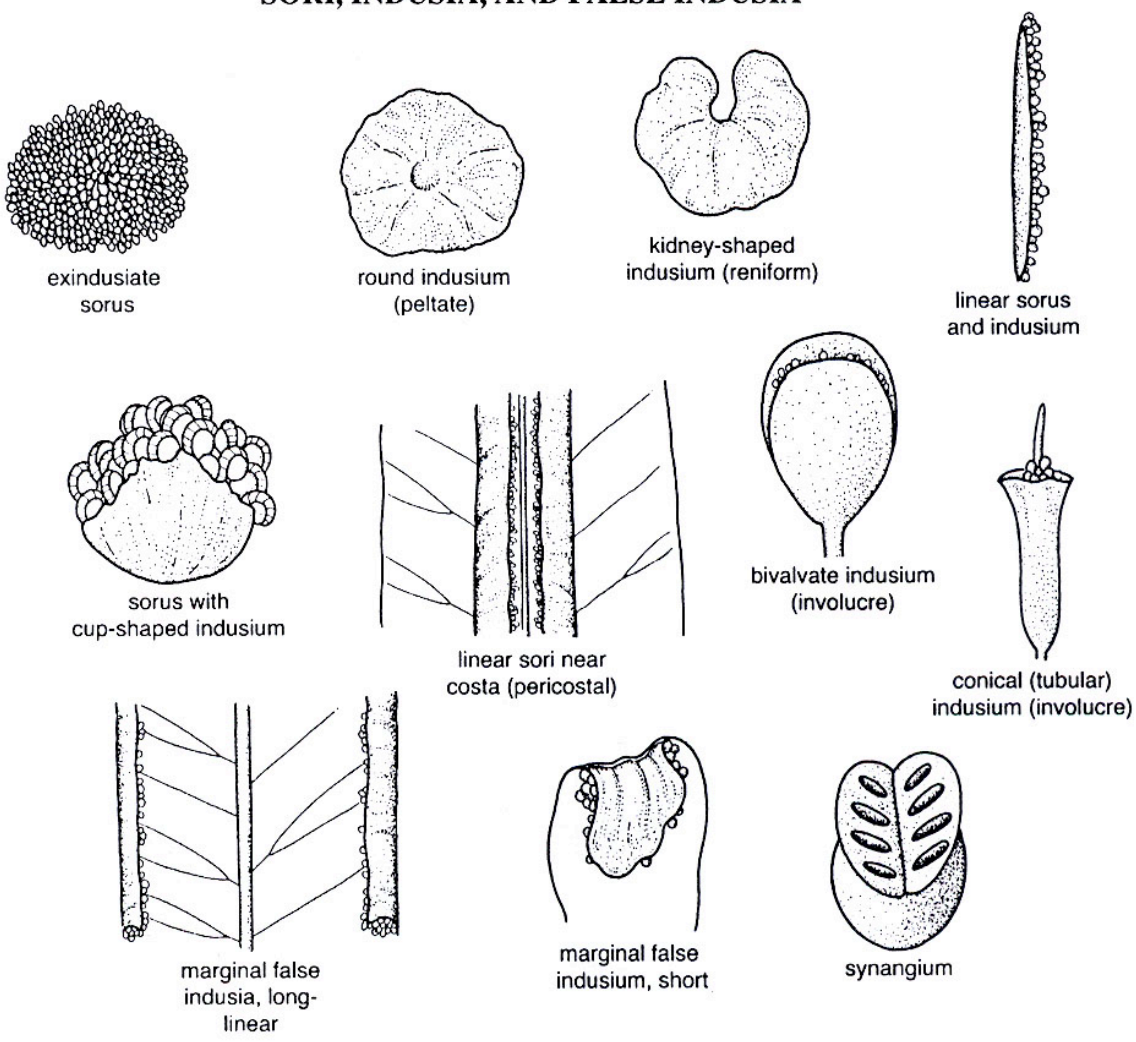


Fig. 54. SALVINIACEAE. A, *Salvinia rotundifolia*: Aa, habit of plant, × 1½; Ab, single plant with sporocarp and submerged pinnatisect leaves, × 1; Ac, sporocarp, × 5; Ad, sporocarps, vertical section with megasporangia (left) and microsporangia (right), × 10. B, *Azolla filiculoides*: Ba, habit, × 1; Bb, sterile branch, × 2; Bc, leaf, × 8. (From L. H. Bailey, *Manual of cultivated plants*, The Macmillan Company, 1949. Copyright 1924 and 1949 by Liberty H. Bailey.)

From Lawrence's Taxonomy of Vascular Plants



(figure from Palmer. 2003. *Hawaii's Ferns & Fern Allies*)

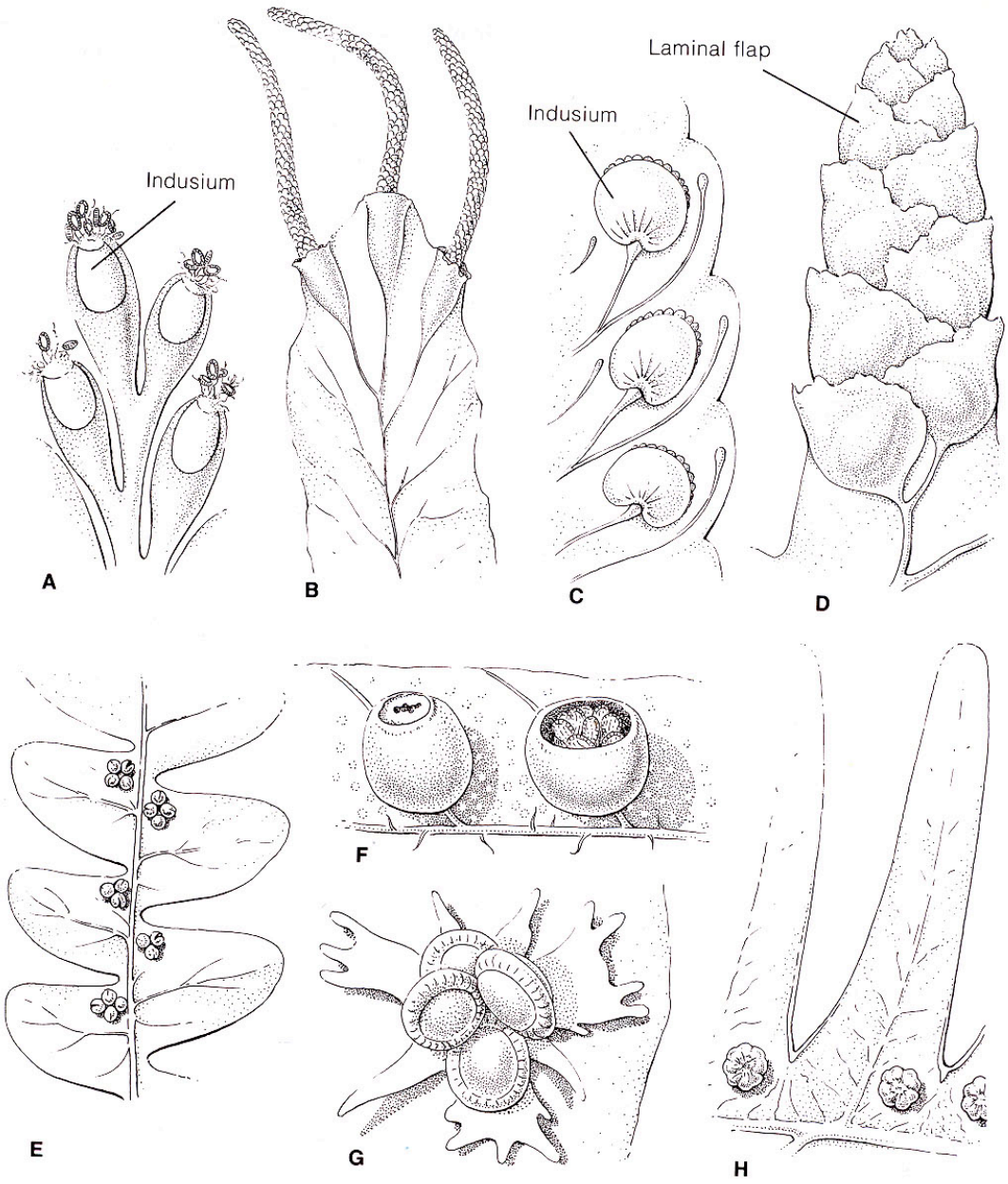


FIGURE 13-7 Variation in position and form of fern sori. **A,** *Davallia,* pouchlike indusium, joined with lamina, open at laminal margin; **B,** *Trichomanes,* marginal, receptacle elongate; **C,** *Nephrolepis,* indusium attached at one side; **D,** *Lygodium,* each sporangium covered by a laminal flap; **E,** *Gleichenia,* superficial position, no indusium; **F,** *Cyathea,* cup-shaped indusium; **G,** *Woodsia,* basal membranous indusial segments; **H,** *Matonia,* peltate indusium. [**C** redrawn from *The Ferns,* Vol. III, by F. O. Bower. Cambridge University Press, London, 1928; **F** adapted from *Morphology of Vascular Plants. Lower Groups* by A. J. Eames. McGraw-Hill, New York, 1936.]

(above figure from p.254. Gifford & Foster. 1974. *Morphology & Evolution of Vascular Plants.* 3ed)

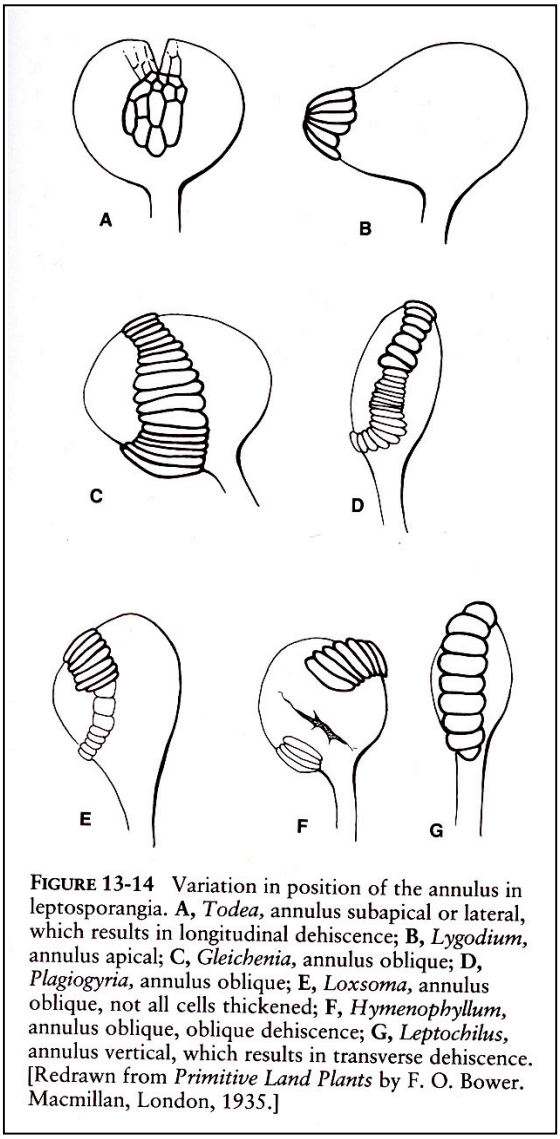


FIGURE 13-14 Variation in position of the annulus in leptosporangia. **A,** *Todea,* annulus subapical or lateral, which results in longitudinal dehiscence; **B,** *Lygodium,* annulus apical; **C,** *Gleichenia,* annulus oblique; **D,** *Plagiogyria,* annulus oblique; **E,** *Loxsoma,* annulus oblique, not all cells thickened; **F,** *Hymenophyllum,* annulus oblique, oblique dehiscence; **G,** *Leptochilus,* annulus vertical, which results in transverse dehiscence. [Redrawn from *Primitive Land Plants* by F. O. Bower. Macmillan, London, 1935.]

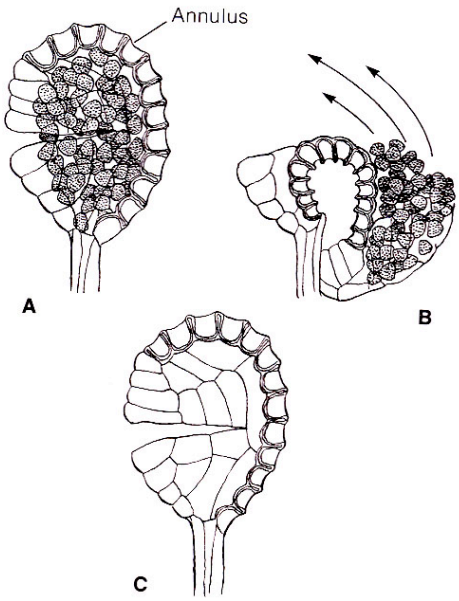
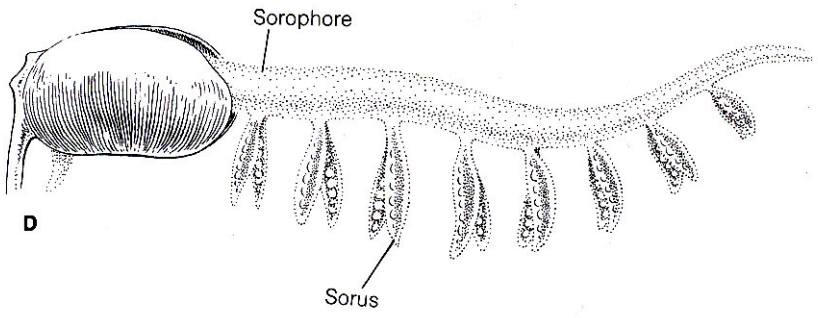


FIGURE 13-16 Behavior of a fern sporangium during drying and dispersal of spores. See text for discussion. [Redrawn from *Plant Physiology,* 1st edition, by B. S. Meyer and D. B. Anderson, © 1939 by Litton Educational Publishing, Inc. Reprinted by permission of Van Nostrand Reinhold Co.]

(above figures from p.261-2. Gifford & Foster. 1974. *Morphology & Evolution of Vascular Plants*. 3ed)



MARSILEACEAE (*Marsilea quadrifolia*) extrusion of gelatinous cylinder (sorophore) to which sori are attached

(above figure from p.309. Gifford & Foster. 1974. *Morphology & Evolution of Vascular Plants*. 3ed)

Glossary: Leptosporangiate Ferns

Definitions from Simpson (2006), Plant Systematics

abaxial: the lower or outer surface of an organ – *syn.* dorsal

acrostichoid: having sporangia spread densely over the abaxial surface of a lamina

adaxial: the upper or inner surface of an organ – *syn.* ventral

annulus: a single row of specialized cells, having differentially thickened cell walls, on the outer rim of a leptosporangium, functioning in its dehiscence

caudex (*pl.* caudices or **caudexes):** a short, thick, vertical or branched perennial stem, underground or at/near ground level – *e.g.* in Cyatheaceae and Dicksoniaceae

circinate vernation: the manner in which new fern fronds emerge (*i.e.* from a coiled fiddlehead)

costa (*pl.* costae) : midrib

crozier: see **fiddlehead**

exindusiate: lacking an **indusium**

false indusium: an extension of the blade margin that overlaps the sorus of a leptosporangiate fern

fiddlehead: a leaf that is coiled during its development, characteristic of the leptosporangiate ferns (Polypodiales) and Marattiales – *syn.* crozier

frond: fern leaf

indusium: a flap of tissue that covers a **sorus**, found in some leptosporangiate ferns

leptosporangium: the sporangium of the leptosporangiate ferns (Polypodiales), characterized by developing from a single cell and having a single layer of cells making up the sporangium wall

paraphysis (*pl.* paraphyses): a sterile filament or hair borne among sporangia

pinna (*pl.* pinnae): the first discrete leaflets or blade divisions of a fern frond.

pinnatifid: pinnately lobed to divided

pinnatisect: pinnately divided, almost into discrete leaflets but confluent at the midrib

pinnule: the ultimate divisions or leaflets of a fern frond

receptacle: in ferns, the cushion of tissue bearing the sporangia (often exserted in *Trichomanes*)

sorus (*pl.* sori): a discrete cluster or aggregation of leptosporangia

sporocarp: the generally spherical reproductive structure of aquatic ferns, functioning in allowing the sporangia inside to remain dormant and resist desiccation for a long time

stipe: a leaf stalk in ferns – *syn.* petiole