ANTHOCEROS

CLASSIFICATION

- KINGDOM : Plantae
- DIVISION: Anthocerotophyta
- CLASS: Anthocerotopsida
- ORDER: Anthocerotales
- FAMILY: Anthocerotaceae
- GENUS: *Anthoceros*

Gametophytic Phase of Anthoceros:

(i) External Features:

The gametophytic plant body is thalloid, dorsiventral, prostrate, dark green in colour with a tendency towards dichotomous branching. Such branching results into an orbicular or semi orbicular rosette like appearance of the thallus.

The thallus is bilobed (A. himalayensis, Fig. 1 A) or pinnately branched (A. hallii) or spongy with large number of sub-spherical spongy bodies like a gemma (A. gemmulosus fig. 1 C) or raised on a thick vertical stalk like structure (A. erectus, fig 1. B).

Dorsal Surface:

The dorsal surface of the thallus may be smooth (A. laevis) or velvety because of the presence of several lobed lamellae (A. crispulus) or rough with spines and ridges (A. fusiformis). It is shining, thick in the middle and without a distinct mid rib (Fig. 1 D).

Ventral Surface:

The ventral surface bears many unicellular, smooth-walled rhizoids (Fig. 1 E, F). Their main function is to anchor the thallus on the substratum and to absorb water and mineral nutrients from the soil. Tuberculated rhizoids, scales or mucilaginous hairs are absent. Many small, opaque, rounded, thickened dark bluish green spots can be seen on the ventral surface. These are the mucilage cavities filled with Nostoc colonies.

In the month of September and October the mature thalli have erect, elongated and cylindrical sporogonia. These are horn like and arise in clusters. Each sporogonium is surrounded by a sheath like structure on its base. It is called involucre (Fig. 1 D).

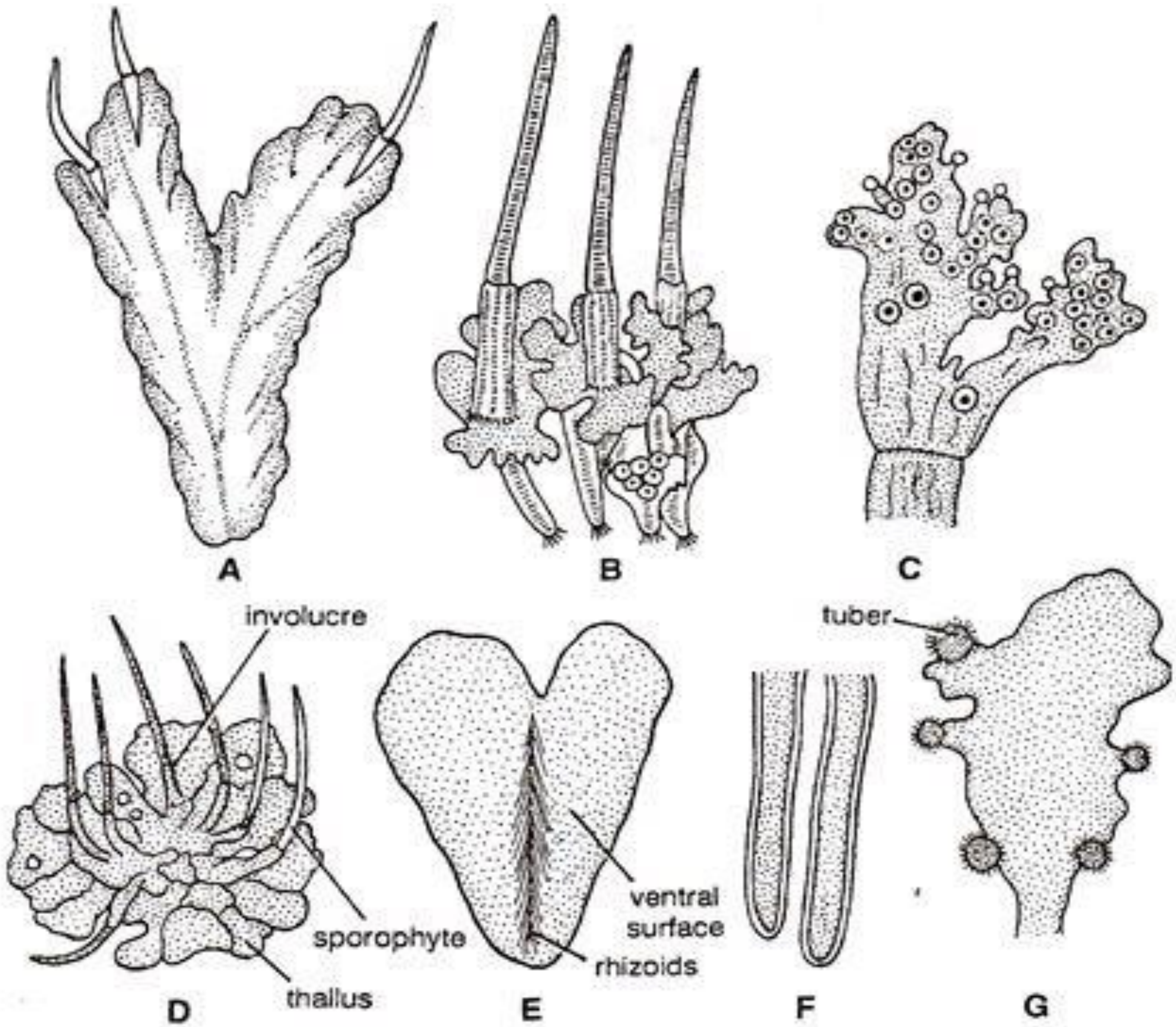


Fig. 1. (A-F). *Anthoceros.* External features (A) *A. himalayensis*, (B) *A. erectus*, (C) *A. gemmulosus*, (D) *A. crispulus* (dorsal surface), (E) Ventral surface, (F) Smooth–walled rhizoids, (G) Thallus with tubers.

(ii) Internal Structure:

The vertical transverse section (V. T. S.) of the thallus shows a very simple structure. It lacks any zonation (Fig. 2 A, B). It is uniformly composed of thin walled parenchymatous cells. The thickness of the middle region varies in different species.

It is 6-8 cells thick in A. laevis, 8-10 cells thick in A. punctatus and 30-40 cells thick in A. crispulus. The outer most layer is upper epidermis. The epidermal cells are regularly arranged, smaller in size and have large lens shaped chloroplasts. In A. hallii the epidermal layer is not distinguishable.

Each cell of the thallus contains a single large discoid or oval shaped chloroplast. Each chloroplast encloses a single, large, conspicuous body called pyrenoid, a characteristic feature of class Anthocerotopsida (Fig. 2 C, D). 25-300 disc to spindle shaped bodies aggregate to form pyrenoid.

The number of chloroplasts per cell also varies in different species. In A. personi each cell has two chloroplasts and in A. hallii the number may be even four. The nucleus lies in the close vicinity of the chloroplast near the pyrenoid (Fig. 2 D). Sometimes the chloroplast enfolds

The air chambers and air pores are absent in Anthoceros. However, in a few species intercellular cavities are present on the lower surface of the thallus. These cavities are formed due to break down of the cells (schizogenous).

The cavities are filled with mucilage and are called mucilage cavities. These cavities open on the ventral surface through stoma like slits or pores called slime pores (Fig. 2 B). Each slime pore has two guard cells with thin walls (Fig. 2 F). The guard cells are non-functional and do not control the size of the pore.

The pore remains completely open. These pores are formed by the partial separation of two adjacent cells. The slime pores represent the vestigial remnants of a previously existing aerating system. With the maturity of the thallus the mucilage in the cavities dries out.

It results in the formation of air filled cavities. The blue green algae Nostoc invades these air cavities through slime pores and form a colony in these cavities. The presence of Nostoc colonies in the thallus of Anthoceros is beneficial for the growth of gametophyte is not definitely known.

Pierce (1906) assumed that the thalli without Nostoc grow better than the ones containing the endophytic algae. However, according to Rodgers and Stewart (1977) it is a symbiotic association.

The thallus supplies carbohydrates to the Nostoc and the latter, in turn, adds to nitrate nutrients by fixing atmospheric nitrogen. The lowermost cell layer is lower epidermis. Some cells of the lower epidermis extend to form the smooth-walled rhizoids (Fig. 2 B).

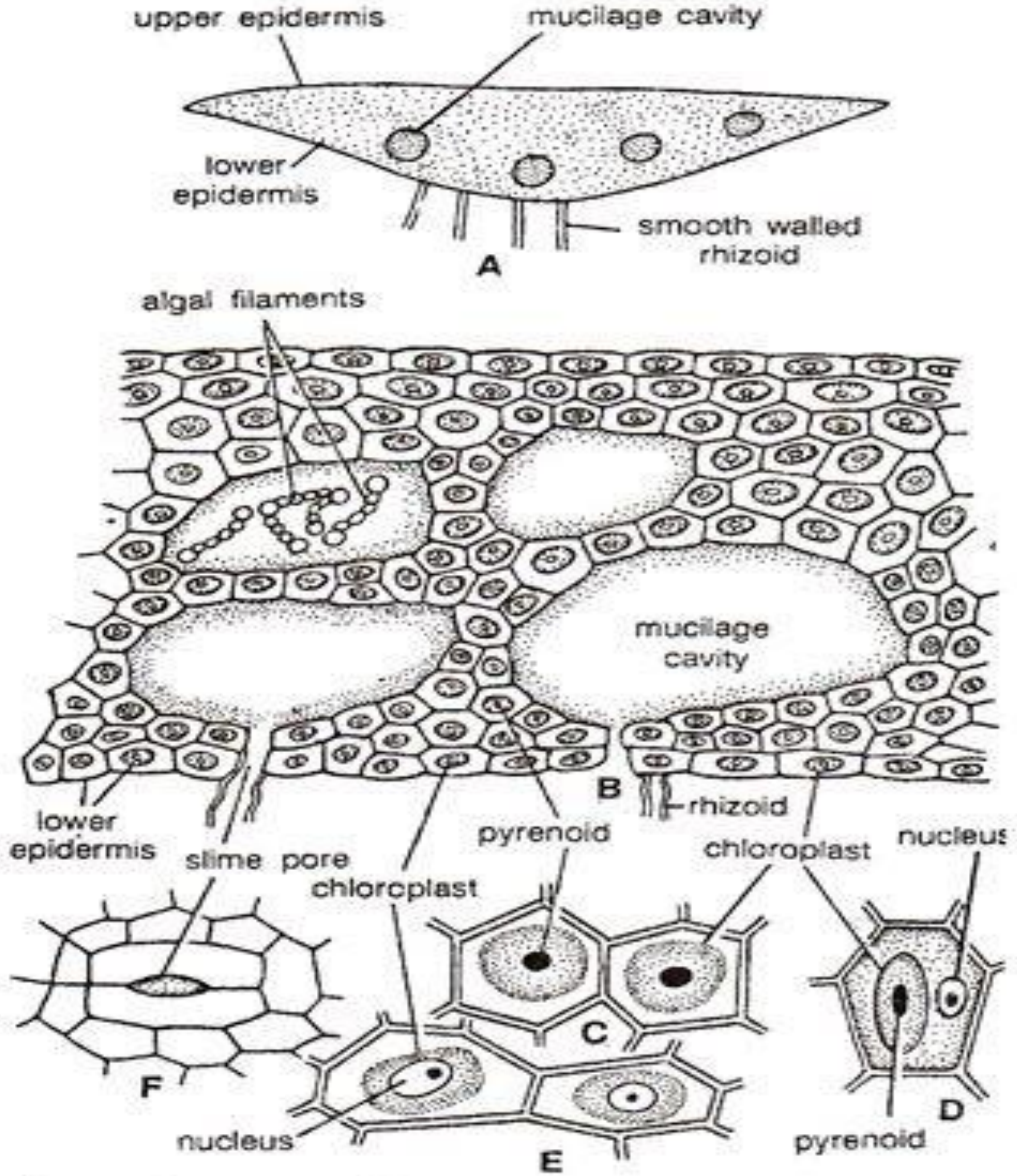


Fig. 2. (A-F). *Antheceros.* Internal structure of the thallus. (A) Vertical transverse section (V.T.S.) of thallus (diagrammatic), (B) V.T.S. of thallus (a part cellular), (C) Cells showing chloroplast and pyrenoid, (D) cells showing chloroplast, pyreroid and nucleus, (E) Parenchymatous cells with chloroplast and nucleus, (F) Surface view of slime pore.

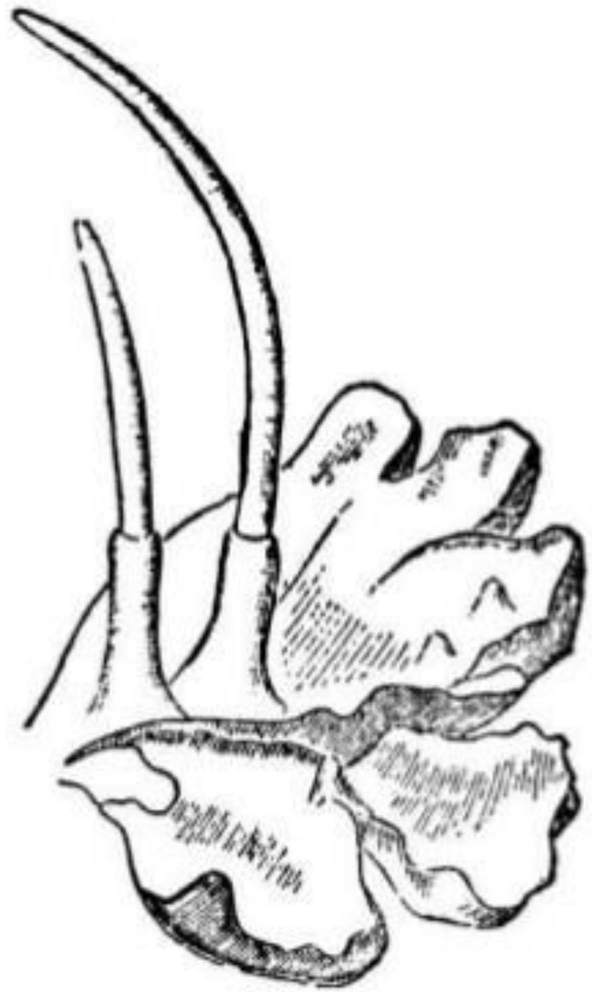
VEGETATIVE REPRODUCTION

- It takes place by the following methods:

- Progressive death and decay of thallus.
- By tubers.
- By Gemmae.
- By persistent growing apices.

Death and decay of thallus

- Not a very common method. More common in Liverworts.
- Part of lobes form a new gametophyte.



BY TUBERS

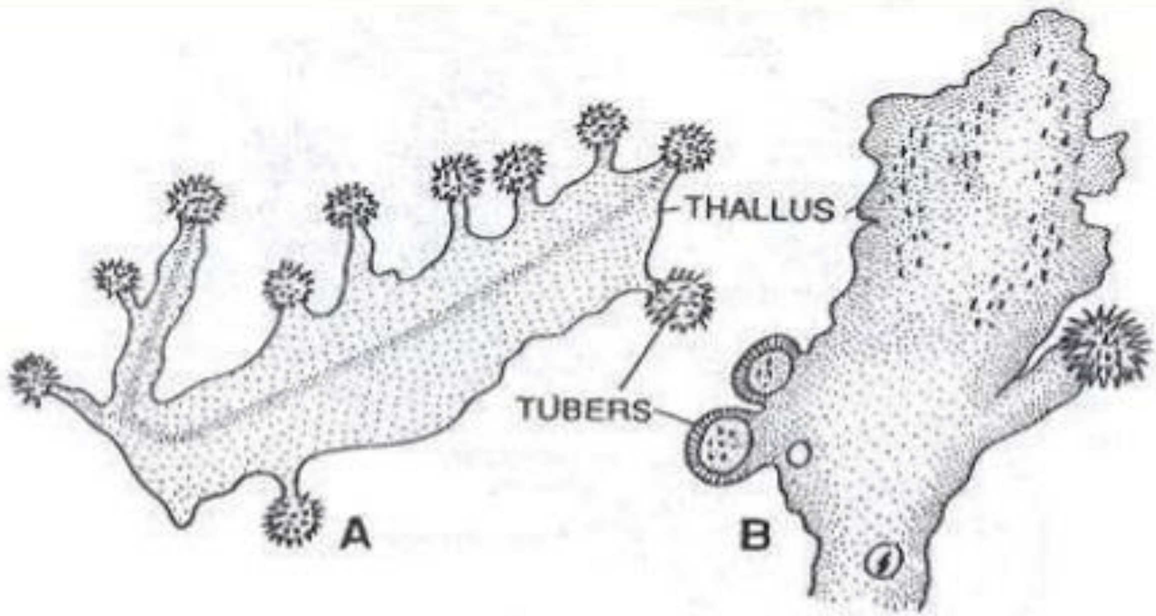
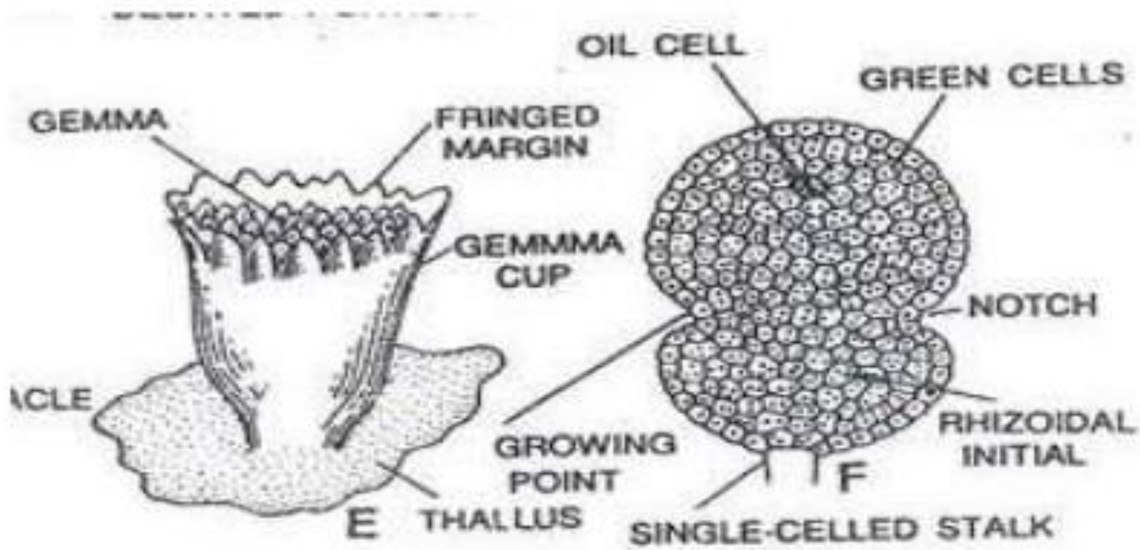


Fig. 22.4. *Anthoceros* sp. Vegetative reproduction. A, thallus of *A. himalayensis* with tubers; B, thallus of *A. laevis* with tubers.

- Tubers have an outer protective corky layer and resist extreme desiccation. They remain alive even after the death of the thallus. In sufficient moisture, they germinate and give rise to new plant.

By Gemmae



- Some species like A. glandulosus , A. formaosae and A. fusiformis bear stalked structures on dorsal surface called called gemmae. On separation from parent thallus they give rise to new plants.

By persistent growing apices.

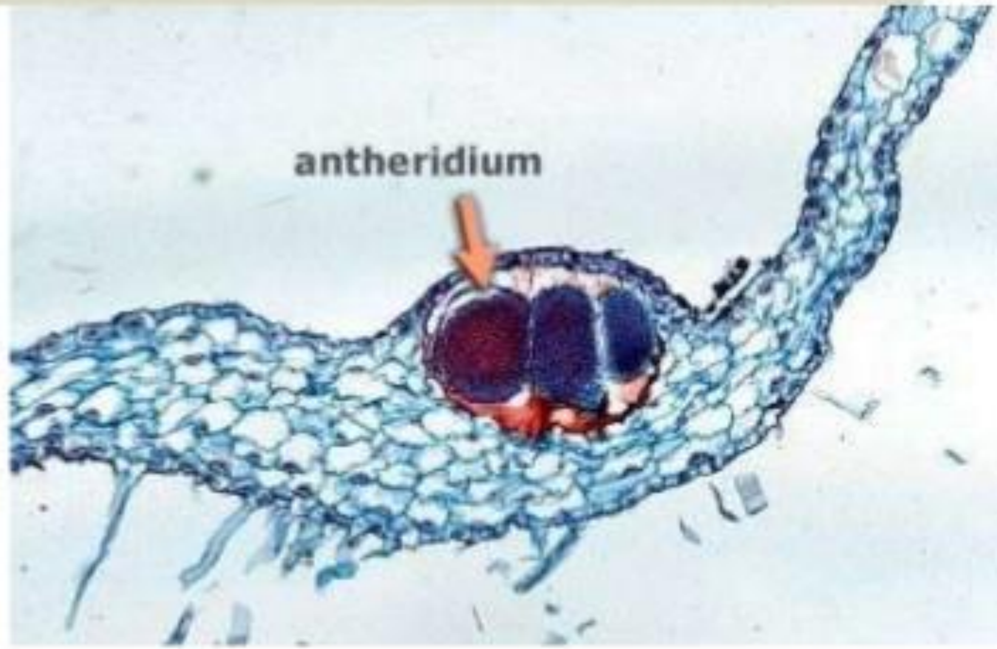
- Species like A. pearsoni and A. fusiformis employ this method.
- Mostly in areas where summer season is very dry.
- All parts of thallus except apical regions become dry. These Apices later after period of dormancy for new plant.

SEXUAL REPRODUCTION

ANTHERIDIA

- They occur endogenously on dorsal surface in a closed cavity called antheridial chambers.

- They enclose mass of androcytes which mature into antherozoids.



Antheridium after maturation

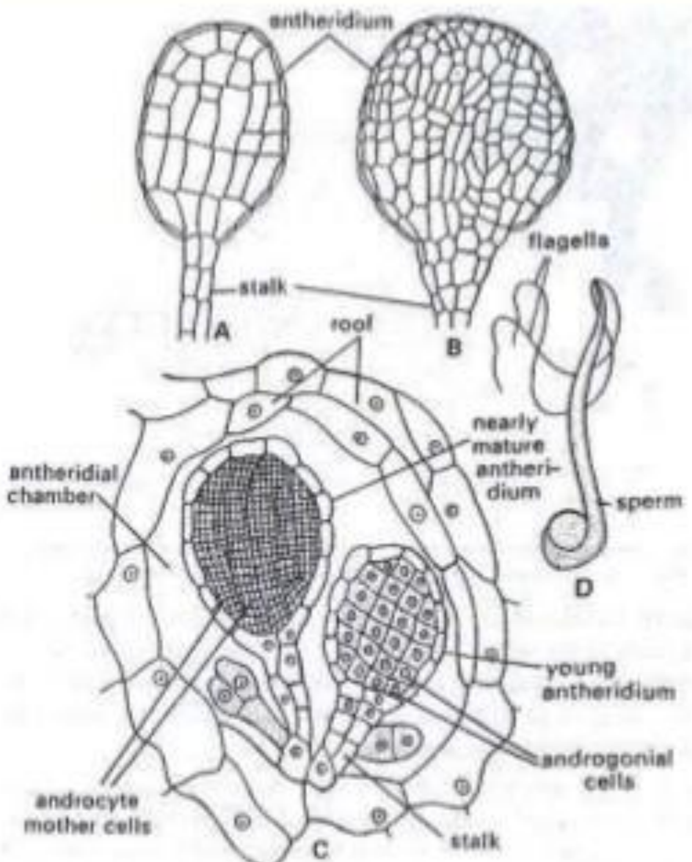


Fig. 22.6. *Anthoceros* sp. Male sex organs. A and B, stalked mature antheridia of *A. crispulus* anc *laevis* respectively; C, young and mature antheridia inside the antheridial chamber, secondary bud antheridia are seen on the stalks of primary antheridia; D, biflagellate sperm or antherozoid.

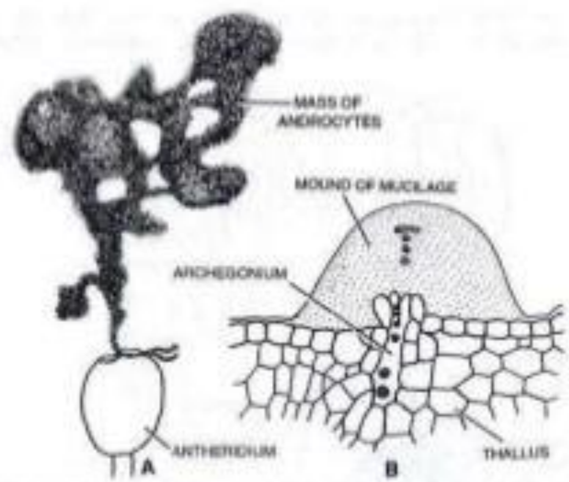


Fig. 22.7. *Anthoceros laevis*. A, antheridium extruding mass of androcytes; B, archegonium showing extrusion of neck canal cells and mucilage mound (After Proskauer).

Antherozoids

- The antherozoid is spindle like and biciliate.
- The cilia are attached to the anterior end of the body.
- The antherozoids swim in the water by the lashing moment of their flagella.

DEVELOPMENT OF ARCHEGONIUM

The development of archegonium begins from a single superficial cell. This cell becomes prominent and acts as archegonial initial.

The archegonial initial first divides vertically, producing three jacket initials which surround an axial cell.

The axial cell divides transversely, producing a cover initial and a central cell. Thereafter, the central cell divides by a transverse wall, giving rise to a primary canal cell and a primary venter cell.

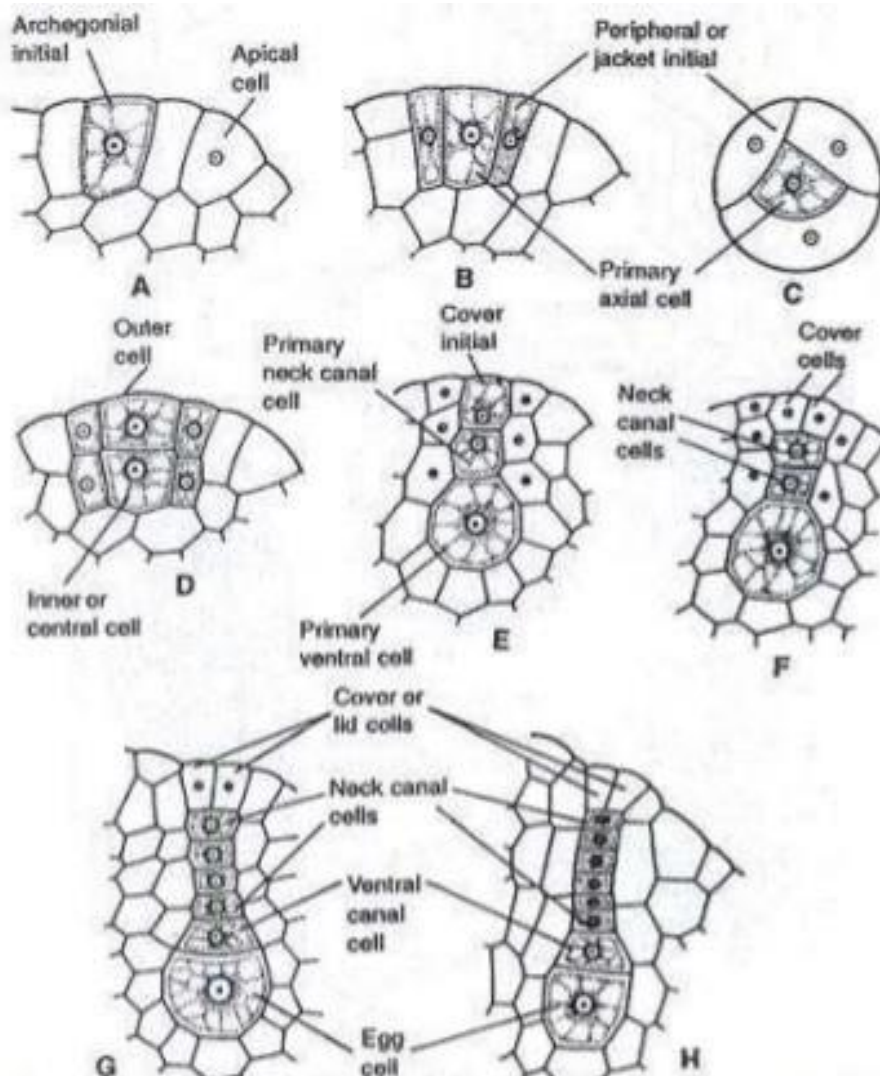


Fig. 22.8. *Anthoceros* sp. Development of archegonium. A, archegonial initial; B, differentiation of primary axial cell in L.S.; C, same in T.S.; D, division of axial cell into inner and outer cell; E, development of cover initial, primary neck canal cell and primary ventral cell; F, archegonium with egg, ventral canal cell, two neck canal cells and cover cells; G, nearly mature archegonium; H, mature archegonium (After Campbell).

Structure of archegonium

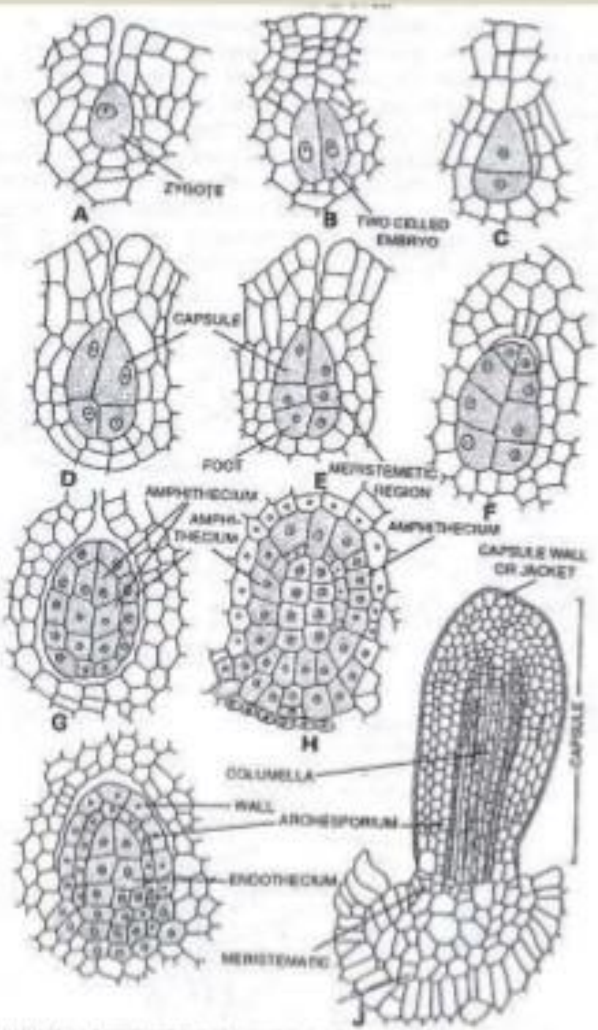


Fig. 22.9. *Anthoceros* sp. Development of sporophyte. A, zygote; B-F, early stages in the development of sporophyte; G-I, stages of the differentiation of endothecium, amphithecium and archesporium of sporogonium; J, longitudinal section of sporophyte showing capsule wall, capsule, arches...rium, columella, meristematic region and foot.

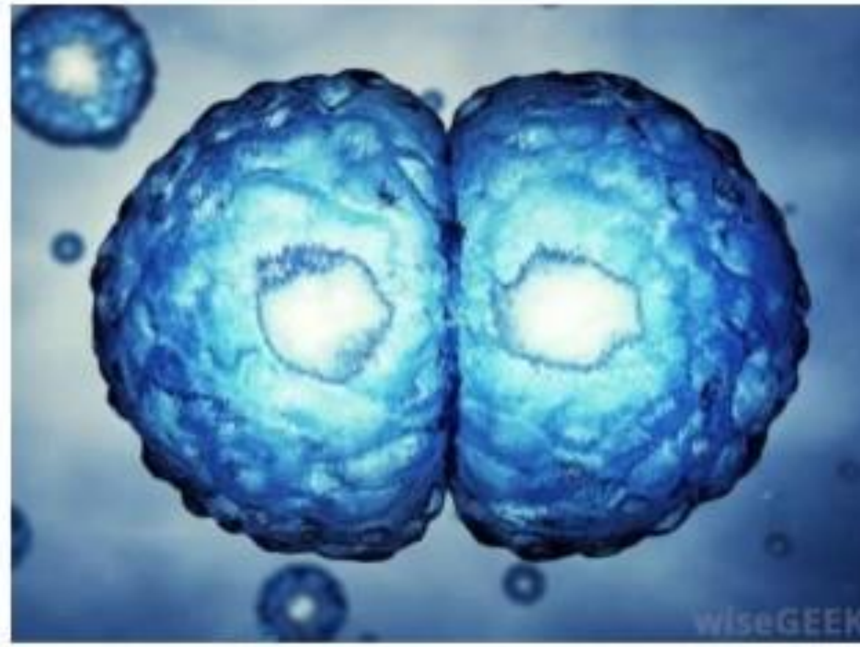
A mature archegonium is flask-like in shape, without neck canal cells and with an egg (oosphere) in its venter.

At the top of the neck of the archegonium there are four cover cells, which become separated from the archegonium, as soon as the gelatinization of the venter and neck canal cells is over.

FERTILIZATION

- Prior to fertilization, the cover cells become detached from the archegonium, and the neck canal cells become gelatinized. Through the medium of water, the antherozoids enter the mouth of archegonium.

- Ultimately, one lucky antherozoid penetrates the egg, and the fertilization is effected. The male and female nuclei unite to each other, producing a zygote (oospore)



DEVELOPMENT OF SPOROGONIUM

- With the result of the first vertical division, the daughter cells are produced, which are subjected to a transverse division producing four cells of equal or unequal size
- These cells again divide vertically, developing eightcelled embryo, four cells in each tier. The upper tier of four cells divides transversely. This way the three tiers of four cells each have been produced.

- The lowermost tier produces the foot, the middle tier produces partly the foot and mainly the seta and the upper-most tier produces the capsule.

SPOROGONIUM TISSUE

- In the young sporogonium, the columella consists of four vertical rows of the cells, but later on it is made up of sixteen rows of cells.
- The jacket initials divide again and again periclinally producing the 4 to 6 layered wall of the capsule.
- Later on, the sporogenous tissue becomes differentiated into two types of cells, i. e., (i) the sporocytes (spore mother cells) and (ii) the sterile cells (pseudoelaters).

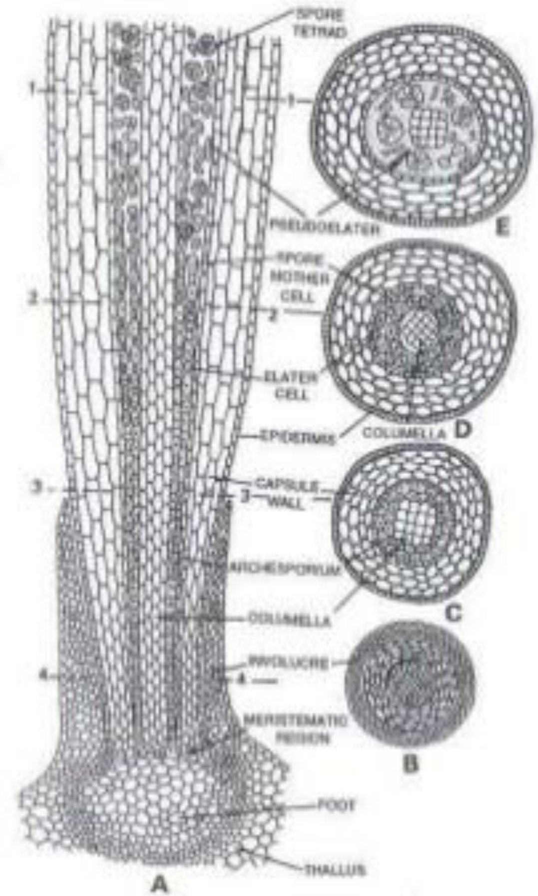


Fig. 22.10. *Anthoceros* sp. A, longitudinal section of sporogonium; B, cross section of sporophyte (A) at 4-4; C, cross section of sporophyte (A) at 3-3; D, cross section of sporophyte (A) at 2-2; E, cross section of sporophyte (A) at 1-1.

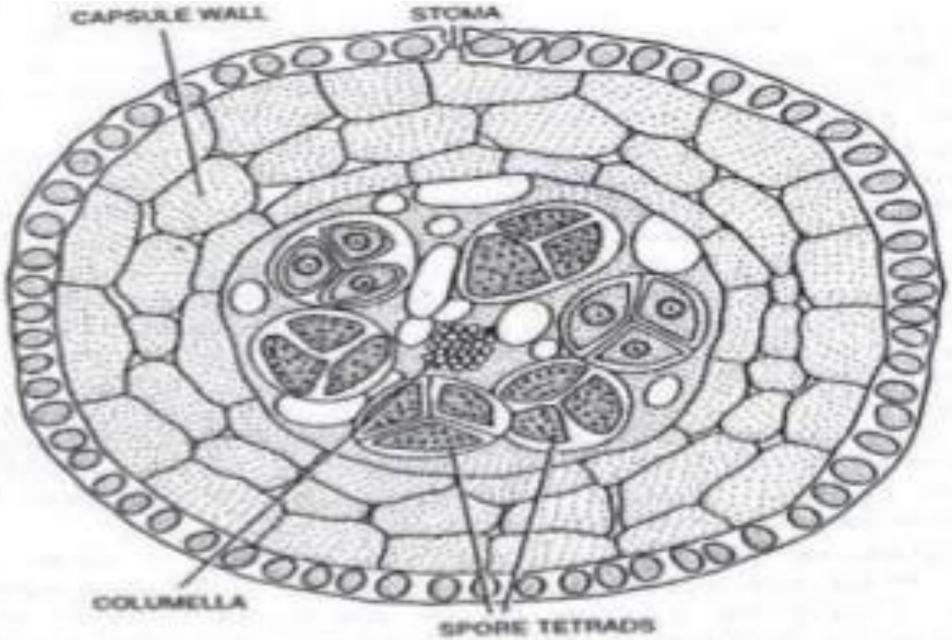
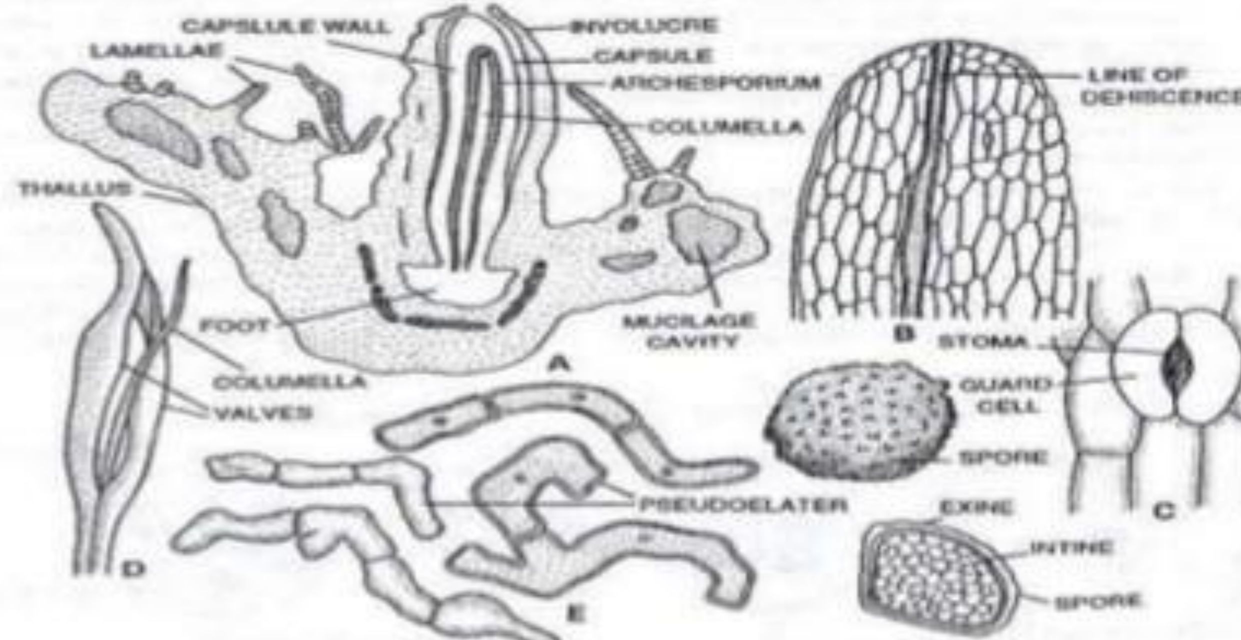
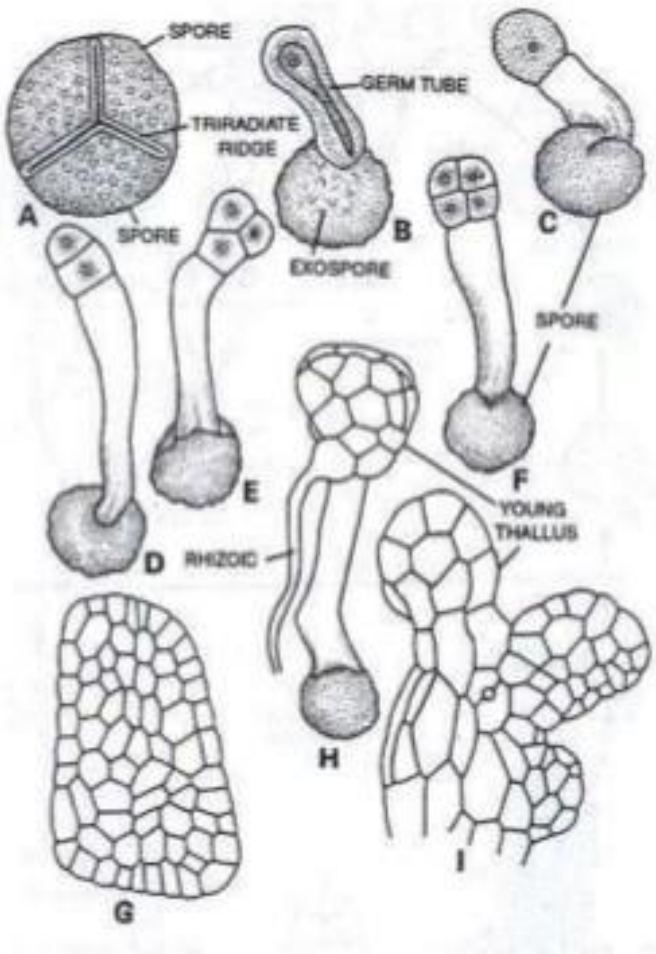


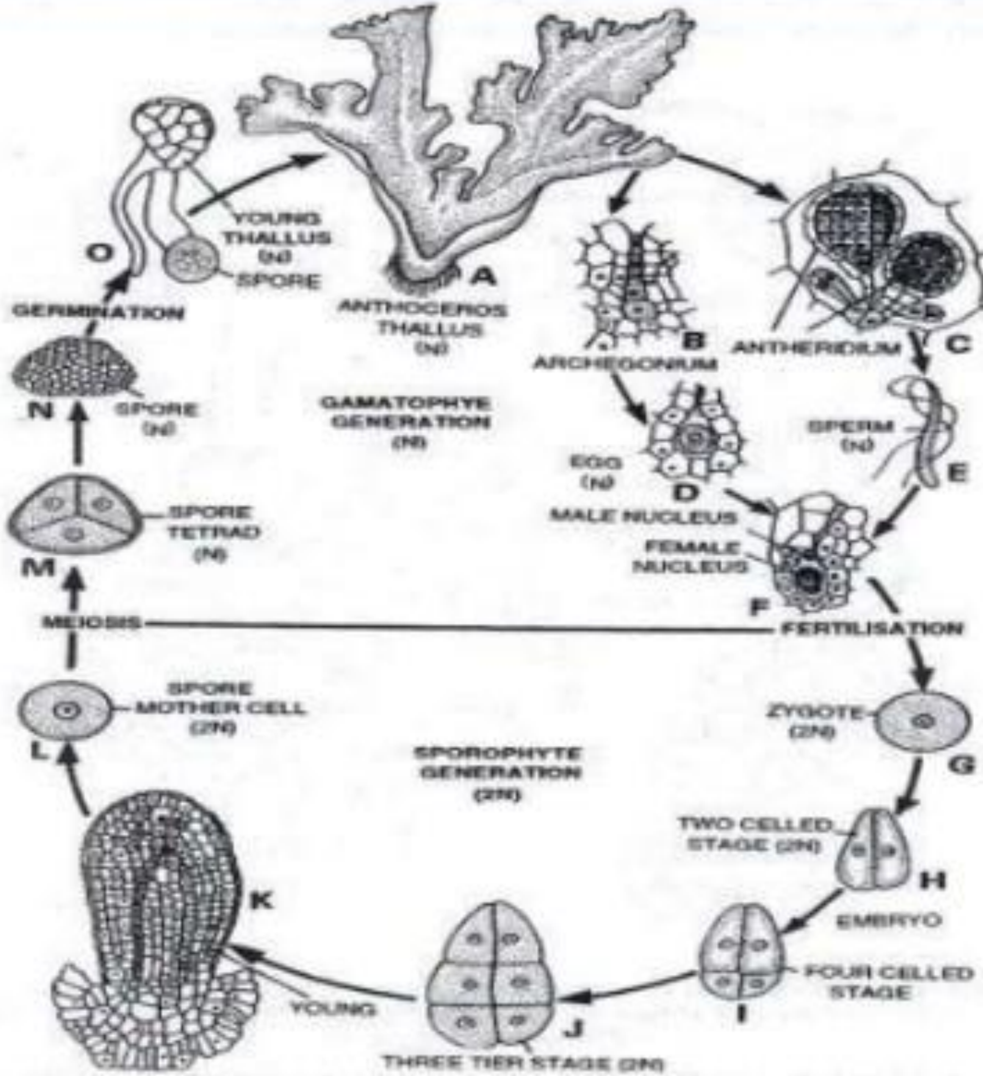
Fig. 22.11. *Anthoceros* sp. T.S. of sporogonium.



GERMINATION OF SPORE



LIFE CYCLE IN NUTSHELL



SCHEMATIC LIFE CYCLE

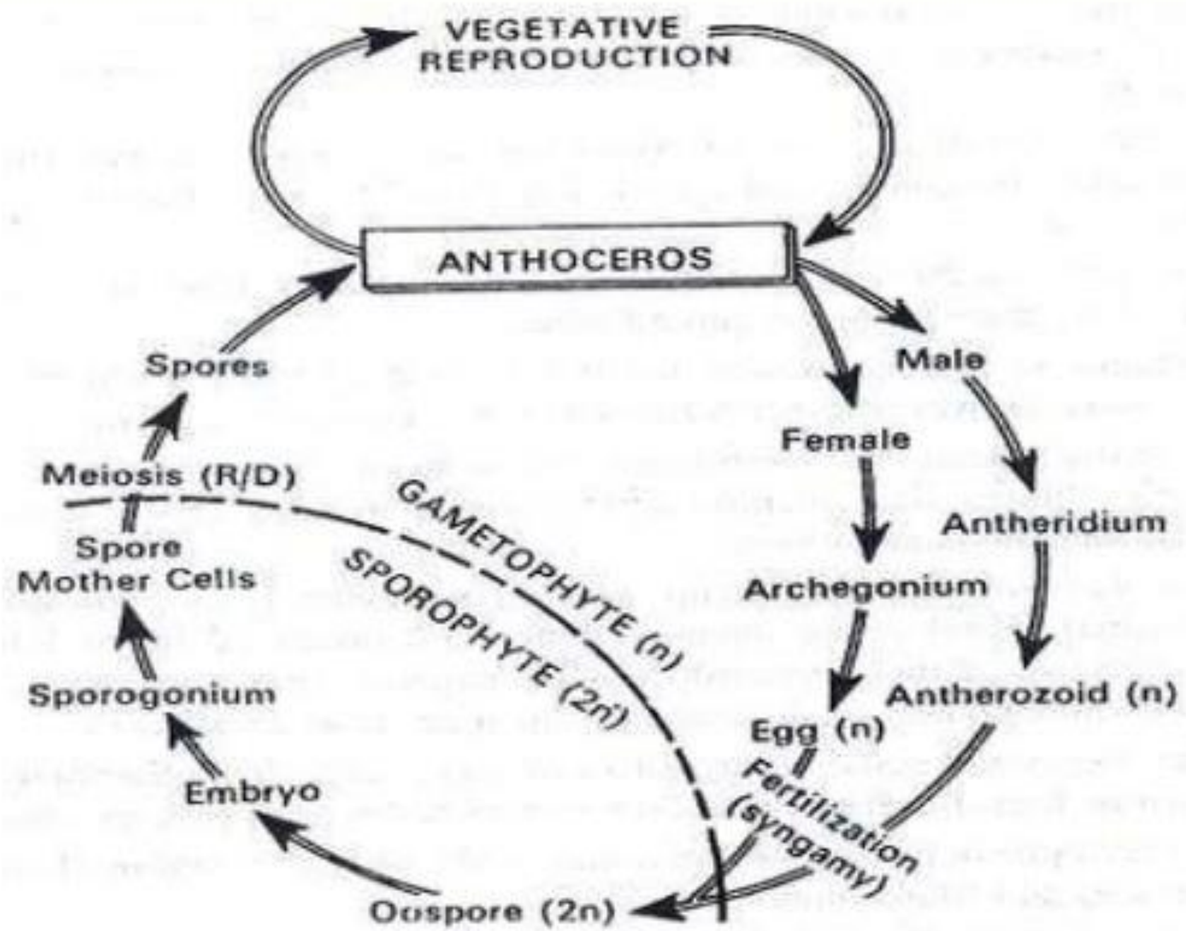


Fig. 22.16. *Anthoceros*. Graphic life-cycle.

THANK YOU