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## Structure, Reproductuion and Affinities of Marchantiales, Jungermanniales

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### *(Lesson Structure)*

- 4a.0 Objective
- 4a.1 Marchantiales
- 4a.2 Jungermanniales
  - (A) Sub-order : Metzgerineae (Jungermanniales Anacrogynae)
  - (B) Sub-order: Jungermannineae (Jungermanniales Acrogynae)
- 4a.3 Questions for Exercise
- 4a.4 Suggested Readings

#### **4a.0 Objective -**

This unit deals with the structure, reproduction and affinities of two large orders of Hepaticopsida ie., Marchantiales & Jungermanniales.

#### **4a.1 Marchantiales**

Characteristic features of the order Marchantiales

- (i) The plant body is gametophyte which is usually a prostrate, dorsi ventral dichotomously branched thallus with a more or less marked midrib.
- (ii) Internal tissues are differentiated into two distinct regions - the dorsal and the ventral region.
- (iii) The dorsal, green region is assimilatory zone which generally encloses air spaces also called the air chambers. The air chambers communicate with the exterior generally through pores.

- (iv) The ventral region is composed of compact, colourless, parenchymatous storage tissue.
- (v) Scales are usually present on the ventral surface of the thallus.
- (vi) The ventral surface of the thallus bears scales and two kinds of rhizoids - smooth walled and tuberculate. The thallus are attached to the substratum generally by means of rhizoids.
- (vii) The male & female sex organs are either scattered along the midrib or grouped in receptacles which are sometimes raised into the air.
- (viii) In the development of the antheridium the primary antheridial cells undergo two sets of vertical centric divisions at angles to each other, thus forming quadrants.
- (ix) The sporogonium is simple in structure and small, either with or without seta. It has capsule wall one cell in thickness. Columella is absent.
- (x) The capsule dehisces by various ways by never by four regular valves.

#### **4a.1.a Distribution and. Habitat :**

The Marchantiales with about 35 genera and approximately 420 species is a well defined order of the Hepaticopsida. The well known Indian members are *Marchantia*, *Preissia*, *Dumortiera*, *Concephalum*, *Exormotheca*, *Cyathodium*, *Tragionia*, *Cryptomitrium*, *Plagiochasma*, *Athalamia* and *Riccia*. Majority of them are terrestrial. These are hygrophilous growing on damp soil or rocks. Few are water floating or submerged.

In their distribution the representatives of this order range from the arctic to the tropical regions with a fair representation in the temperate zones. In India Kashyap made a fair collection of liverworts in the Himalayas west of Nepal and the Punjab Plain. Some members are fairly represented in Eastern Himalayas, Gangetic plain and Southern India also.

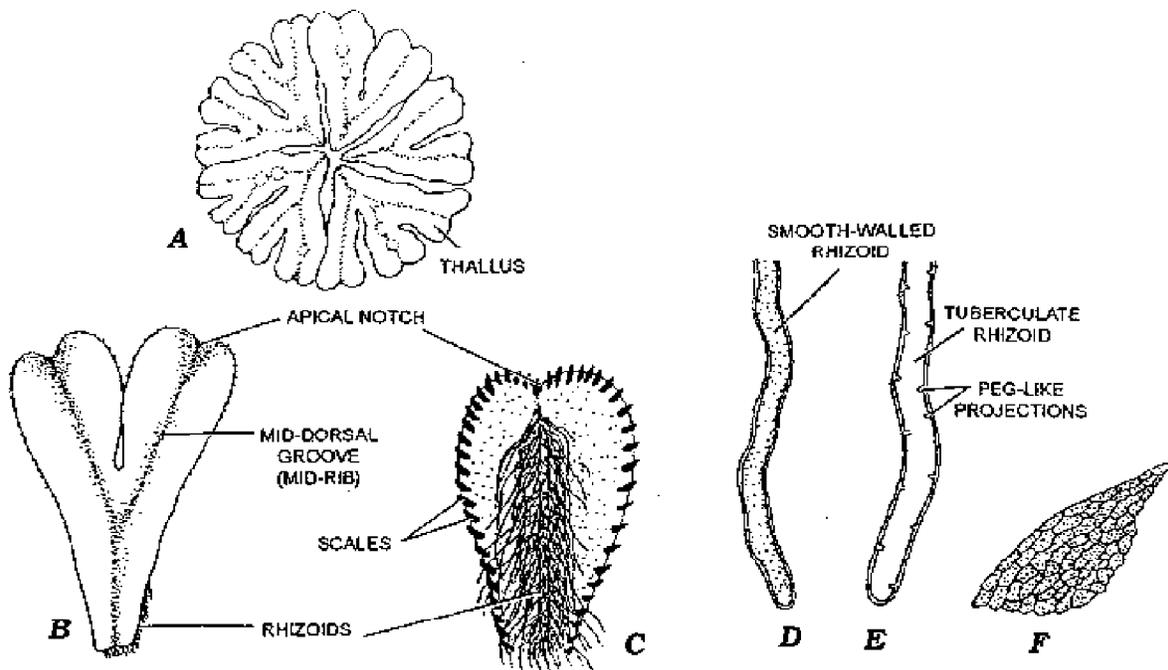
#### **4a.1.b Structure**

##### ***Morphological structure of Gametophyte***

The gametophyte plant is thallose. The thallus is green, flat, thick and fleshy. It is dichotomously branched, dorsiventral, often with conspicuously

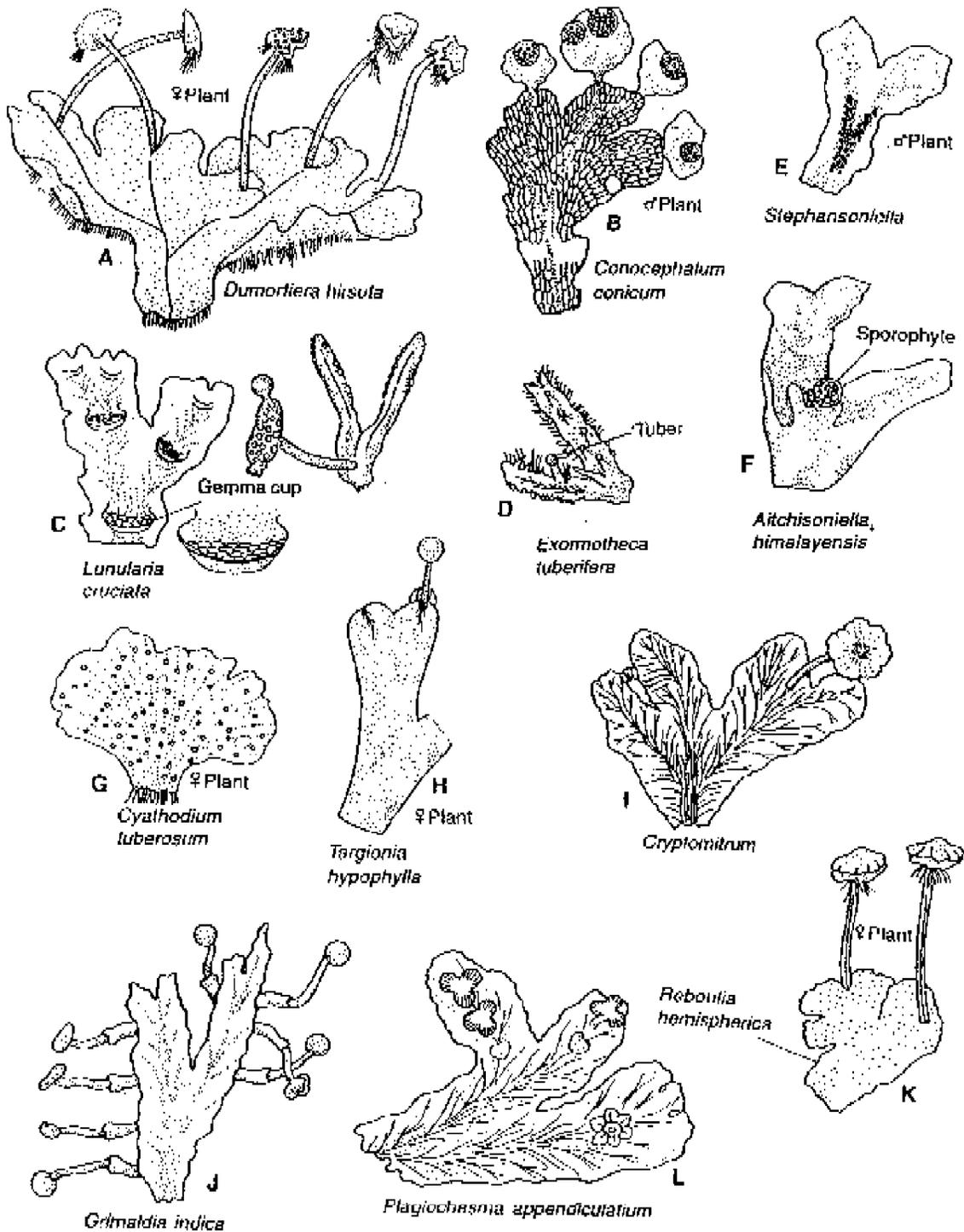
prominent lobes. Each lobe has an apical notch in which lies the growing point. The dorsal surface of the thallus has polygonal areas called areolae. Each such area has an air pore in the centre. The air pores may be simple or compound in different forms. From the lower surface the thallus of all the members arise two kinds of appendages - **rhizoids** and **Scales**.

Rhizoids are of two types smooth walled & tuberculate. Tuberculate rhizoids have peg-like thickenings that project into the lumen. The scales are multicellular plate like, one cell in thick purplish structure. They may be arranged in one row as in the young thallus of *Riccia*, in two rows one on each side of the midrib (*Reboulia*, *Tragionia*), or in two to four rows on each side of midrib (*Marchantia*). They are irregularly distributed over the entire ventral surface in *Corsinia*, *Athalamia* etc.



**Figure - 4a-1.1 : *Riccia* sp., External features of the gametophytic plant body**

- A. *Riccia* rosette**
- B. Dorsal surface of thallus**
- C. Ventral surface of thallus**
- D. Smooth walled rhizoid**
- E. Tuberculate rhizoid;**
- F. Scale**

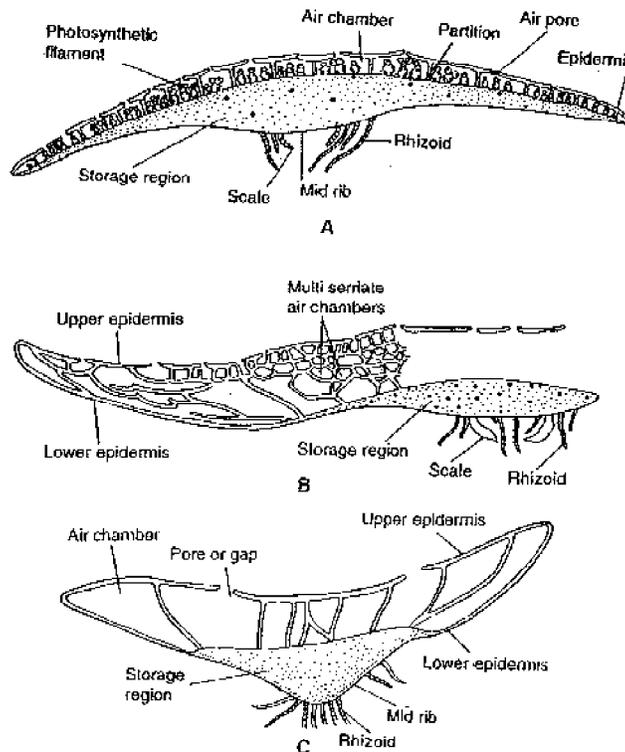


**Figure - 4a.1.2 : (A-L) Marchantiales. Some of the important representatives of the order. (H, after Smith and the rest after Kashyap).**

### Internal structure of thallus

Internally thallus is differentiated into two distinct- (i) Upper, green photosynthetic or assimilatory zone and (ii) lower colorless storage zone. The upper & lower epidermis is well- differentiated in the thallus.

The deep, green upper assimilatory region encloses air chambers. The chambers are roofed by a single layered epidermis. In the family Ricciaceae the chambers are reduce and are in the form of deep canales or channels. The chambered condition is represented in a relic condition in *Dumortiera* and is absent in *Monoselenium*. In species in which the chambers are present they may be in one or more than one layer. Each chamber is separated from its neighbours by partitions which are generally one cell thick. Air chamber may be empty or contains assimilatory filaments. When multilayered the chambers are invariably empty. Each chamber opens to the outside by a pore. These pores vary widely in structure in different genera. In *Stephensiella* the pores are simple and wide. They are large and barrel shaped in *Marchantia* and *Preissia*. In *Targionia* they are semi - barrel shaped.



**Figure - 4a.1.3 : (A-C) Marchantiales. Transverse sections of thalli.**

**Thick dots represent oil cells.**

**A. *Marchantia nepalensis* (outline sketch); B. *Plagiochasma appendiculatum* (outline sketch of a portion of the thallus showing the disposition of chambers); C. *Stephensiella brevipedunculata* (outline sketch). (After Mehra)**

The ventral zone of the thallus functions as the storage region. It lies below the air chambers and consists of colorless parenchyma. The parenchyma cells are compactly arranged. They lack chloroplasts but contains starch. Oil cells are also present. The lowermost layer of this region is lower epidermis which bears two kinds of rhizoids and scales.

#### **4a. 1-c Reproduction :**

In Marchantiales reproduction occurs both vegetatively and sexually.

**Vegetative reproduction** - It takes place by different methods

(i) Fragmentation (*Riccia*, *Marchantia* and others).

(ii) Production of adventitious branches often from the underside of the midrib and separation of these to form new thalli (*Targionia* and *Riccia fiuitans*)

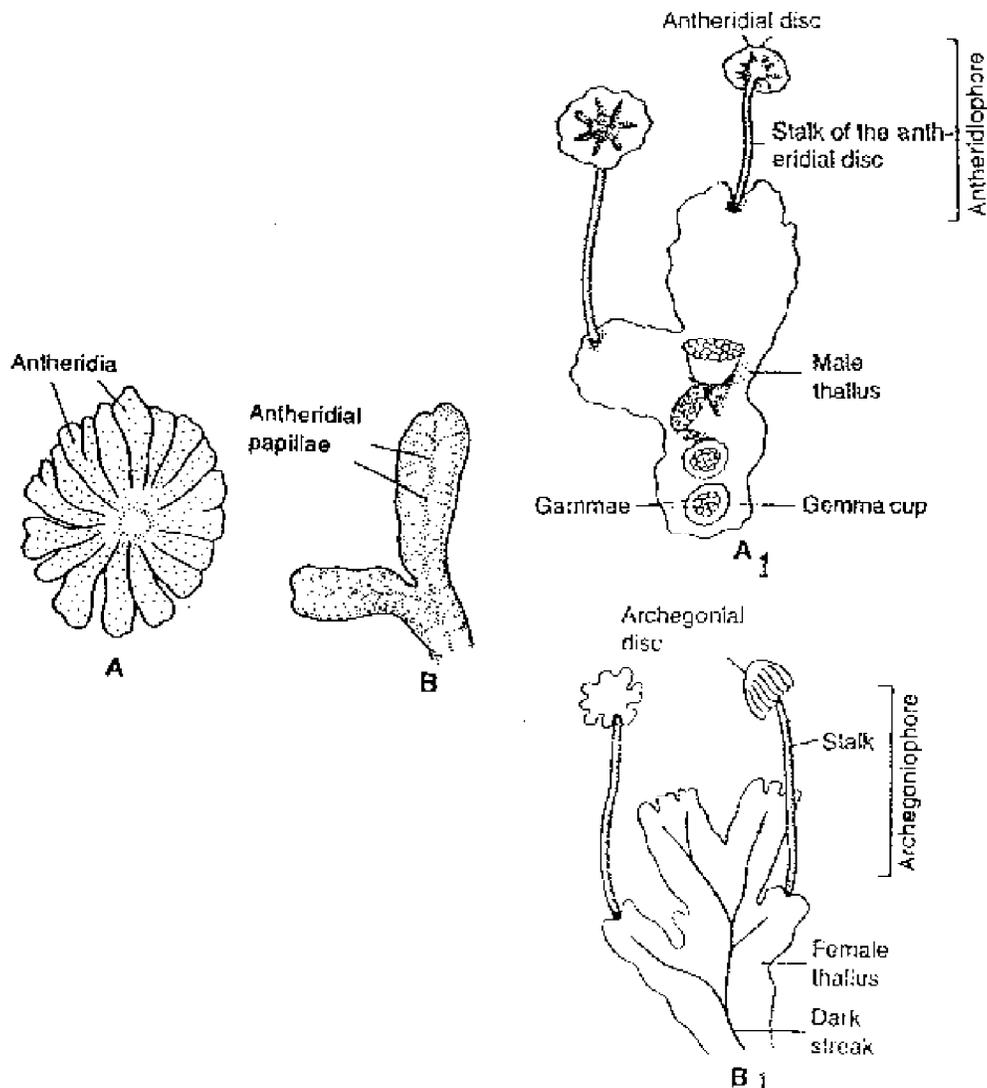
(iii) Gemmae formation (*Marchantia* and *Lunularia*) and

(iv) Tuber formation (*Riccia bilardieri*, *R. Vesicata*, *Exormothica tuberifera* and *Cyathodium tuberosum*)

**Sexual reproduction** - It is of oogamous type. Male sex organs are antheridia and female sex organs are archegonia. In some forms kinds of sex organs may be on the same thallus (Homothallic or monoecious) eg. *Riccia crystallina*, *Riccia billardieri*, *Targionia*, some species of *Cyathodium* etc. but in some cases male & female sex organs are produced on different thalli (Heterothallic or dioecious) eg. *Marchantia*, *Preissia quadrata*, *Riccia discolor*, *Riccia frostii* etc.

The sex organs arise in acropetal succession (ie., youngest at the apex and oldest at the base) on the dorsal surface of thallus along the median longitudinal groove. In the simplest forms they occur singly and scattered, each in a separate cavity on the dorsal side of the thallus (*Riccia*). Sometimes they tend to be aggregate into groups. The sex organs are restricted to special localized cushion like areas on the thallus which are known as receptacles. The receptacles may be sessile but in the advanced members of the order they are stalked eg *Marchantia*. In some species the male receptacle may be sessile and the female stalked (*Asterella blumeana*).

The antheridia bearing stalked receptacle is called antheridiophore and the archegonia bearing is called archegoniophore.



**Figure - 4a.1.4 : Riccia sp. A. Male thallus of *R. frostii*; B. Male thallus of *R. Discolor*; Marchantia so. A1 Male thallus of *M. polymorpha***

**Antheridia -**

The body of the antheridium has wall of a single layer of sterile cells. It surrounds a mass of small squarish or cubical cells called the androcytes. The latter produce the biflagellate male gametes called the sperms. Several sperms are produced in each antheridium. Each sperm is motile usually consist of a minute, slender, spirally curved body furnished with two long, terminal whiplash type flagella.

**Archegonia :-**

The Archegonium is a flask - shaped organ. The slender, elongated

upper portion is called neck and the lower sac - like swollen portion, the Venter. The Venter is usually embedded in the parent plant tissue.

The neck has a wall of a single layer of sterile cells which surrounds a central row of elongated, naked cells called the neck canal cells. The neck is usually projecting or freely exposed. The Venter also has a wall of sterile cells one or more cell layers in thickness. The Venter wall encloses two cells. Venter has larger egg cell and the smaller ventral canal cell.

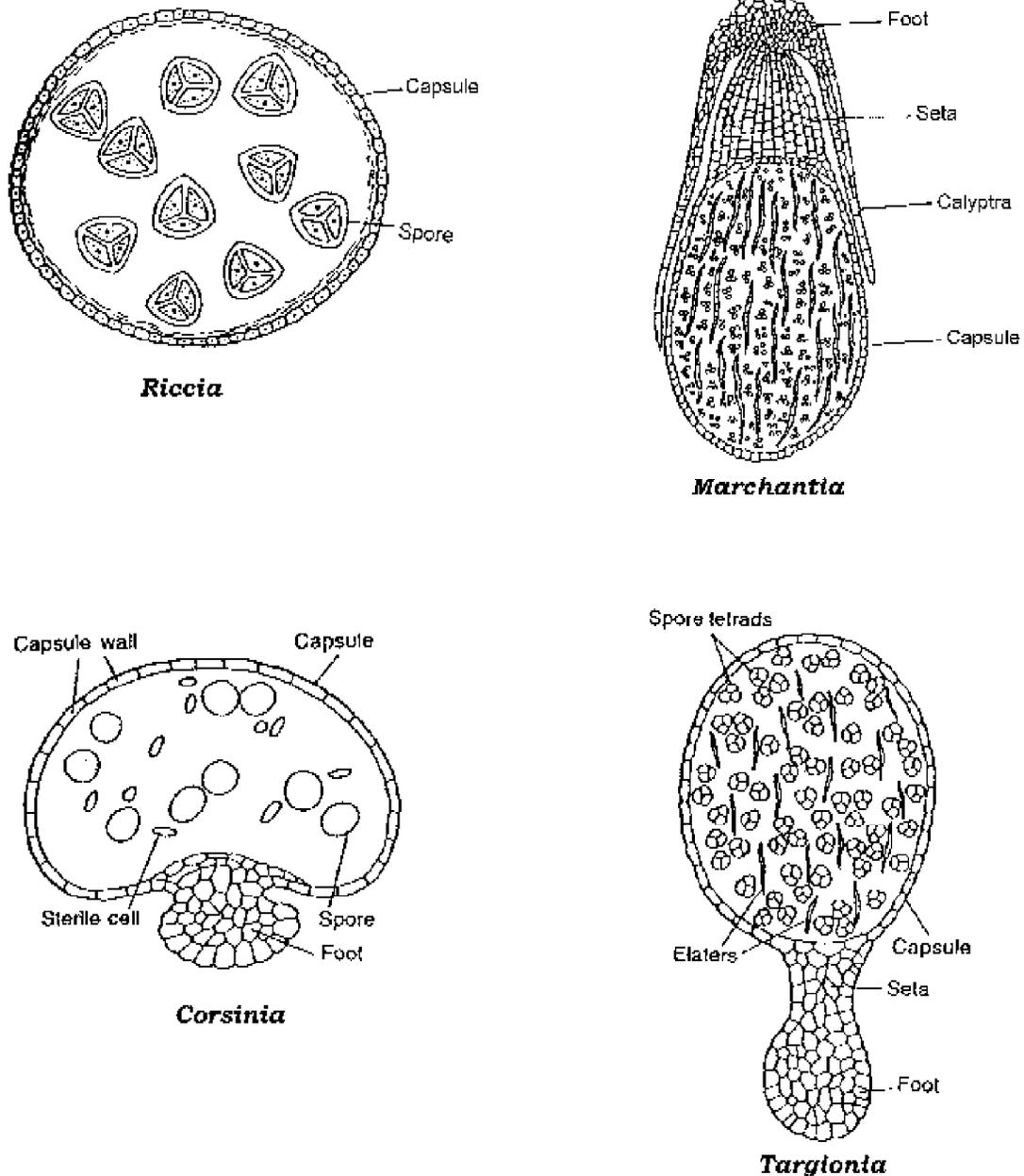
### **Fertilization -**

At maturity the antheridium ruptures at its apex liberating the sperms. At the same time the axial row of neck canal cells & ventral canal cells disorganise. A narrow canal opening to the exterior is formed. The liberated sperms swimming in a thin film of water reach the archegonium & then to egg. First one sperm to reach there fuses with the egg and zygote is formed. With the act of fertilization the gametophyte generation ends and the saprophyte generation starts.

### **Sporophyte -**

The zygote is the first cell of saprophytic generation. It produces diploid sporophytic plant body (Sporogonium) which is attached to the parent gametophyte and nourished by it. The sporogonium is concerned with the production of and dispersal of haploid spores (meiospores). The sporogonium in all the Marchantiales remains covered and thus protected by calyptra until the spores within it ripe. All the cells of sporogenous tissues may produce spores or a part of them produce sterile cells elaters. Among the lower Marchantiales, the simplest type of sporogonium is found in *Riccia* (Ricciaceae) where it is represented only by capsule. Foot & seta are absent. The sporogonium thus never projects above the surface of the thallus and remain covered by the calyptra. It consists of a peripheral layer of cells constituting the capsule wall and a central mass of spore mother cells practically all of which produce spores. The sporogonium in *Corsinia* is differentiated into a basal portion, the **foot** which is an absorbing organ and **the capsule** region concerned with spore production. There is no seta. The capsule has one cell thick jacket. All the cells of sporogenous tissue may produce mother cells or a part of them produce sterile cells or elaters. Spore mother cells differentiates into haploid spores.

The sporogonium in the higher Marchantiales (*Targionia*, *Marchantia*) has in addition a slender stalk - like structure the seta in between the foot and the capsule. With the ripening of spores the capsule is forced through the calyptra and placed in a position favorable for the dispersal of spores by wind.



**Figure - 4a.1.5 : Sporophytes of Marchantiales**

**4a.1.d Affinities of Marchantiales :**

(A Affinities with Algae Particular)

1. The plants are usually thalloid.
2. The roots are absent and replaced by filamentous rhizoids.
3. The plant possesses chloroplasts (The assimilatory region) and the mode of nutrition is autotrophic. The chloroplast pigments are common in both the group.

4. The reserve food material is true starch (made up of amylose and amylopectin).
5. The cell walls are made up of cellulose.
6. The vascular tissue (i.e., xylem & phloem) is absent.
7. Production of motile and flagellated sperms (antherozoids). The flagella are of whiplash type.
8. The dominant phase of life cycle is gametophyte.
9. Retention of the swimming habit by the sperms.
10. The early stages of development in the gametophyte of many forms are green filaments which strikingly resemble the filamentous thallus of green algae.

**(C) Affinities with pteridophytes**

1. Terrestrial habit
2. Thalloid gametophytic plant body of many marchantiales resembles gametophyte of *Equisetum*.
3. The sex organs are multicellular and protected by sterile jacket.
4. Oogamous sexual reproduction takes place.
5. Flagellated male gametes are present.
6. The presence of water is necessary for fertilization.
7. The zygote develops embryo.
8. Mitospores are completely absent.
9. The sporogonium of some forms of marchantiales resembles simple rootless and leafless sporophytes of psilophyta (eg. Horneophyton).
10. Plants exhibit distinct heterologous type of alternation of generations.

**(B) Affinities with Jungermanniales**

1. Prostrate habit and dorsiventral configuration.
2. Presence of unicellular, simple, smooth, wall rhizoids.
3. Sex - organs similar in essential respects in both.
4. The same basic chromosome complex of  $n=9$  chromosomes (Mehra).

5. Similar radial and general plan of construction of sporogonium of some forms of Marchantiales into foot, seta and capsule.

6. Similar type of elaters.

7. Presence of intercalary growth in the sporophyte.

#### ***4a.2 Jungermanniales :***

##### ***4a.2-0 Characteristic features of Jungermanniales***

1) Jungermanniales is the largest order of Hepaticopsida. It includes about 244 genera and about 9,000 species.

2) They are widely distributed.

3) Gametophytes of Jungermanniales may be of a simple thallose type or foliose but with little internal differentiation of tissues in either case.

4) The rhizoids are all smooth-walled, tuberculate rhizoids and ventral scales are often absent.

5) Growth is by single apical cells.

6) The antheridia are usually globose and borne on long stalks.

7) The development of the antheridium differs from that of the

Marchantiales in that the primary antherial cell does not undergo two centric vertical divisions at right angles to one another and consequently a quadrant of four daughter cells is not formed.

8) The neck of the archegonium is formed of five vertical rows of cells and the venter is almost as broad as the neck.

9) The sporogonium is differentiated into capsule, seta and foot, the seta becomes much elongated at maturity.

10) The Archegonium gives rise to spores and elaters.

11) The wall of the capsule is two or more celled thick.

12) The spore mother cells become deeply four lobed before the first nuclear division thus indicating the position of the four spores.

13) The mature capsule usually dehisces by splitting into four valves.

#### **4a.2-a Distribution & Habitat**

The Jungermanniales are widespread in their distribution. They occur both in the temperate and tropical regions of the world extending far north and south up to the polar regions. Combination of shade and abundant moisture is a precondition for their successful growth. The majority of the species are hygrophytic or mesophytic. They grow on damp soil, moist rocks, and bark of trees.

The order Jungermanniales consists of two sub - orders

(A) Sub - order: Metzgeriineae (Jungermanniales anacrogynae) &

(B) Sub- order: Jungermannineae (Jungermanniales acrogynae).

In the Anacrogynae, the archegonia are borne on the dorsal surface of the prostrate shoot and the apical cells are not involved in their formation. In the Acrogynae, the archegonia are borne at the apex of the shoot, the apical cell being utilized in their formation.

(A) Sub-order - ***Metzgeriineae (Jungermanniales Anacrogynae)***

This suborder has about 23 genera and 550 species. It includes the following families- Treubiaceae, Fossombroniaceae, Pelliaceae, Blasiaceae, Pallaviciniaceae, Metzgeriaceae, Riccardiaceae and Monocleaceae.

***Pellia, Riccardia, Metzgeria, Pallavicinia, Calycularia, Blasia, Fossombronia, Cryptothallus*** etc, are Indian genera. A species of *Cryptothallus* known as *C.mirabilis* is of unique interest. It is mycorrhizal in habit and fleshy thallus lacks chlorophyll.

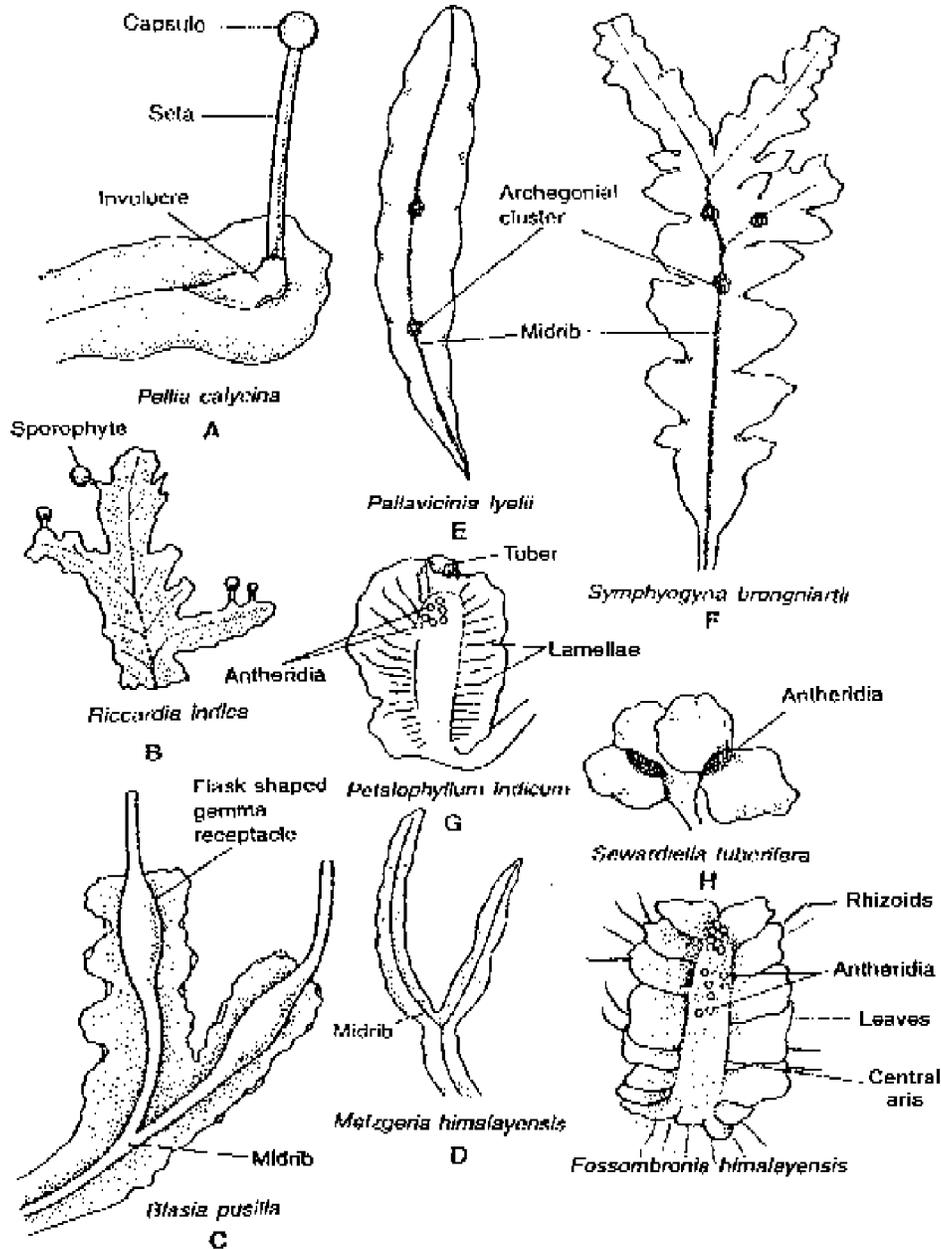
#### **4a.2-b(A) Structure**

*Morphological structure of the gametophyte of Metzgeriineae (Jungermanniales Anacrogynae)*

The plant body is gametophyte which is thin, prostrate, dorsiventral, dichotomously branched thallus as in *Pellia*. The dorsal surface of the thallus is almost smooth except the median, broad midrib. At the anterior end, each branch terminates in a median notch in which is located the growing point. *Riccardia* shows much variation in the form of the gametophyte. It may be wholly prostrate (*R. pinguis, R. indica* and others) or partially prostrate and partially erect (*R. bogotensis, R. thaxteri*). The prostrate thalli may be broad, thick and slightly

branched (*R. indica* and *R. pinguis*) or narrow and regularly or pinnately branched (*R. multifida*, *R. levieri*). In some cases there is also division of labour in the gametophytes. The lateral wings are photosynthetic organs and the main axis is mechanical & conducting organs.

The ventral surface of the prostrate thallus bears smooth walled rhizoids and mucilage hairs. Tuberculate rhizoids & ventral scales are absent. Young rhizoids may contain chloroplasts, old rhizoids lack them.

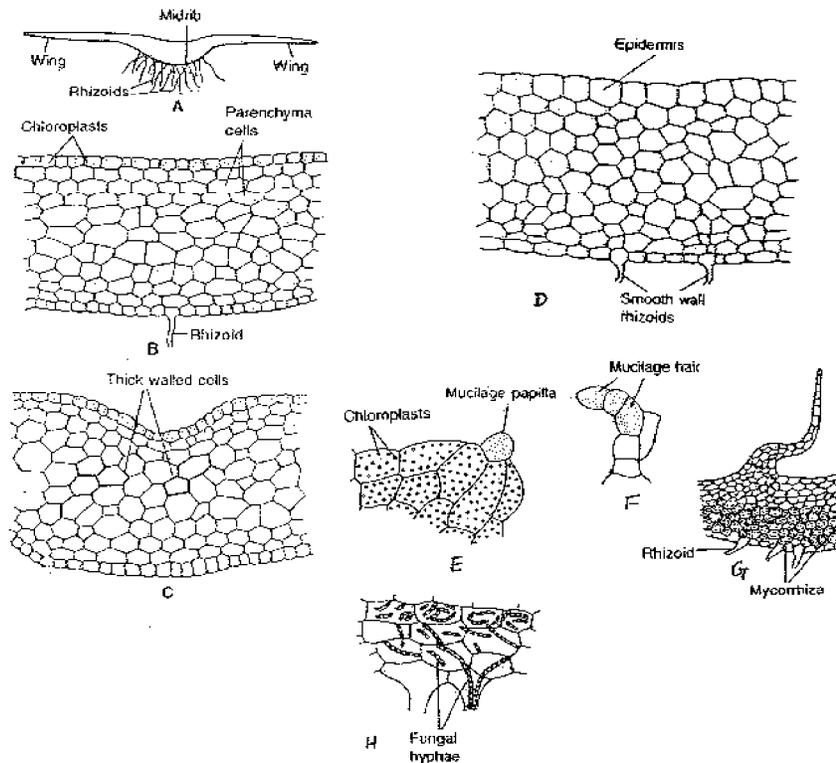


**Figure - 4a.2.1 : Metzgeriales. Some of the important genera (A-D, and G-H after Kashyap; E-F after Haupt).**

**Anatomy** - In *Pellia* the internal structure of the thallus is very simple, and mainly consists of parenchymatous cells. The outline of the transverse section of the thallus shows a many-layered thick midrib, projecting below, and merging gradually with the thin marginal region, single layer of cells in thickness. The cells of the wings and the upper layer of the midrib contain abundant chloroplasts, whereas the lower cells of the midrib contains very few or no chloroplasts, but starch grains are present in all the cells of the thallus. In some species yellow or brown thickened band run vertically and transversely in thallus.

Species of *Riccardia* with wholly prostrate gametophyte devoid of a midrib, have thalli which are wholly thicker along the midrib. There is no internal differentiation. All the cells contain chloroplasts at sometime. From the lower surface, smooth walled unicellular rhizoids arise.

A section through the posterior part of the older thalli of *F. himalayensis* shows abundant mycorrhiza. According to Pande *et al.*(1954) infection probably takes place through the rhizoids. The actively growing regions of the thallus invariably do not show any fungal infection.

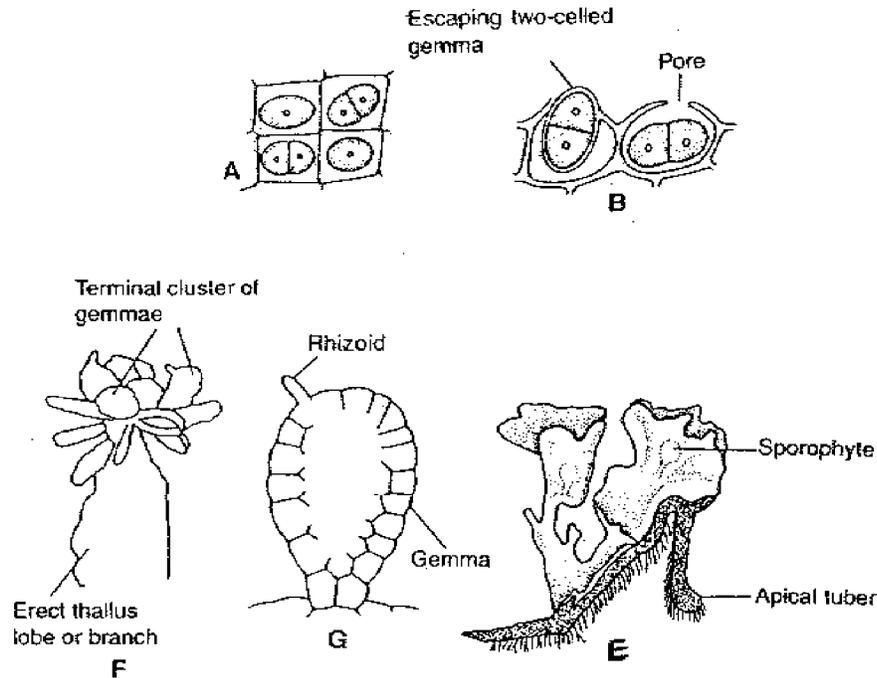


**Figure - 4a.2.2 :** (A-C) *Pellia* sp. structure of thallus (A) structure of outline sketch of V.S. of thallus of *P. epiphylla* (B) T.S. of thallus of *P. caespitosa* (C) T.S. of thallus of *P. epiphylla*; (D) T.S. of thallus of *Riccardia*; (E-h) *Fossombronina himalayensis* (E) Marginal leaf cell bearing a mucilage papilla and containing chloroplast (F) Mucilage hair (G) Thallus in section showing structure are mycorrhiza in the ventral region of midrib.

#### 4a.2-c(A) Reproduction

Members of Jungermanniales anacrogynae reproduce vegetative as well as sexually.

**Vegetative reproduction** - In favourable condition it takes place by fragmentation, adventitious branches, gemmae & tubers.



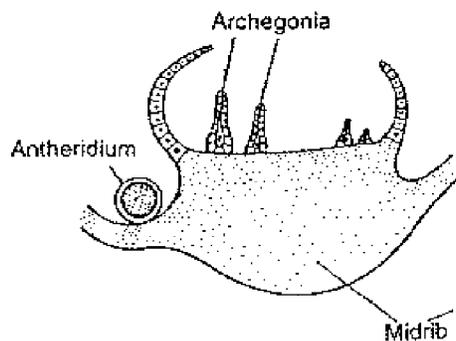
**Figure - 4a.2.3 : Different methods of vegetative reproduction in metzgeriales**

**(A-B) Formation & release of gemma in Riccardia sp. (C) Clusters of gemmae formed at the tip of a thallus lobe in Metzgeria tritriculosa & (D) bearing an apical tubes.**

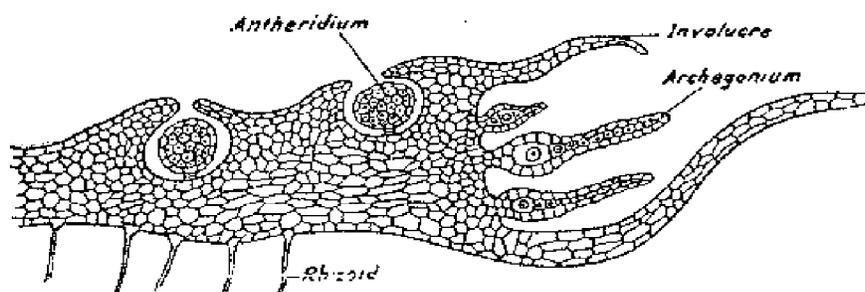
**Sexual reproduction** - It is of oogamous type. The sex organs are antheridia and archegonia. Some species are monoecious or some are dioecious. The antheridia in thallose forms may occur singly or scattered, in rows (*Pellia*) or in groups (*Calycularia crispula*) on the dorsal surface of the thallus or its lobes (branches). The lobes are specialized short branches which arise ventrally in Metzgeria but they arise as side branches in *Riccardia pinguis*. Unlike *Marchantia* the sexual branches are not specially modified. The sex organs are thus never borne on stalked receptacles. In *Pezzia* and *Riccardia* the antheridia occur in sunken pits formed by the upward growth of adjacent vegetative tissue. This provides efficient protection and allows violent discharge of sperms. The

antheridium is differentiated into globose sac - like body & short multicellular stalk. The wall of antheridial body is one cell thick and encloses androcyte mother cells which forms sperms. The sperms are biflagellate and they are larger in size with more coils.

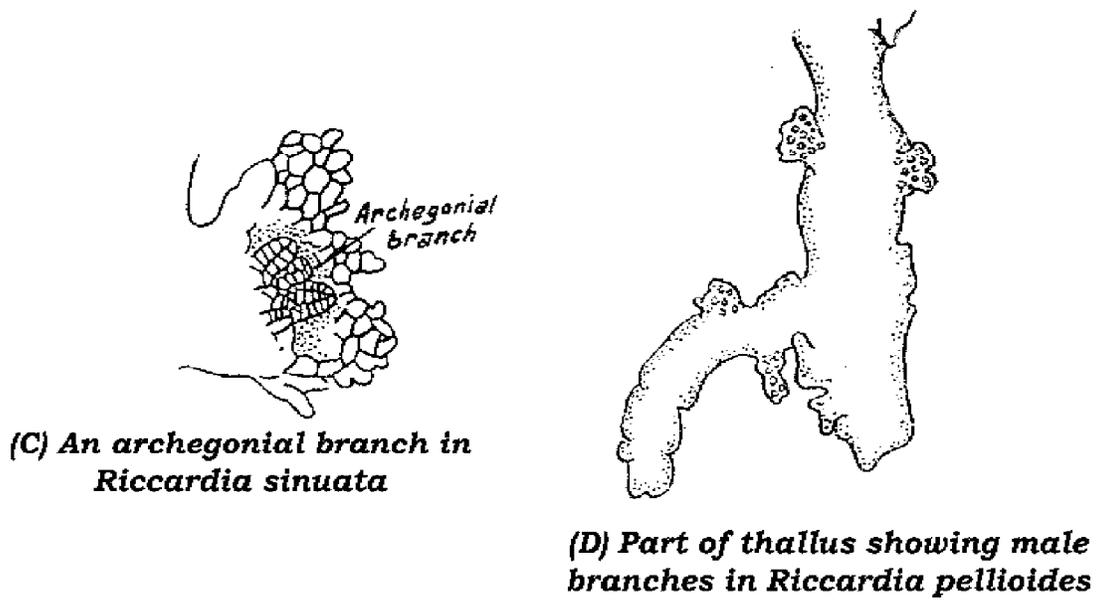
The archegonia in the thallose Metzgerineae occur singly (*Riccardia*) or in groups (*Pazlavicinia lyelii*) on the upper surface of thallus or its lobes but never on stalked receptacles. They originate behind the apical cell from the segments derived from the latter but the apical cell itself never develops into an archegonium. The Metzgerineae is thus anacrogynous. In a leafy form *Fossombronia* they occur in small groups laterally on the central axis. They originate near the growing point at the bases of young leaves. The archegonia have distinct stalks. The archegonium has a neck consisting of five vertical rows of neck cells and a Venter slightly broader than neck. The archegonial groups in some of thallose Metzgerineae is generally surrounded by an envelope known as the involucre or pericaetium formed as a result of the upward to growth of the adjacent thallus tissue.



**(A) Monoecious thallus in section bearing both antheridia and archegonia in *Fossombronia Limalayensis***



**(B) Monoecious thallus through sex organs in *Pellia epiphylla***



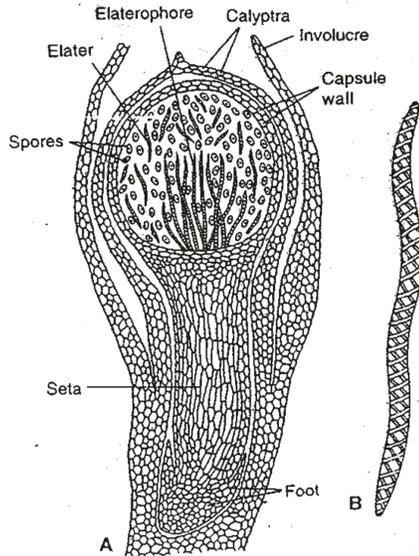
**Figure - 4a.2.4 : (A-D) Showing sex organs in Metzgeriales**

**Fertilization:** Excepting the egg, the axial row of cells in mature archegonium disintergrates. A passage leading to the egg in the venter results. The sperms are liberated from the antheridium. They swim to archegonia and enter the open archegonial neck and finally reach to the egg. One of them probably the first to reach there loses its flagella and penetrates the egg & fuses with it. The fertilized egg secretes a wall around it and is now called the zygote or oospore.

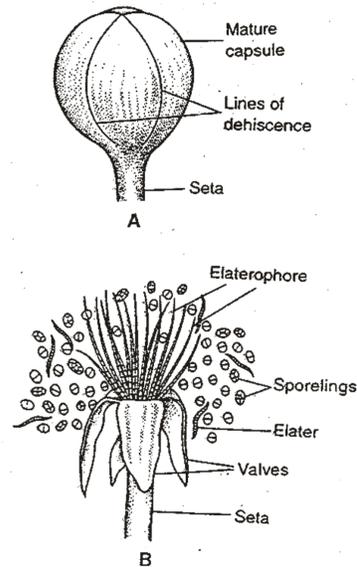
**Sporophyte** - The zygote divides & redivides to form diploid sporophyte. The sporophyte in the Metzgerineae is differentiated into **foot**, **seta** and **capsule**. The foot is the absorbing and anchoring swollen base burrowing deep in the gametophyte tissue. It absorbs nutrients form the gametophyte. The seta is long stalk like transparent & fragile.

The dark mature capsule is variable in form. It is globose in *Pellia* and *Fossombronia* but ovoid cylindrical in *Blasia* and *Riccardia*. The capsule wall is two or more layers of cells thick. The cells of the capsule wall develop annular or rod- like thickening on their walls. The sporogeous tissue within the capsule wall forms spore mother cells & sterile cells. There is no columella. The spore mother cells usually become four-lobed prior to sporogenesis. The sterile cells get metamorphosed into elaters. In some genera a tuft of fixed elaters occurs at the base of the capsule (*Pellia*) or at the apex, (*Riccardia*) in addition to the free

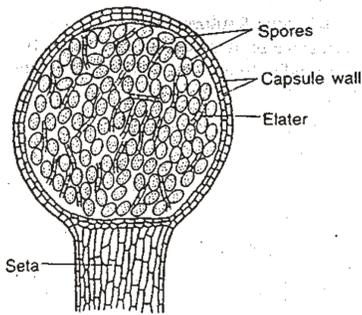
elaters which occur intermixed with the spores. Mature capsule splits by four - valves usually to the base but in *Cryptotillius* the valves fail to separate distally. In *Pellia* the tuft of fixed elaters usually called elaterophore stands at the base of the dehiscent capsule whereas in *Riccardia* the fixed elaters remain attached to the tip of each valves and stand nearly erect.



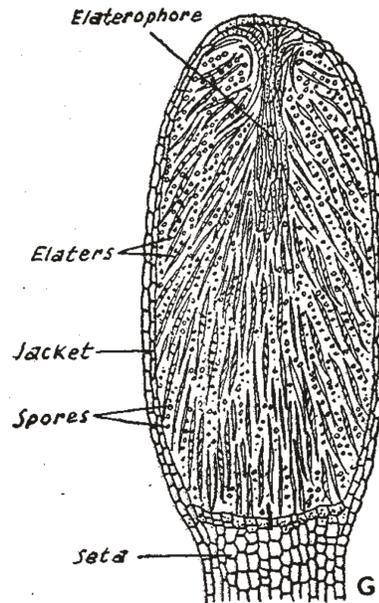
*Pellia* sp. (A) L.S. of a mature spongonium  
(B) Elater with a double spiral band of thickening



*Pellia* sp. (A) ripe capsule showing line



sporophyte of *Fossombronia* sp.



Mature capsule of *Riccardia pinguis*

Figure - 4a.2.5 : Showing sporophyta of different genera

### **(B) Sub-order: Jungermanninea (Jungermanniales acrogynae)**

The Jungermanniales comprise 80% of the Hepaticopsida. There are about 220 genera and 8500 species. Evans (1938) divides this sub-order into 17 families. The well known genera are *Porella* (*Madotheca*) and *Frullania* which belongs to the families Porellaceae (*Madothecaceae*) and Frullaniaceae respectively.

#### **4a.2-b(B) Structure of gametophyte of Jungermanninea (Jungermanniales acrogynae)**

The gametophyte is a leafy thallus (foliose liverworts) with few exceptions (*Herberta* and *Anthelia*) it is prostrate to decumbent in habit and dorsiventral in configuration. The plant body is differentiated into a central axis or stem bearing leaf like appendages. The stem is generally branched. The branching is monopodial and never dichotomous. The branch arises besides the leaf and is never axillary. The thallus is usually attached to the substratum by rhizoids which are simple, unicellular and smooth walled. The ventral scales and tuberculate rhizoids are absent. The whole thallus consists of uniform green parenchyma cells. Air chambers and air pores are absent.

**Leaves-** The central axis and its branches bear leaf-like expansions. The leaf is invariably without a midrib and consists of a single layer of cells containing chloroplast. Majority of the acrogynous Jungermanniales are anisophyllous. They bear leaves of two sizes & shapes arranged in a spiral manner in three rows on the stems. Two of these rows consist of large dorsal leaves placed laterally one on each side of the stem. The third row consists of small more or less reduced ventral leaves usually called the amphigastria or underleaves. *Porella*, *Frullania* etc. are common anisophyllous Jungermanniales. In some genera e.g. *Herberta*, *Anthelia* the erect gametophyte is radially symmetrical. The erect stem bears three rows of similar, radially arranged leaves (isophyllous) and each is cleft to the base into two tapering lobes.

The dorsal or lateral leaves are close set on the central axis and its branches overlap. The overlapping is of two types, **succubous and incubous**. In the former, the posterior margin of each leaf overlies the forward edge of the next older leaf on the same side in dorso-lateral view.

Cephalozia, Lophocolea, Lophozia etc. are the common examples of succubous arrangement. The overlapping is reversed in the incubous arrangement

of leaves. Apical growth always takes place by means of a single apical cell which is pyramidal in shape.

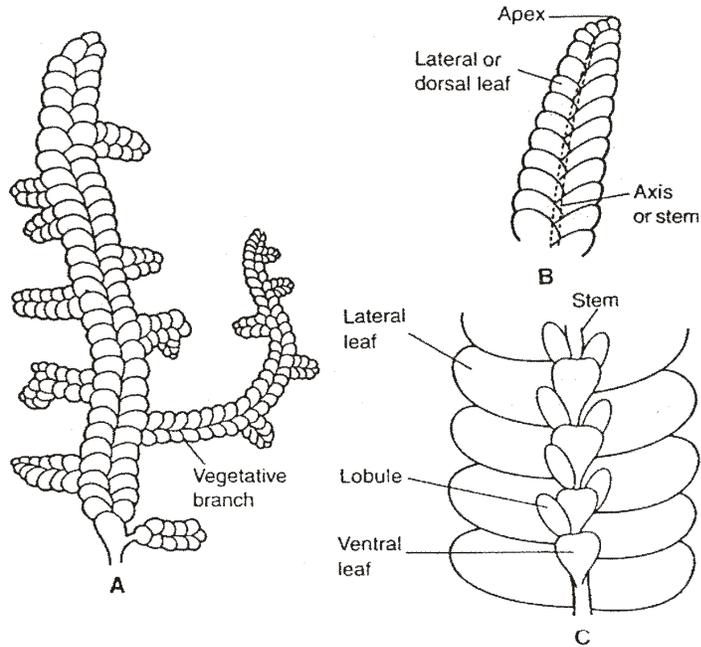


Figure - 4a.2.6 : (A-C) *Parella* sp. A. par of the plant showing habit, a branch seen from the upper surface showing incubous arrangement of leaves. C. ventral view of B. showing ventral leaves and lobules of dorsal leaves.

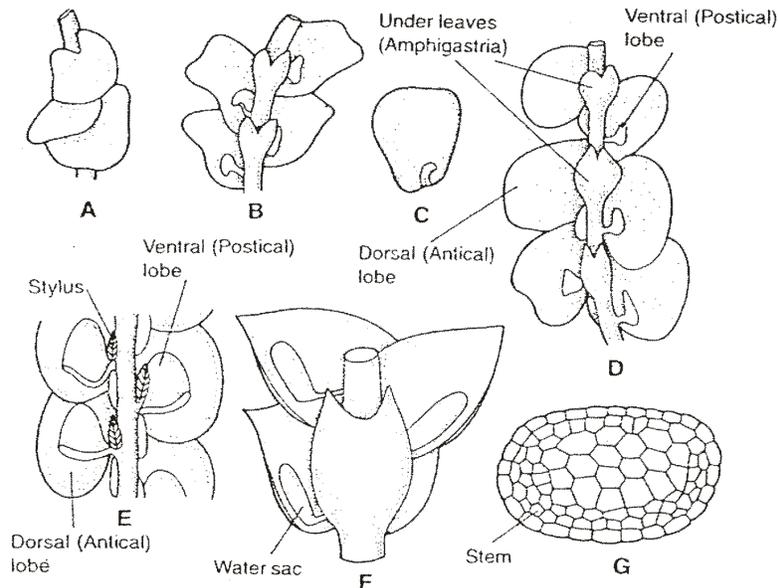


Figure - 4a.2.7 : (A - G) *Frullania* A. part of a shoot of *F. Squarrosa* form above; B, part of a shoot of *F. squarros* as seen form below; C. dorsal leaf of *F. squarrosa* with an appendage; D, shoot of *F, musicola* (ventral view) showing water sacson lateral leaves; G, C.S. of *F. dilatata* (A-D after Kashyap; E and G after Caver and F after Verdoon).

#### 4a.2-c(B) Reproduction

In acrogynae Jungermanniales, reproduction takes place by both vegetative as well as sexual means.

##### **Vegetative reproduction**

It takes place by fragmentation, gemmae, leafy propagula, etc. several species of leafy forms withstand drying for a considerable period without apparent injury. With the return of favorable conditions the apparently dried up specimens resume growth and become green.

##### **Sexual reproduction**

Some Acrogynae (Jungermanniales) are monoecious and some dioecious. The monoecious forms may be autoicous (autoecious) or paroicous (parioecious). In the autoicous species, antheridia and archegonia occur on different branches of the same plant (*Cephalozia pleniceps*). Monoecious paroicous species have both kinds of sex organs close to one another on the same branch (*Cephalozia rubra*). The sex organs are superficial and projecting.

**Antheridia** - The antheridia occur in groups of 2 - 5, sometimes singly in the axils of modified leaves called perigynal bracts, on ordinary branches (*Lophazia*, *Nardia*) or specially modified antheridia branches. The mature antheridium is globose in form and is raised on a long stalk. The antheridial wall which encloses the sperm mother cells is usually one cell layer thick in the upper part and 2- 3 cells thick in the basal part.

**Archeonia** - They occur singly or in a small group, and are apical in position. The apical cell itself is involved in the formation of the archegonium and so they are called acrogynous. The archegonia are surrounded and thus protected by a special envelope known as the perianth. It is formed by the lateral fusion of 2 or 3 terminal perichaetial bracts. In some species there is in addition, another envelope external to the perianth. It is known as the involucre. The shape of perianth varies in different species. The mature archegonium is stalked. The archegonial neck consists of five vertical rows of neck cells. They enclose neck canal. The basal portion of archegonium is venter containing a small egg & ventral canal cell above it.

**Fertilization** - Dehiscence of sex organs and fertilization takes place in the presence of water provided by rain or dew. The sperms from the dehiscent antheridia swim and reach to the archegonia and finally to the egg. One of them

probably the first to reach the fuses with egg and form zygote. The zygote after division & redivision forms sporophyte.

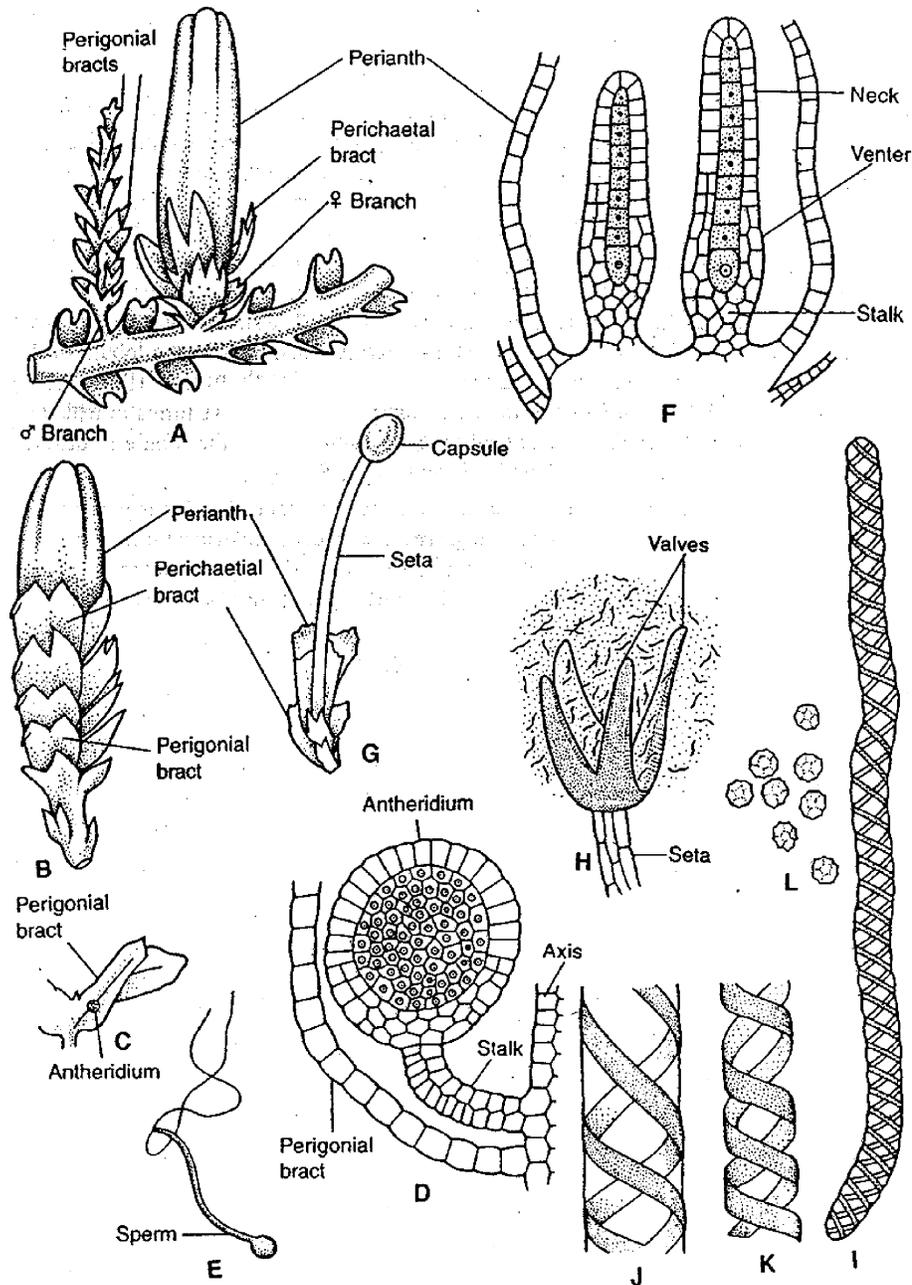


Figure - 4a.2.8 : (A - 1); Jungermanniaceae. A *Cephalozia pleniceps*. monoecious autoicous species; B. *Cephaloziella rubella*, monoecious paricous species; C, portion of antheridial branch *Diplophyllum albicans* with an antheridium in the axil of a perigonal bract; D, I.S. antheridium of *Porella* ; E, Liberated sperm of *Porells*; F, L.S. perianth of a leafyliverwort *Frullania*; G, apical region of a female branch of *Lophocolea heterophylla* with a perianth and the sporogonium; H-L, *Cephalozia bicuspidata*; H, dehisced empty capsule; I, elater with a ddouble spiral band of thickening; J, part of an elater filled with water ; K, part of an elater after partial evaporation of contained water; I, a few spores (A-B after Schuster, C and G after Watson. H - I after Ingold).

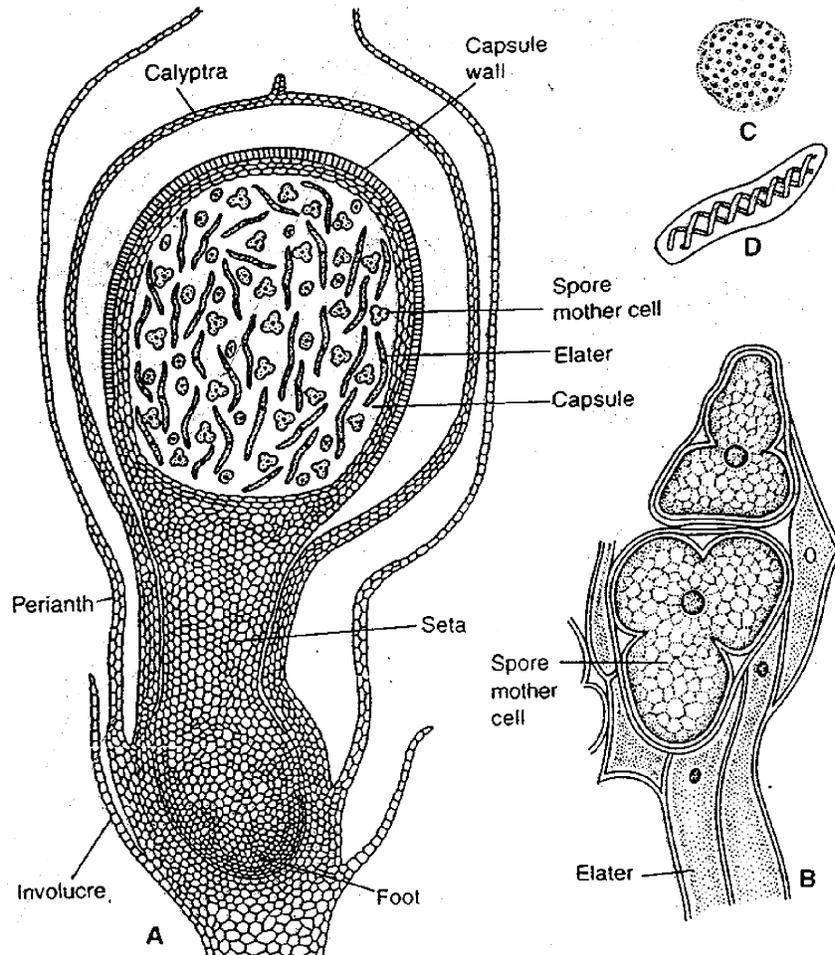


Figure - 4a.2.9 : (A - 1); *Porella sp.* A, I.S. through a nearly mature sporogonium showing structure; B, portion of capsule enlarged to show the lobed spore mother cells and elater cells; C, mature spore; D, an elater with a double spiral band (B after Campbell, C - D after Kashyap).

Sporophyte: The terminal sporophyte is differentiated into the foot, the long seta and ovoid capsule. The ripe **capsule** contains spores and free **elaters**. There is no elaterophore except in *Gotschea*. The spore mother cells are conspicuously four - lobed and dehiscence is by means of 4 valves. The capsule wall is two or more cell layer in thickness. The cells of the inner layer generally develop spiral thickening.

#### 4a.2-d(B) Affinities of *Jungermanniales*

The order *Jungermanniales* includes members diverse in form. There are genera such as *Pellia* in which gametophyte is a simple, dorsiventral, flat, green

dichotomously branched thallus resembling that of *Riccia* or *Marchantia* in external appearance or even simpler. Beside the strictly thallose forms, the order comprises genera which show foliar development of a rudimentary type. Typical example of this type is Fossombronia. The Jungermanniales exclusively have gametophyte with a sharp distinction into stem and leaves and for this reason the Jungermanniales are often called leafy liverworts. The tempting hypothesis that the leafy liverworts are transitional to the mosses in the ascending series. There has been much argument whether the above series, represents generic relationship in upward direction or in downward direction. The consensus of opinion at present regard the leafy liverworts as primitive and derive the thallus forms like Pellia and Sewardiella from them. The Jungermanniales resemble the Marchantiales in the following features

1. Prostrate habit and dorsiventral configuration.
2. Presence of unicellular, simple, smooth - walled rhizoids.
3. Sex organs similar in essential respects in both, differing only in details.
4. Presence of perianth in both. It is widespread in Jungermanniales and is represented in some of the Marchantiales.
5. The same basic chromosome complex of  $n=9$  chromosomes (Mehra).
6. Similar radial and general plan of construction of the sporogonium into foot, seta and capsules in both.
7. Similar type of elaters,
8. Presence of intercalary growth in the sporophytes of both.
9. Absence of ventilated photosynthetic tissue in both so that the sporophyte is physiologically dependent on the gametophyte.

#### **4a.3 Questions for Exercise**

##### **Long Answer type**

1. Describe the salient features of the order Marchantiales and mention its affinities.
2. Discuss the external and internal structure of the gametophyte of the Marchantiales.
3. Describe the anatomy and reproduction in Marchantiales.

4. Give a general account of *Jungermanniales*. Discuss its affinities.
5. Describe the salient features of *Jungermanniales acrogynae*. How does it differ from *Metzgerineae* (*Jungermanniales Anacrogynae*).

**Short Answer type :**

Write short notes on

1. Sporophyte in *Marchantiales*
2. Important features of *Marchantiales*
3. Sex organs in *Metzgerineae*
4. Sporophyte of *Jungermannineae*
5. Gametophyte of *Metzgerineae*

**4a.4 Suggested readings**

1. *Bryophyte* by B.R. Vashishta, A. K. Sinha, Adarsh Kumar  
(S.Chand & Company Ltd.)
2. *Bryophytes: Morphology, Growth and differentiation* by Dr.(Mrs.)Prempuri  
(A TMA RAM & SONS)
3. *An Introduction to Embryophyta: Bryophyta* by N. S. Parihar (Central Book Depot).



