

Volvox- Life Cycle

Systematic Position

Class	:	Chlorophyceae
Order	:	Volvocales
Sub-order	:	Chlamydomonadineae
Family	:	Volvocaceae
Genus	:	<i>Volvox</i>

Occurrence of Volvox:

Volvox is a colonial alga, it grows in fresh water of pools, ponds etc. It is represented by about 20 species. Single colony looks like a small ball about 0.5 mm in diameter. In rainy season the colour of the ponds becomes greenish due to rapid growth of Volvox.

Plant Body of Volvox:

Plant body of Volvox (L. *volvere*, **the roll**) is a **coenobium**, like a hollow sphere of gelatinous substance (Fig. 3.52A, B). In the hollow sphere, huge number of cells are arranged towards periphery in a single layer (Fig. 3.52C, D). The number of cells varies from species to species (500-1,000 in *V. aureus*, 2,000-3,000 in *V. rousseletii*) and it ranges from 500-60,000.

Individual cell is typically like *Chlamydomonas* (except a few like *V. globator* and *V. rousseleti*, those are *Sphaerella* type). The cells are spherical in shape having cup-shaped chloroplast, with one or more pyrenoid, an eye-spot, 2-6 contractile vacuoles and a single nucleus.

Each cell has two equal flagella placed anteriorly (Fig. 3.52D). Thus, the coenobium is the aggregation of a number of *Chlamydomonas*-like cells. But individual cell performs its own metabolic functions like photosynthesis, respiration, nutrition, excretion etc.

Adjacent cells remain connected by cytoplasmic strands formed during cell division (Fig. 3.52C). In some species like *C. tertius*, *C. mononae*, cytoplasmic thread is absent. The central region of the coenobium is generally hollow but in some cases it is filled with gelatinous material (*V. aureus*) or water (*V. globator*).

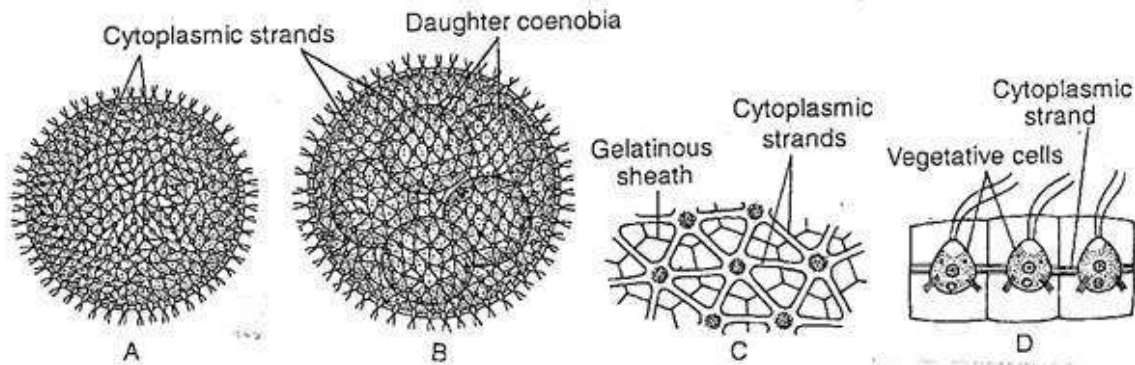


Fig. 3.52 : *Volvox* sp. : A. Young daughter colony, B. Mother coenobium containing daughter coenobia, C. Surface view of a portion of colony showing gelatinous sheath and cytoplasmic strands, D. Portion of peripheral region of colony showing position of vegetative cells and cytoplasmic strands.

The cells of the anterior region have large eye-spots than the posterior region, indicating the clear polarity in the coenobium.

Important Features of Volvox:

1. Plant body is coenobium and consists of large number of biflagellate, pear-shaped cells.
2. The cells of the coenobium are connected together by means of protoplasmic strands.
3. Young coenobia consist of only vegetative cells and are concerned with locomotion and food production.
4. Older coenobium consists of vegetative cells, daughter coenobia and antherozoid mother cells and/or ovum mother cells.
5. Sexual reproduction is oogamous and the coenobia may be monoecious or dioecious.
6. The female gametes or ova are large and non-motile, produced singly inside the oogonium.
7. The male gametes or sperms are spindle-shaped, narrow with a pair of apical cilia and are produced in bunch inside the antheridium.
8. The result of sexual union is the zygote, which on germination develop into new coenobium either directly or by the formation of single biflagellate zoospore.

Reproduction of Volvox:

Volvox reproduces both asexually and sexually. Asexual reproduction takes place during favourable condition, but the sexual reproduction occurs during unfavourable condition i.e., towards the end of the summer months.

Asexual Reproduction:

A few cells at the posterior side of the coenobium enlarge about 10 times. The cells withdraw their flagella and become more or less round. They are pushed inside the colony during their development. These cells are called **gonidia** (Fig. 3.53A) or **parthenogonidia** or **autocolony initials**. The gonidium is separated from the vegetative cells by its position and size.

Development of Daughter Colony:

The gonidium undergoes repeated divisions of about 15 or more times and can develop more than 3,200 cells. Those cells ultimately form a colony.

Initially the gonidium undergoes longitudinal division with respect to the colony and form 2 cells (Fig. 3.53B), The second division is at right angle to the first one and forms 4 celled stage (Fig. 3.53C). These cells again divide longitudinally (3rd division) and form 8 celled stage. The cells are arranged in such a pattern that their concave inner surface faces towards the outer side of the colony.

This stage is called **plakea stage or cruciate plate** (Fig. 3.53D). The 4th division forms 16 celled stage (Fig. 3.53E) and at that time it becomes a hollow sphere with an opening towards the outer side, called **phialopore**.

The division of cells continues up to the number specific for a particular species. The cells now face towards the centre (Fig. 3.53F). This group of cells then undergoes inversion through the phialopore, by which normal pattern of the colony is achieved.

Inversion:

During inversion a constriction appears at a point opposite to phialopore. This constricted region becomes pushed gradually towards the phialopore (Fig. 3.53G). Simultaneously the phialopore

becomes enlarged, through which the lower part comes out and the edges of phialopore hang backwards.

With the help of inversion, the anterior side of the cells changes their position from inner to the outer side and the position of phialopore becomes reversed i.e., changes its position from outer to inner side (Fig. 3.53H).

The phialopore gradually closes down and a complete hollow sphere is formed. After completion of inversion, the cells secrete their own gelatinous cell wall and each develops two flagella. Thus, the daughter colony is formed.

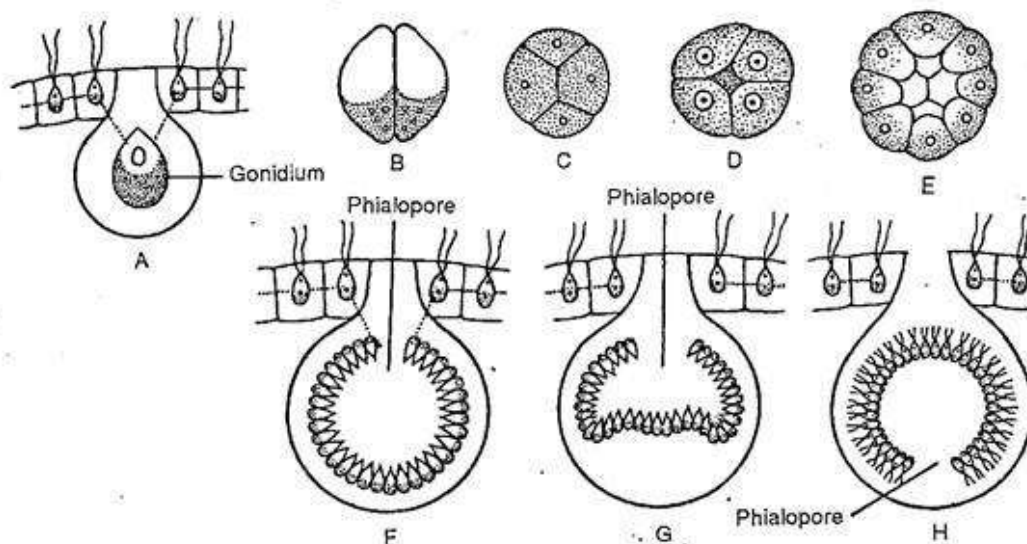


Fig. 3.53 : *Volvox* sp. Stages in the development of daughter coenobium : A. Single gonidium, B-E. Stages of gonidium development. 2-, 4-, 8- and 16- celled stages, F. Final stage before inversion, G. During inversion, and H. Flagella development

Many such colonies may develop in a coenobium and they swim freely inside the gelatinous matrix of the mother coenobium (Fig. 3.52B). Later on the daughter coenobia come out by rupture or disintegration of the mother colony. In some species like *V. carteri* and *V. africanus* daughter colonies of 2-4 generations may remain within the mother coenobium.

Sexual Reproduction:

Volvox reproduces sexually during unfavourable condition i.e., towards the end of growing season (late summer). The sexual reproduction is oogamous. Some species (*V. globator*) is monoecious and others (*V. aureus*) are dioecious.

Most of the monoecious species are of protandrous type (i.e., antheridia develop and mature earlier than oogonium). Some cells of the posterior region of the colony withdraw their flagella and develop into reproductive bodies called **gametangia**. The male gametangia are called **antheridia** and the female as **oogonia**.

Development of Antheridium:

During development of antheridium, an antheridial initial becomes differentiated from the colony. It is like a gonidium, which is aflagellated, larger in size than vegetative cells and contains dense cytoplasm with a single nucleus.

The cell undergoes repeated longitudinal divisions like the asexual stage and forms generally about 64-128 cells (though the number varies from 16-512, depending on species). Like the asexual stage the cells are arranged in groups and then undergo inversion by which the anterior side of the cells faces towards outer side (Fig. 3.54).

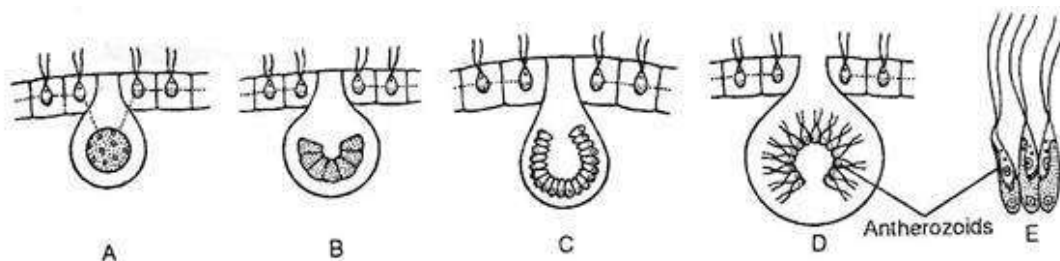


Fig. 3.54 : *Volvox* sp. Stages in the development of antherozoid : A–D. Sequential stages of antherozoid development, and E. Antherozoids

Each cell develops into unicellular, elongated, fusiform, naked and biflagellate antherozoid. The antherozoids are released individually. In some species they are also released in groups.

Development of Oogonium:

Single vegetative cell of the colony at the posterior side withdraws its flagella, enlarges in size and become a more or less flask-shaped oogonium. The entire protoplast without undergoing any division, forms an uninucleate non-flagellated egg or female gametophyte (Fig. 3.55A).

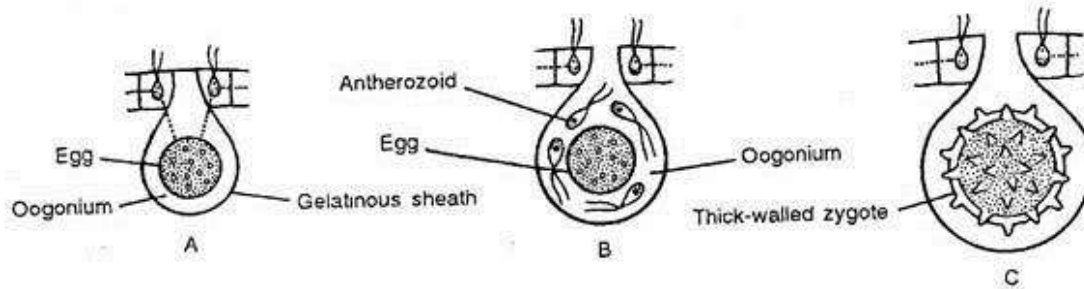


Fig. 3.55 : *Volvox* sp. Stages in the development of egg and zygote : A. Portion of coenobium with an egg, B. A stage before fertilisation, and C. Zygote inside the coenobium

The egg or female gametophyte is spherical, uninucleate, non-flagellated, green in colour and has parietal chloroplast. It has many pyrenoids and large amount of reserve food. The mouth of the flask-shaped oogonium opens towards the outer surface of the colony.

Fertilisation:

After maturation, the antherozoids (= spermatozooids) are liberated from the antheridium either singly or in mass. They move in water and get attracted by the chemotactic stimulation to the surface of the oogonium.

A few antherozoids enter near the egg (Fig. 3.55B) by breaking the oogonial wall with the help of proteolytic enzyme probably secreted by the antherozoids. Out of many antherozoids entered into the oogonium only one succeeds to fertilise the egg and forms a zygote.

Zygote:

The zygote secretes a thick wall around itself (Fig. 3.55C). It accumulates the haematochrome and becomes red in colour. The wall of the zygote may be smoothly, (*V. monanae*, *V. globator* etc.) or spiny (*V. spermatorophora* etc.). Zygote is liberated by the disintegration of the mother wall and remains dormant for a long period.

Germination of Zygote:

During favourable condition the zygote germinates. Before germination, the diploid (2n) nucleus (Fig. 3.56A) of the zygote undergoes meiotic division and forms 4 haploid cells (Fig. 3.56B, C).

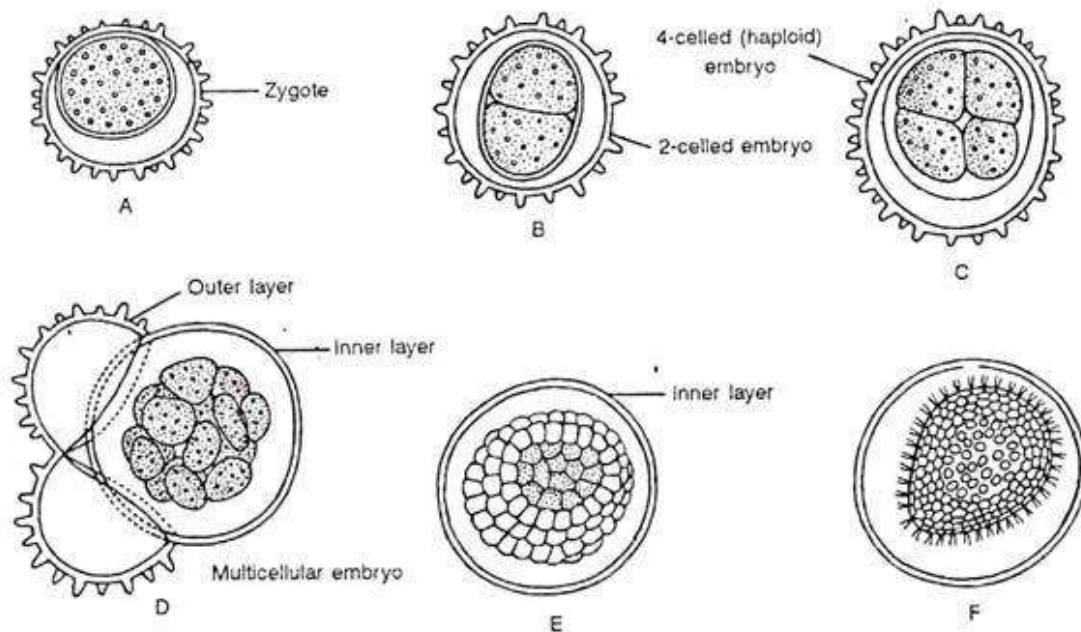


Fig. 3.56 : *Volvox* sp. Stages in the development of zygote into coenobium : A. Single zygote, B–C. Reduction division and formation of 4-celled stage, D. Multicellular embryo after splitting the outer layer, E. Multicellular embryo with inner layer, and F. Young coenobium

Further development of zygote varies with species:

1. In *V. minor* and *K. aureus*, after meiotic division the cells undergo repeated mitotic division and form a new colony as formed during asexual reproduction (Fig. 3.56D, E and F).

2. In *V. rousseletii*, out of 4 haploid cells generally only one survives. The outer wall (exospore) of the zygote breaks and the inner wall (endospore) comes out in the form of vesicle containing a single biflagellate meiospore.

The meiospore is then liberated in the water by breaking the inner wall i.e., endospore. The biflagellate meiospore then undergoes divisions like the development of daughter colony during asexual process and forms new coenobium.

3. In *V. campensis*, out of many zoospores formed in the oogonium by zygotic division only one survives and others degenerate. The surviving one comes out and by repeated mitotic division it forms a new colony like asexual reproduction.

Indian Species:

V. aureus, *V. merrille*, *V. rousseleti*, *V. africanus*, *V. globator* and *V. prolificus* are very common.

Life Cycle of Volvox:

Fig. 3.57 and 3.58 depict life cycle of Volvox.

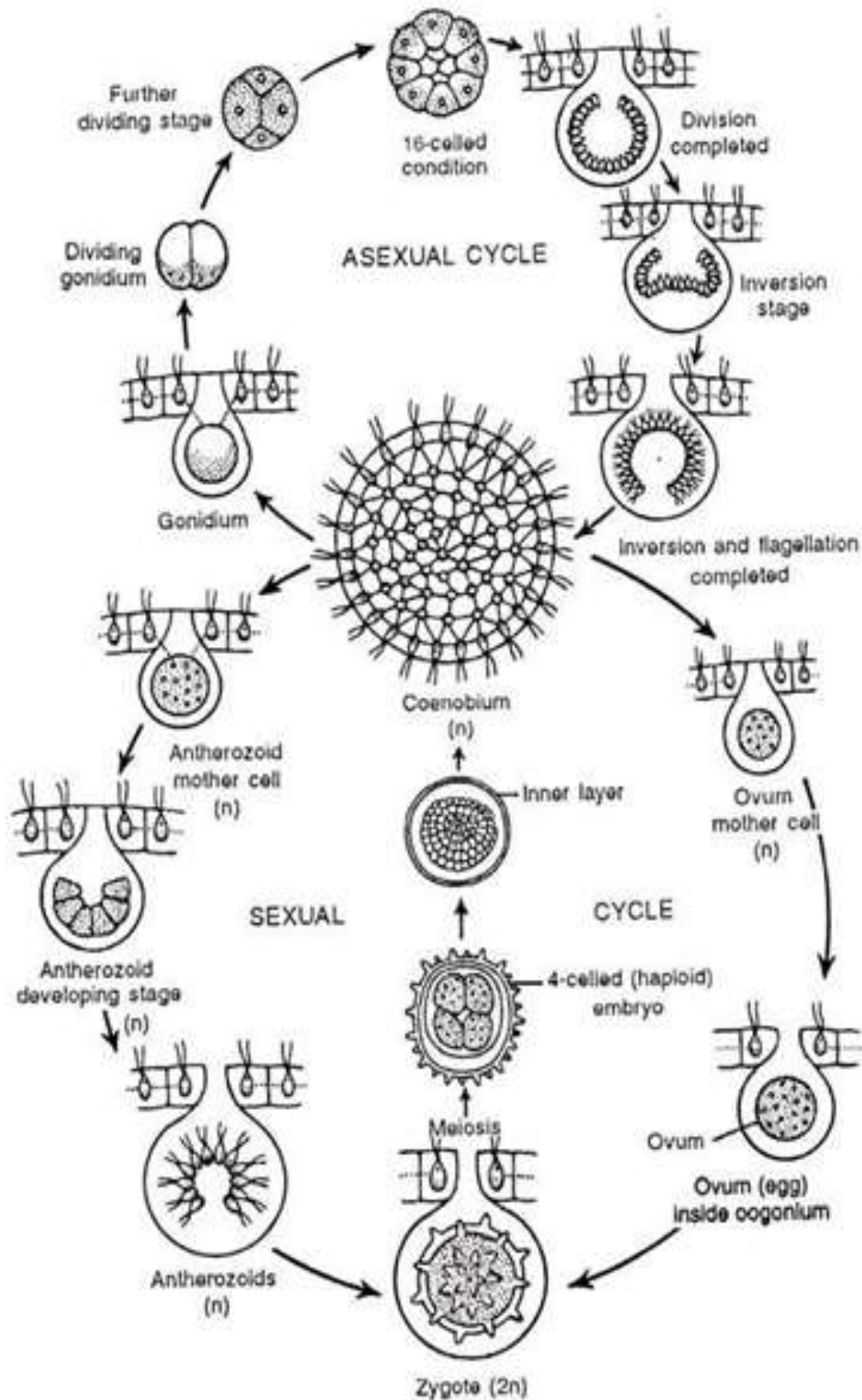


Fig. 3.57 : Life cycle of *Volvox* sp.

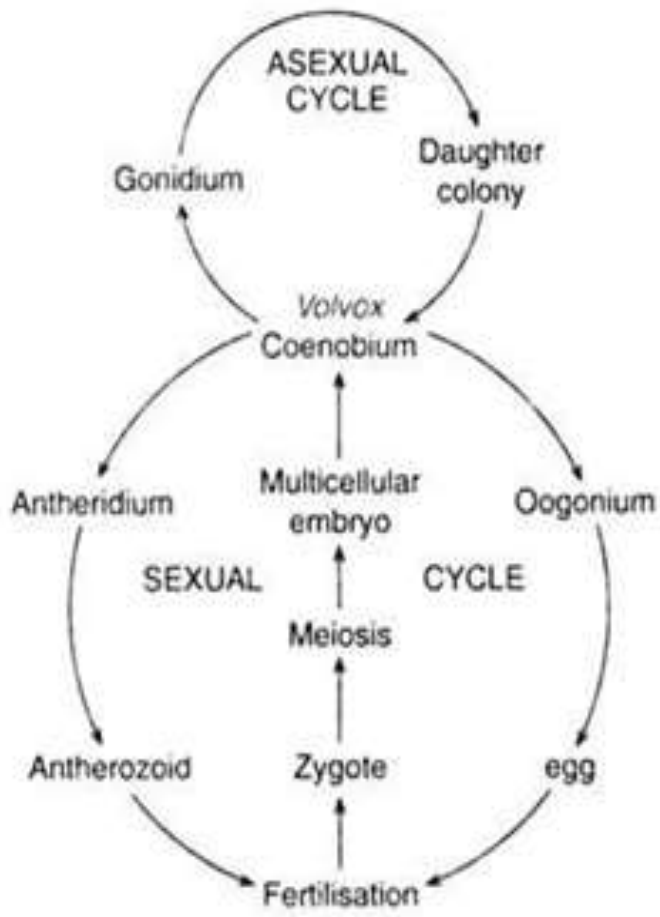


Fig. 3.58 : Graphic life cycle of *Volvox* sp.