
Ophioglossales

Lesson Structure

- 10.1 Introduction
- 10.2 Adult Sporophyte
- 10.3 Nature of Fertile spike.
- 10.4 The gametophyte / Prothallus structure
- 10.5 Apogamy and Apospory
- 10.6 Systematic position of ophioglossales.
- 10.7 Suggested Readings.
- 10.8 Questions for Exercise.

10.1 INTRODUCTION :

Ophioglossales.

This order is now divided into three families:-

1. *Ophioglossaceae* : includes 50 sps. (Christensan 1938)
 (R. Br. Agardh) includes 43 sps. (F. O. Bower 1926)
 includes 30 sps. (A. J. Eames 1936)
 includes 45 sps. (Reimers 1954)
2. *Helminthostachyaceae* Chind - includes one species.

***Helminthostachy zeylanica* L.**

3. Botrychiaceae Nakai - includes 10 species.
 e.g. Botrychium.

Family - *Ophioglossaceae* is represented by two genera.

Pendula (L) Pres.

(a) **Ophioderma**

Distributed in Assam, Andman and Nicobar Island (India), Old World tropics

in Madagascare Srilanka, Malay Peninsula, Formosa, Phillipines, Sumatra, Java, Borneo, Maluccas, New Guinea Casoine Island, Australia, New Herbrides, Fiji Samoa, Tahite and Hawaian Islands.

- (b) **Ophioglossum**. L. It is represented in India by 13 species. These species are:-
1. **Ophioglossum coslatum** F. Br. - Distribution North-West to Easter Himalayas, Madhya Pradesh, West Bengal, Maharashtra, South India
 2. **O. gramineum** willd. Distribution - Uttar Pradesh, Madhya Pradesh, South India..
 3. **O. gramineum** Var. **majus** wieff. Distribution - Tripura
 4. **O. lusitanicum**. L. - Distributed in Madhya Pradesh, Tamil Nadu.
 5. **O. nudicauler**. L. - Pantropic areas.
 6. **O. nudicaule** var. **macrorhizum** kunze. Madhya Pradesh, Gujrat, West Bengal, Uttar Pradesh, Tamilnadu.
 7. **O. petialatum**. Hook Distributed : Uttar Pradesh and Madhya Pradesh.
 8. **O. polyphyllum**. A. Braun, Distribute din orth-West Himalayas
(= *O. aitchisoni* (Clarke) 'a' almeida. **O. lusitanicum**. Sensu.
 9. **O. reticulatum**. L. Distributed throughout India.
(= *O. cordifolicum* Roxb.)
 10. **O. reticulatum**. L. F. **comphicatum** (Riq) Weiff. Distributed Eastern India, Sikkim.
 11. **O. reticulatum** L. F. **dilatatum** (Miq) Weiff.
 12. **O. thermale** kumarov. var. **nipponicum**. (Phiyobe & Kudo) Eastern Himalaya.
 13. **O. vulgatum**. L. (North-West Himalaya and widely distributed in temperate zones through out India.

Ophioglossum is being treated by some authers as a genus of four subgenera:-

- (a) Euophioglossum - Majority of species.
- (b) Ophioderma - e.g. **O. pendulum**.

(c) Cheiroglossum - e.g. *O. palmatum*.

(d) Rhizoglossum - e.g. *O. berginianum*.

Botrychiaceae is represented in India by 8 species.

1. *Botrychium ducifolium* wall. Through mountains of India.
2. *B. duafoium*. var. *parvum*. Humalayan region.
3. *B. lanuginosum* var. *lanuginosum*.
(= *B. Virginianum* var. *lanuginosum*)
4. *B. lunaria* (L) - North West Himalayas, Sikkim, Eastern Himalaya and South India.
5. *B. lunaria* (L) Sw. Var. *Onondagnse* (Undrew) North West Himalayas.
6. *Botrychium multifidum* (Gmel)
Distributed in Sikkim.
7. *B. ternatum* (Thumb) Sw.
North-West to Eastern Himalayas.
8. *B. virginianum* (L)
North West and Eastern India.

ADULT SPOROPHYTE

In most of the species of *Ophioglossum* and *Botrychium* the sporophyte has a short, erect, subterranean rhizome. In *O. pendulum* and, intermedium the rhizome is markedly dorsiventral. In *Helminthostachys*, the young plant has an erect axis but the rhizome becomes horizontal as the plant grows larger. Rhizome branches dichotomously which is due to the formation of axillary buds.

In *Helminthostachys*, the leaves are borne in two ranks along the upper side of the thick creeping rhizome. The leaves are erect in terrestrial but drooping in epiphytic species. The lamina of the leaf in most species except in few species as e.g. *O. palmatum* is simple, entire and narrowly linear to broadly oval in outline. The sterile segment found is usually pinnately compound in *Helminthostachys*. At the junction of the blade and lamina there is single fertile spike. In *O. palmatum* the mature leaves are more or less clearly dichotomous and the lamina is palmately divided into a number of narrow lobes. In *O. pendulum*

the long, pendent leaf may reach a length of 1.5 mm or more. The venation of the lamina is reticulate but *Botrychium* and *Helminthostachys* have dichotomous open venation. No distinct midrib. The venation of the leaf is erect or non-circinate.

The rhizome bears numerous, thick, succulent, smooth adventitious root devoid of root hairs. In *Helminthostachys*, roots arise from the ventral surface of the creeping rhizome. The roots may be unbranched in sub genus. *Euophioglossum* or branch freely in subgenus, *ophionderma* or branch freely in subgenus *churoglossa*. The roots are mycorrhizic.

The apical cells is pyramidal in shape and helps in apical growth.

T. S. OF RHIZOME

T.S. (Transverse) of Rhizome shows irregular outline due to attachment of numerous adventitious roots and leaf bases. It usually shows a peripheral cortex and central stele. Cortex composed of thin-walled Parenchyma with intercellular spaces. In older portion of rhizome suberized by formation of Periderm layer, though there is no functional Cork Cambium (Maheshwarized and Sing 1934. According to Campbell (1911) the presence of periderm is doubtless. In extreme basal portion of rhizome possess outer endodermis e.g. *O. Pendulum* (Pentry 1910), *O. polyphyllum* (Vashistha 1927), *O. Capense* and *O. elliptecum* Stele shows - variation, it is protostele e.g. *O. reticulation*. The vascular cylinder of the rhizome of ophioglossaceae is an ectophloic siphonostele and in some species there is non-overlapping leaf-gaps. The xylem is mesarch in *helminthostachys* and endarch in *Botrychium*. *Metaxylem elements of Botrychium and Helminthostachys* are uniform with circular bordered pits. The phloem is usually four or five layers cells in thickenss but in *O. pendulum* (Pentry 1914) and *O. Polyphyllum* (Vashistha 1927) the phloem is of single layer of cells. There is small amount of secondary thickening in *O. vulgatum* and in *Botrychium virginianum*. In some species tracheids occur in pith e.g. *O. pendulum* (Petry 1914) and *O. Polyphyllum* (Vashistha 1927). The pith is intrastelar in origin.

The section of the root shows epidermis (not distinguishable in *O. costatum*) broad cortex (differentiated in two concentric zones) and stele. Endodermis with characteristic casparian stripes present. The stele of the root is usually monarch or diarch, but tri, tetra and pentarch stele have been observed in *O. costatum*, *O. polyphyllum Band*, *O. pendulum*. In *Helminthostachys* the stale is tetrarch

to octarch.

Anatomy of Petiole shows callateral bundle, xylem flattened and endarch. In internal structure of Lamina stomata may be less numerous upon the upper surface. In *Helminthostachys* the stomata are found only on upper surface. The structure of the bundle is similar to Petiole. Vegetative reproduction takes place by the formation of adventitious buds on the roots e.g. *O. pendulum*, *O. vulgatum*, *O. Polyphyllum*, *O. nudicaule* and *O. Petiolatum*.

SPORE PRODUCING ORGAN:

The sporangia are born on fertile spike that arise on the basal portion of the sterile leaf. The fertile spike is simple and linear in *Botrychium* and complex in *Helminthostachys* Mature Sporangium has several layer of cells, like Marattiales wall. After maturity the sporangium delisces by a transverse cleft in *Ophioglossum* and *Botrychium* but in *Helminthostachys* by longitudinal slit.

Chromosome number shows variation, *O. lusitanicum* has $n = 125 - 130$, in *O. vulgatum* $n = 250 - 260$ and in *O. reticulatum* $n = 631 + x_0$ fragments (Manton 1950, Abraham and Ninan 1954. *Botrychium* has haploid number $n = 45$ (Manton 1950), *Helminthostachys* has $n = 46$ or 47 .

10.3 NATURE OF FERTILE SPIKE

The morphological nature of fertile spike is debatable Bower (1896, 1908) Considered fertile spike as septate sporangium arising on the aerial part of ophioglossaceae to be single sporophylls. In 1926, Bower himself relinquished his hypothesis. K. Goebel (1915) holds that the spike represent a single pinna. Roeper (1859) suggested that the fertile spike represented two laterally fused pinnae. Chryster ((1916, 1925) and Bower (1926) agree with Roeper. The pinna mature of spike is shown by *Botychium lanuginosum*. Zimmerman (1930, 1942) suggested that leaf of ophioglossaceae is a modified, reduced dichotomous branch system and interpreted the division of the leaf into fertile spike and the sterile portion to represent a dichotomy. Zimmerman states "Certain developmental and anatomical data would harmonize with antero-posterior dichotomy of which one limb became photosynthetic and other fertile.

10.4 THE GAMETOPHYTE

The spores are tetrahedral type. They are usually trilete in all the three genera but Pant and Khare (1971) reported alete or sometimes monolete spores

in *O. reticulatum*. The spores are approximately 20-35 x 30-35 mm in size (Devi and Nayor, 1969).

The mature Prothalli of all the three genera are subterranean, fleshy and tuberous. They are non-green saprophytic and infected by endotrophic mycorrhiza. The apices of the Prothalli are white but the lower parts are grayish, yellowish or brownish. They may be short lived i.e. for one year or less e.g. *O. molucoconum*, *O. nudicaule* Var. *tenerum* and *H. zeylanica* or are long lived perennial e.g. *O. vulgatum*, *O. pendulum* and *B. virginianum*. The size range of Prothallus varies from a few mm to about 6 cm. in length and 0.5 mm. to 2.5 mm. in diameter. In form the prothallus are elongated and cylindrical, straight or curved *O. reticulata*, or globose e.g. *O. Costatum*, *Botrychium* or lensshaped e.g. *O. Crotalophoroides*. They may be branched or unbranched. In *O. petiolatum*, *O. Moluccanum* and *O. Pendunculosum*, the prothalli show a prominent basal expanded knob like tubercle. The prothalli of *H. Zeylonica* are thicker and lobed and the irregular lobes with apical cells, representing as short lateral branches.

In *Ophioglossum* and *Helminthostachys*, the prothalli have fundamental axial organization i.e. they are radially symmetrical apical meristem and radial distribution of gametangia and rhizoids. In *Botrychium* the axis of tuberous flattens, dorsiventral prothallus is horizontal rather than vertical, and the apical meristem is located on one end. The prothallus of *O. pendulum* and *O. palmatum* may give rise to several embryos. The mature basal region may remain infected by mycorrhizal fungus, which may belong to Peronosporaceae or Endogonaceae.

The prothalli are usually monoecious but dioecious-gametophyte are reported in *O. molucnum*, *O. nudicaule* and *H. zeylanica*. The sex organs remain confined to upper region. In *Botrychium* the antheridia and archegonia are restricted to distinct zones.

The antheridia originate from a single superficial cell of the prothallus. The mature antheridia are smaller or massive, partly or completely embedded in the Prothallus

The antheridium wall is single-layered but in *O. vulgatum*, *O. costatum*, *O. nudicaule*, *O. palmatum* and *pedunculosum* the antheridium wall is double-layered. The opercular cell is small and triangular in outline. Inside the wall there are fewer (*O. Pedunculosum*, *O. Vulgatum*) or far greater number (4

to 5 thousand) of antherozoids e.g. *O. costatum*, *O. nudicoule*. In *Botrychium* and *H. Zeylanica* the antheridia are large and their jacket walls two or three layered thick. The antherozoids are produced in large numbers and they are narrowly coiled and numerous flagellar are developed from the portion which has blepharoplast. On maturity the triangular opercular cell disintegrate and antherozoids escapes out.

Mature archegonia has a neck consisting of four vertical rows of cells and usually 3 to 4 cells in height. It remain sunk in the tissue of the porthallus or project slightly. The axil row consist of a single binucleate neck canal cell and an egg the ventral canal cell is inconspicuous or absent. A ventral canal cell may be present in *Botrychium Japonicum*, *B. ternatum*, *B. bomuginosum* and *B. Virginianum*. Eggs become active when two canal cells disintegrates. Union of egg and antherozoids forms zygote which later on form embryo. The embryogeny is exoscopic. No suspensor is formed. The development of young sporophyte takes eleven months is *O. Crotalophoroids* and in some species 30 months or earlier. In *Botrychium* apogamy and apospory has been reported.

10.5 APOGAMY:

It is production of sporophyte from a gametophyte directly without syngamy or sexual fusion.

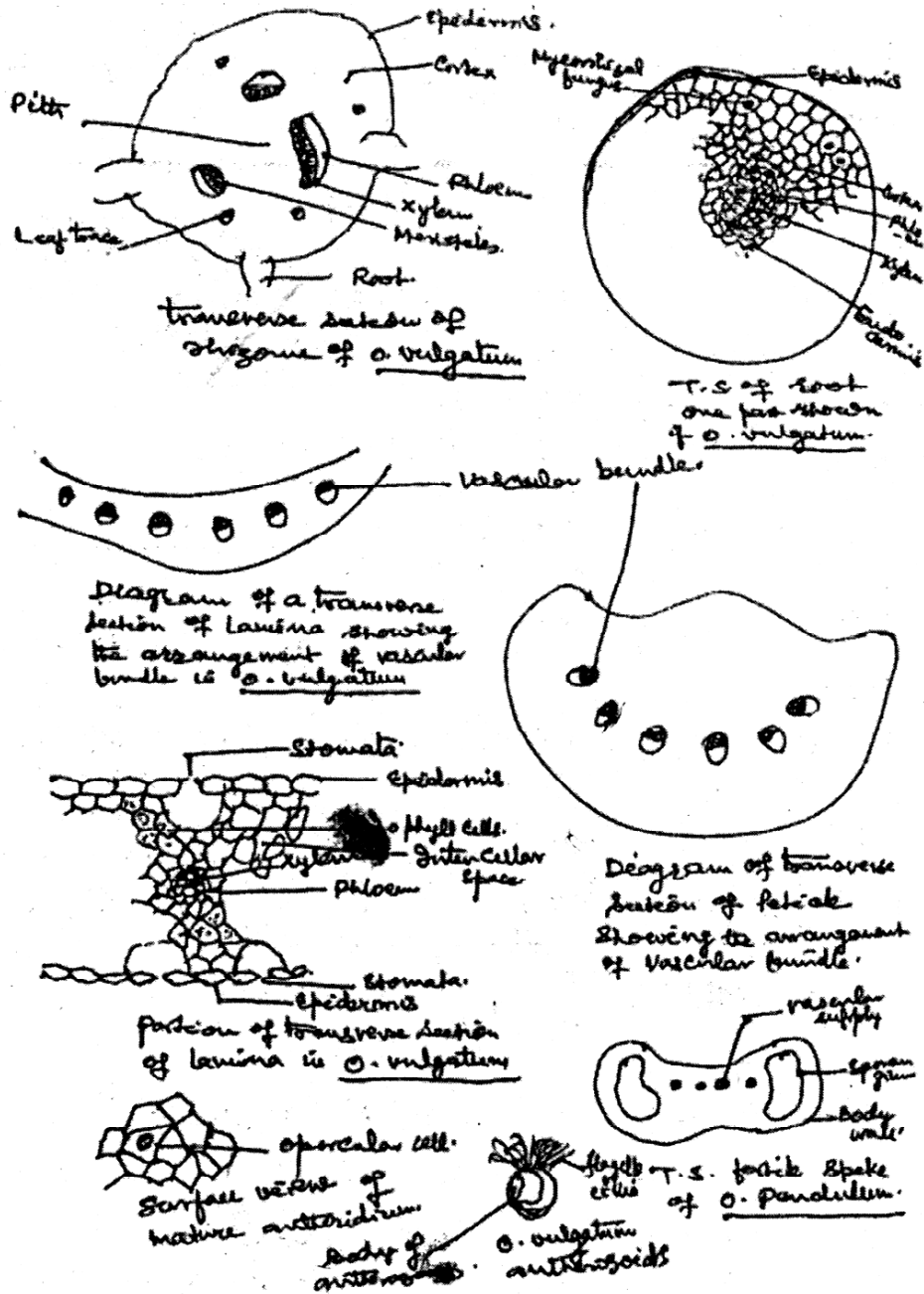
Apospory - the production of a gametophyte from a sporophyte directly without the formation of spores.

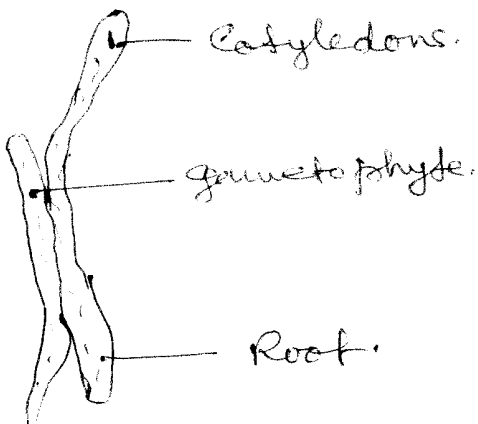
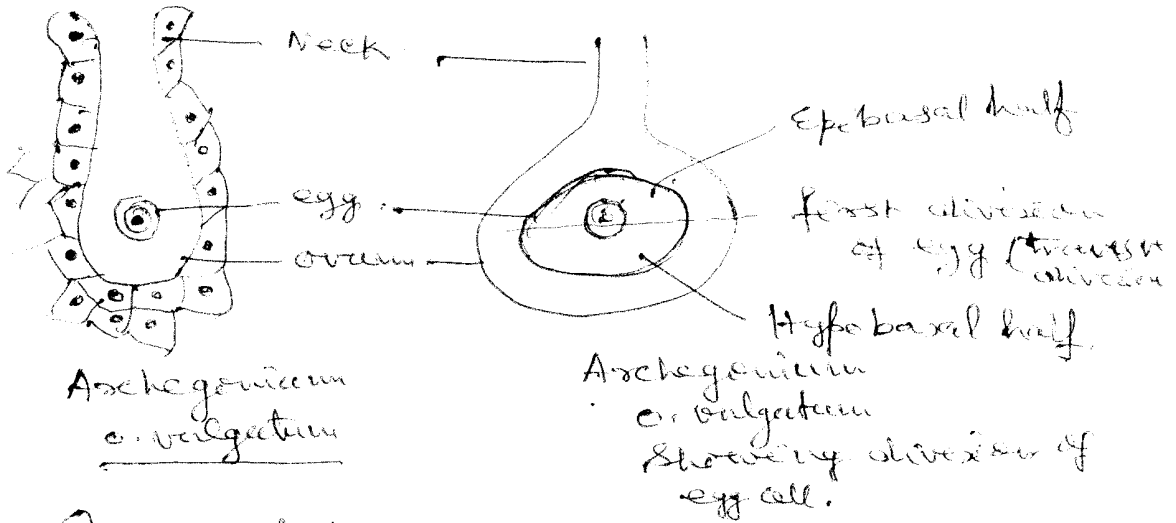
10.6 SYSTEMATIC POSITION OF OPHIOGLASSALES.

The plant group has no fossil record and generally referred to ferns but the relationship is obscure. This group shows progress in the evolution of vegetative parts of sporophyte but retains primitive reproductive features in gametophyte and too some extent in the sporophyte organization in some abnormal or anomalies found in ophioglossales are as such:-

1. Outer structure of plant body single leaf or fertile and sterile segments.
2. Non-circinate vernation with an exception of **Botrychium**.
3. Absence of sclerenchyma in plant body.
4. Presence of collateral vascular bundle.
5. Secondary growth in *Botrychium* and *Helminthostachys*.

6. Presence of Vessel in Ophioglossum, Botrychium and Helminthostachys.
7. Treacheary structure suggests their Progymnospermous affinity.
8. Absence of root hairs and association of endophytic mycorrhizal fungus.
9. gametophyte subterranean axial and association of fungus.
10. Ophioglossoid fertile leaf with epiphyllous sporophores in comparable to angiosperm carpel with adaxial ovules. (Zimmeruan 1930).





Median section through
a gametophyte and a
young sporophyte
before the formation of bud.
o. montucanum.



10.7 QUESTIONS FOR EXERCISE

1. Describe salient feature in Distribution/Structure/Reproduction of eusporangiatae.
2. Give a brief account on distribution and morphology of Ophioglossaceae/ Botrychiaceae/helminthostachys.
4. Describe anatomical features of rhizome/root of ophioglossales.
5. Trace salient feature in life history/life cycle of ***Ophioglossum/ Batrychium/ Helminthostachys***.
6. Write distinguishing characters in spore producing organs of Botnychiaceae or Helminthostachys and compare it with ophioglossaceae.
7. Write about nature of fertile spike in ophioglossales or ophioglossum.
8. Describe Prothallus structure in ophioglossales. Give required diagrams.
9. Describe embryogeny in ophioglossales.
10. Give brief idea on
 - (a) Apogamy and Apospory.
 - (b) distribution of Ophioglossales in India.
 - (c) Characters of Eusperangiatae ferns.
 - (d) Antheridium and Archegonium structure.

10.8 Suggested Readings-

1. The Biology and Morphology of Pteridophytes by N. S. Parihar
2. An Introduction of teridophyta by A. Rashi.
3. The Morphology of Pteridophytes by K. R. Sporne
4. A Census of Indian Pteridophytes by R. D. Dixit.

