Bhagalpur National College, Bhagalpur

(A Constituent unit of Tilka Manjhi Bhagalpur University, Bhagalpur)

PPT Presentation for B.Sc.-I- Life Cycle of Polysiphonia

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POLYSIPHONIA

Systematic Position

Division : Rhodophyta
Class : Rhodophyceae
Sub Class : Floridae
Order : Ceramiales
Family : Rhodomelaceae

Common Indian Sps.

Polysiphonia elongata
P. platycarpa
P. urceolata
P. vaiegata

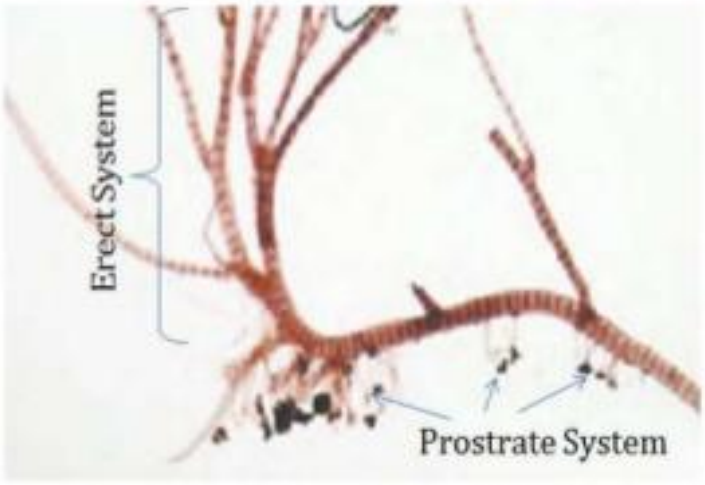
Habitat/ Occurrence

- A marine alga
- A lithophyte
- Some are semi-parasite
- Some are epiphytes
- Cosmopolitan in distribution

Habit/ Thallus Structure

- Multiaxial thallus
- Form violet – red thick tufts
- Heterotrichous habit – prostrate and erect system
- Prostrate system creeps over the substratum- well developed and multiaxial - e.g. *P. nigrescens*, *P. urceolata* and gives rise to rhizoids
- In some species, multiaxial prostrate system is absent and instead the basal cells of erect aerial branches form massive attachment discs.

  (*P. elongata* and *P. violacea*)



Prostrate & Erect System of Thallus

POLYSIPHONIA .....

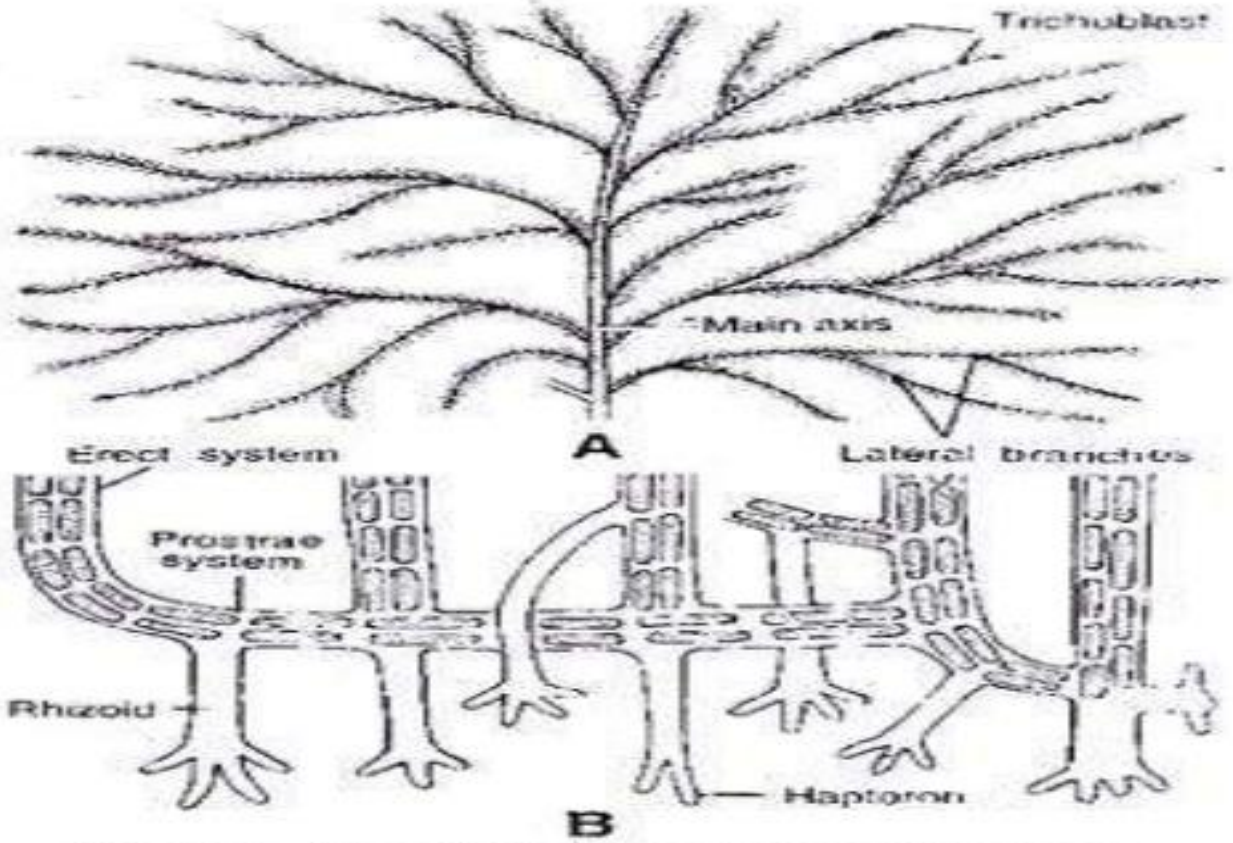


Fig. 1 (A, B). *Polysiphonia*. External features. (A) Habit, (B) Prostrate and erect system

- Prostrate system gives off many multiaxial aerial branches
- The main axis of the long aerial branches consists of a central (axial)siphon of elongated cylindrical cells, surrounded by smaller pericentral cells or siphons.
- Cells of central and pericentral siphons are interconnected through pit connections .
- In the older portions of the main axis, pericentral cells become corticated by one or more layers of small cortical cells.

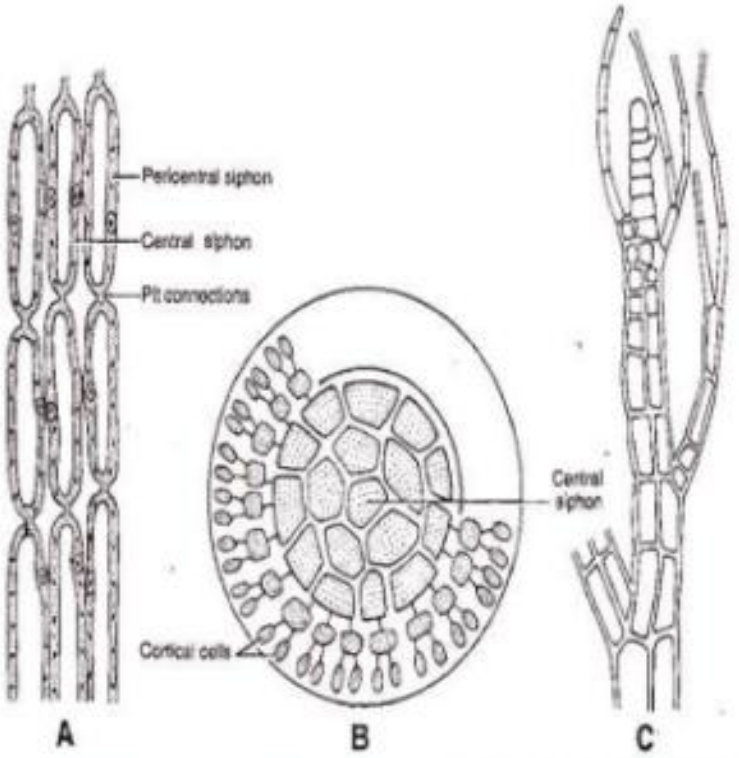


Fig. 2 (A–C). *Polysiphonia*. Thallus structure. (A) Part of aerial branch, (B) T.S. of aerial axis, (C) Vertical section of main axis.

Main axis has -

i) Short branches of limited growth or Trichoblasts

- Arise from the main axis in a spiral manner.
- Uniaxial and lack pericentral siphon
- Cells contain very few chromatophores
- Fertile trichoblasts bear male and female reproductive structures.

ii) Long branches of unlimited growth.

- Basal part is polysiphonous , but distal part is monosiphonous.
- Do not bear reproductive structures.

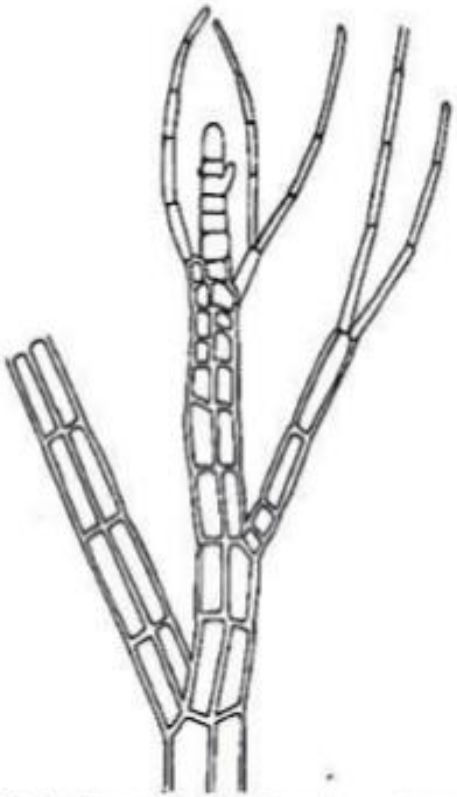


Fig. 13. Thallus organization. Pseudoparenchymatous forms. *Polysiphonia*

Cell Structure

- Cells of the central and pericentral siphons are long and cylindrical
- Cell wall is two layered - outer pectin and polysulphate esters and inner cellulose
- Internal to the cell wall is the cell membrane
- Cytoplasm forms a lining layer – contains a single nucleus, several discoid chromatophores which contain photosynthetic pigments – Chlorophylls a and d , carotene, xanthophylls, blue Phycocyanin, red Phycoerythrin (Phycobilins) .
- Pyrenoids are absent
- The reserve food is Floridian starch
- A large central vacuole
- Pit connections occur between adjacent cells.

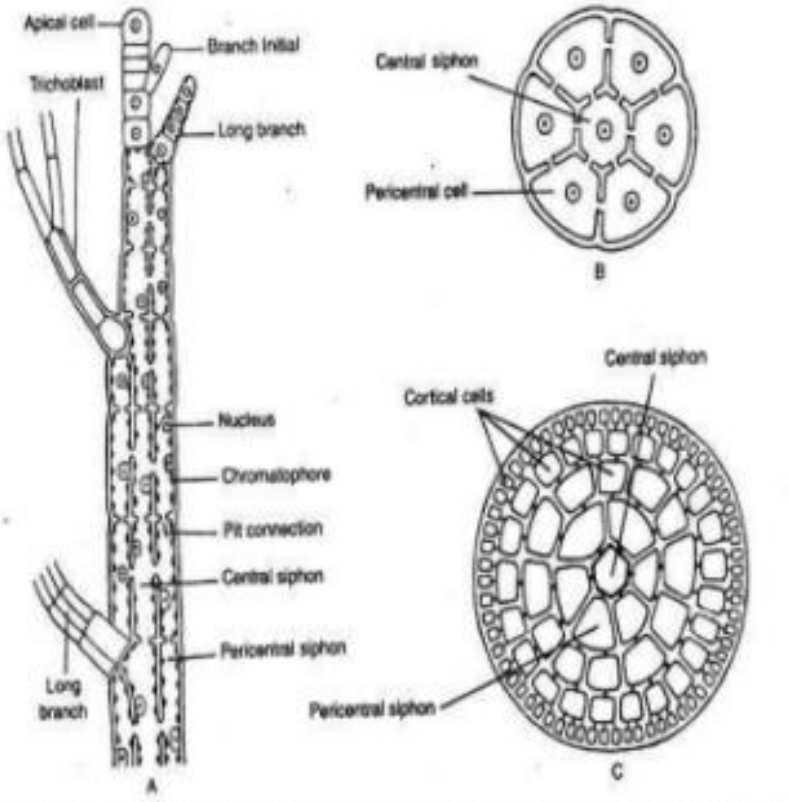


Fig. 3.132 : *Polysiphonia* sp. : A. Apical portion of a plant body showing central siphon, pericentral siphon, long branch and trichoblast, B. T.S. of thallus showing central siphon, surrounded by pericentral cells, and C. T.S. of old thallus showing cortical cells in addition to central and pericentral siphons

POLYSIPHONIA

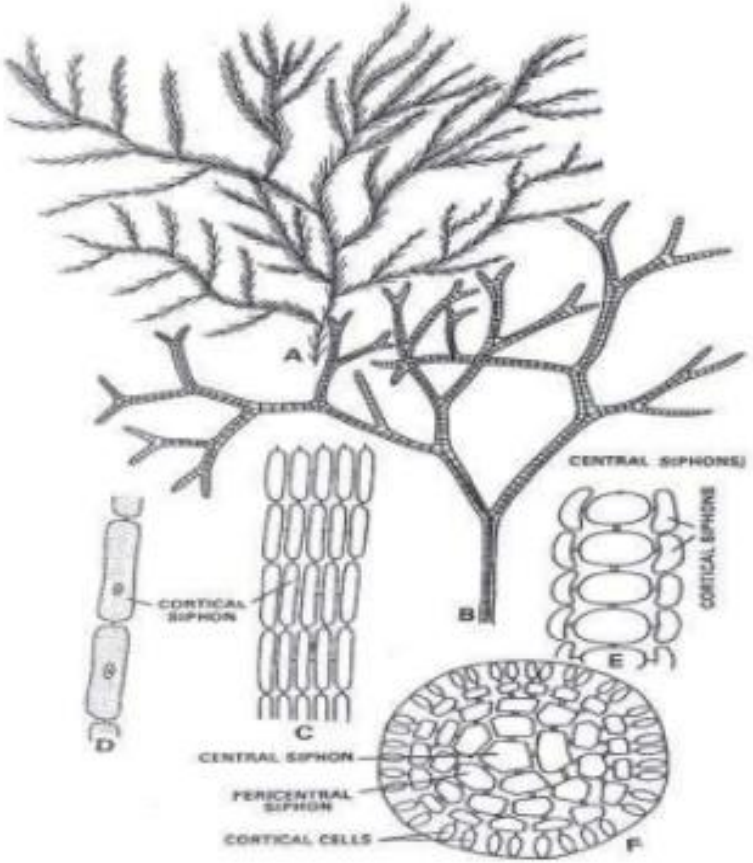


Fig 7.1. *Polysiphonia* sp. Vegetative structure A, habit of the plant; B, a portion of the plant (somewhat enlarged); C-D, cortical siphons; E, filament showing central siphons; F,T.S. of siphonous filament.

Growth

Takes place by the activity of the dome-shaped apical cell.

Reproduction

Asexual and Sexual

- *Polysiphonia* is heterothallic.
- It exhibit triphasic alternation of generations. Three kinds of thalli are present in the life cycle of *Polysiphonia.*

i) The Gametophyte

The thallus is haploid , free living and dioecious . There are separate male gametophyte which bear the male sex organ Spermatangium and female gametophyte which bear the female sex organ, Carpogonium.

ii) The Carposporophyte

These are diploid thallus which develop from the zygote. They produce carposporangia which produce diploid carpospores.

iii) The Tetrasporophyte

Formed by the germination of diploid carpospore. It is diploid and produces tetrasporangia which produce haploid tetraspores which on germination produce male and female gametophytes.

i) The Gametophytes

- The gametophytes are concerned with sexual reproduction which is Oogamous.
- *Polysiphonia* is heterothallic or dioecious – the male sex organs and the female sex organs are borne on different gametophytes.
- Male gametophyte produces male sex organ Spermatangium
- Female gametophyte produces female sex organ Carpogonium.
- Both male and female gametophytic plants are morphologically similar.

Male Gametophyte

- It bears the male sex organs Spermatangia which are borne in dense clusters and are closely packed forming a compact cone – shaped structure on the upper branch of dichotomously branched male trichoblasts. In some species, both the branches of the trichoblasts become fertile.

- The two basal cells of the trichoblast functions as the stalk. Other cells cut off pericentral cells. Thus the fertile portion of this branch becomes polysiphonous
- The pericentral cells may divide once or twice producing a large number of spermatangial mother cells which are arranged in the form of a compact layer external to the central siphon.

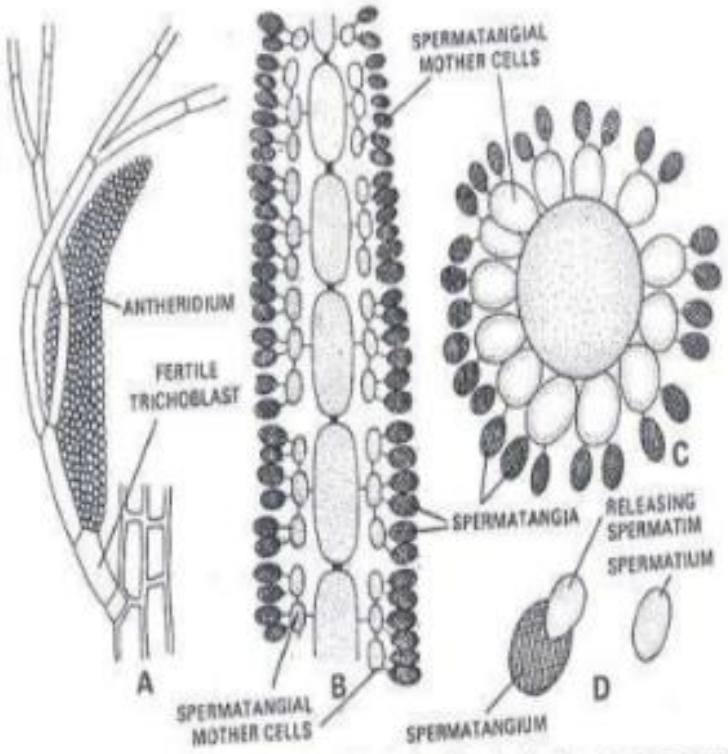


Fig 7.2. *Polysiphonia* sp. A, a terminal portion of the thallus with antheridia; B, a part of the antheridium with spermatangial mother cells and spermatia in longitudinal view; C, the same in transverse section; D, releasing spermatium from spermatangium.

- Each spermatangial mother cell gives rise to 2 to 4 spermatangia or antheridia.
- The spermatangia are spherrical or oblong unicellular structures
- The contents of each spermatangium produce a single , non – motile spherical male gamete or spermatium.
- Spermatia are liberated by the formation of a narrow slit in the spermatangial wall and are carried by water currents to the vicinity of the female sex organ.

Female Gametophyte

- It bears the female sex organ , Carpogonium.
- The female trichoblast initial arises from the central siphon 3 or 4 cells behind the apical cell. It divides repeatedly to form a reduced female trichoblast 5 to 7 cells in height.
- The 3 lowermost cells of the female trichoblast divide vertically to form an ensheathing layer of pericentral cells which are arranged in three tiers one above the other.
- One of the pericentral cells in the middle tier on the adaxial side becomes the supporting cell. The latter cuts off a small initial cell at its free end known as the procarp initial. The initial cell divides and redivides to form a small, curved four – celled branch called the carpogonial filament or procarp.

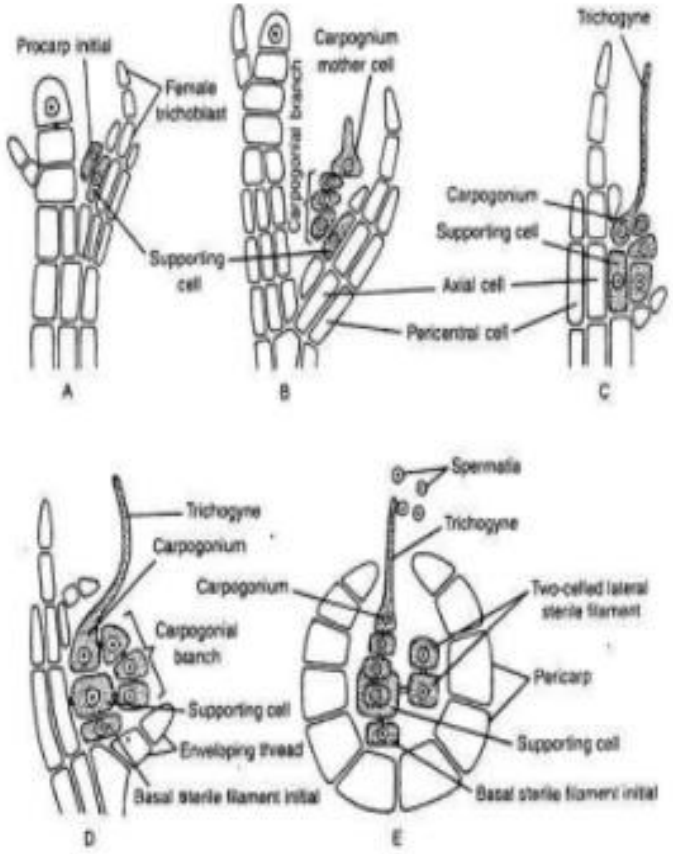


Fig. 3.135 : *Polysiphonia* sp. : A-E, Development of carpogonium

- The terminal cell of the carpogonial filament functions as the carpogonium mother cell which gets modified into the carpogonium .
- The carpogonium has a basal swollen portion in which the egg or female gamete is present and a terminal slender portion called trichogyne.
- In the mean time, the supporting cell cuts off two sterile cells, one towards its base called the basal sterile filament initial and another on one side called the lateral sterile filament initial . The latter divides immediately to form a two – celled lateral sterile filament.
- At this stage, the carpogonium is ready for fertilization.

Fertilization

- The spermatia, liberated from the male gametophytic plants are carried by the water currents to the carpogonium.
- When a spermatium adheres to the trichogyne of the carpogonium, the point of attachment dissolves and the male nucleus enters into the trichogyne.
- The male nucleus then enters the trichogyne and moves down and reaches the swollen base of the carpogonium and fuses with the female gamete to form the zygote.
- The formation of zygote represents the end point of the haploid gametophytic generation and the starting point of the diploid carposporophyte .

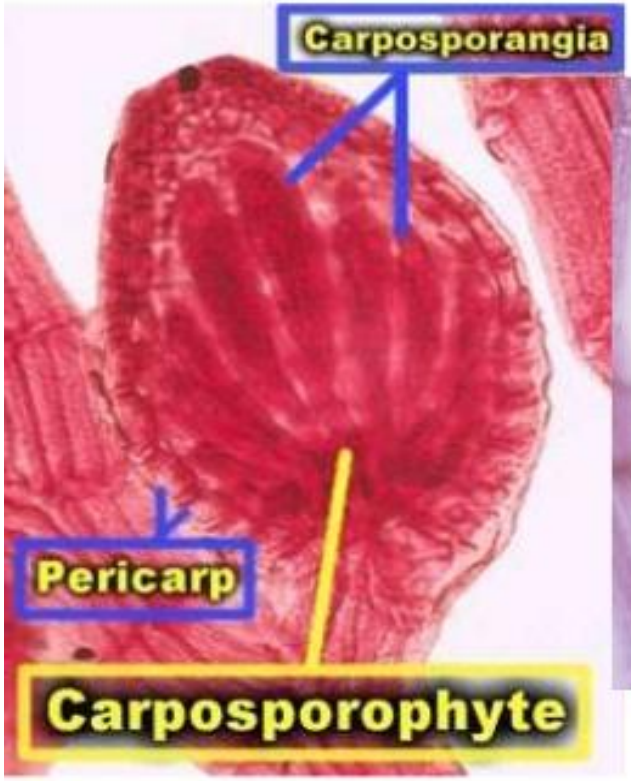
Post – Fertilization changes

The post – fertilization changes in *Polysiphonia* include the following events.

- The 2 celled lateral sterile filament becomes 4 to 10 celled.
- The basal sterile filament initial divides to form a 2 – celled filament.
- The sterile filaments are nutritive in function.
- The supporting cell buds off an Auxiliary cell at its upper end. It has a haploid nucleus and lies close to the carpogonium.
- The auxiliary cell establishes a tubular connection with the base of the carpogonium.
- The diploid nucleus of the carpogonium divides mitotically into 2 daughter nuclei and one of these nuclei migrates into the auxiliary cell through the tubular connection. The haploid nucleus of the auxiliary cell now degenerates leaving behind only the diploid nucleus.

- The carpogonial branch gradually begin to shrivel.
- The outgrowths of the pericentral cells adjacent to the supporting cells start producing an envelope around the developing carposporophyte.
- Now, many initials called Gonimoblast initials are produced from the Auxiliary cells.
- The diploid nucleus of the auxiliary cell divides mitotically and each daughter nucleus migrates into the gonimoblast initial. Thus each gonimoblast initial contains a diploid nucleus. Each gonimoblast initial divides and redivides to form a short gonimoblast filament.
- The terminal cell of the gonimoblast filament develop into an elongated , pear-shaped carposporangia.
- The contents of each carposporangium differentiate into a single diploid carpospore.

Polysiphonia : Post – Fertilization changes



- By this time, the supporting cell, auxiliary cell, carpogonial filament and the sterile filaments fuse to form an irregularly shaped nutritive cell called the placental cell.

ii) The Carposporophyte or Cystocarp

- This is the second individual formed in the life cycle of *Polysiphonia*.

- The whole structure consisting of gonimoblast filaments, carposporangia, carpospores and placental cell gets completely enveloped by the developing young vegetative filaments which form an urn-shaped body called the cystocarp or the carposporophyte
- The wall of the cystocarp is called Pericarp and the opening is called Ostiole.
- The cystocarp or the carposporophyte is dependent on the female gametophytic plant .
- The carpospores are liberated through the ostiole and are carried by water currents.

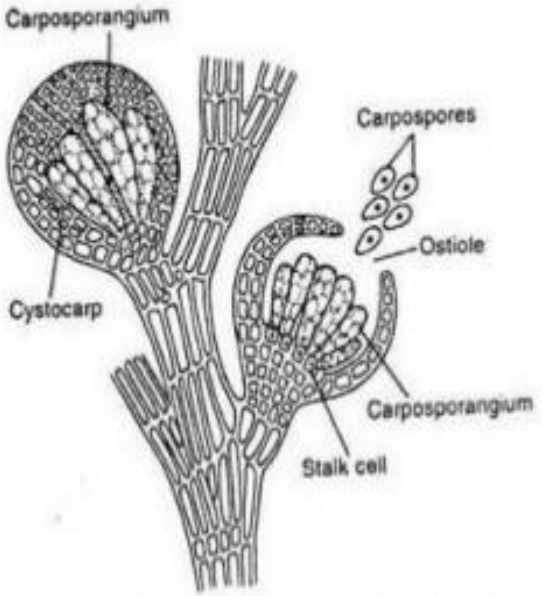


Fig. 3.137 : *Polysiphonia* sp. : A branch bearing cystocarps

iii) The Tetrasporophytes

- The diploid carpospore on germination produce new diploid plants called tetrasporophytes which resemble gametophytic plants in morphology - It consists of the central siphon encircled by the pericentral siphons. The thallus is laterally branched.
- The tetrasporophyte is a free living diploid plant
- They produce sac like tetrasporangia from small – sized pericentral cells.
- Each pericentral cell divides vertically into an outer cell and an inner cell .
- The outer cell divides and forms two or more cover cells , where as the inner cell functions as the sporangial mother cell.

- The sporangial mother cell divides transversely into a lower stalk cell and an upper tetrasporangial cell.
- The tetrasporangial cell functions as the tetrasporangium.

- The diploid nucleus of each tetrasporangium divides meiotically to form 4 haploid nuclei and form 4 tetraspores which are arranged tetrahedrally.
- Tetraspores are liberated by the rupturing of the sporangial wall.
- Tetraspores germinate and produce haploid gametophytic plants . Out of the 4 tetraspores, 2 develop into male gametophytes and the other 2 develop into female gametophytes.

Polysiphonia : Tetrasporophyte

Polysiphonia : Post – Fertilization changes

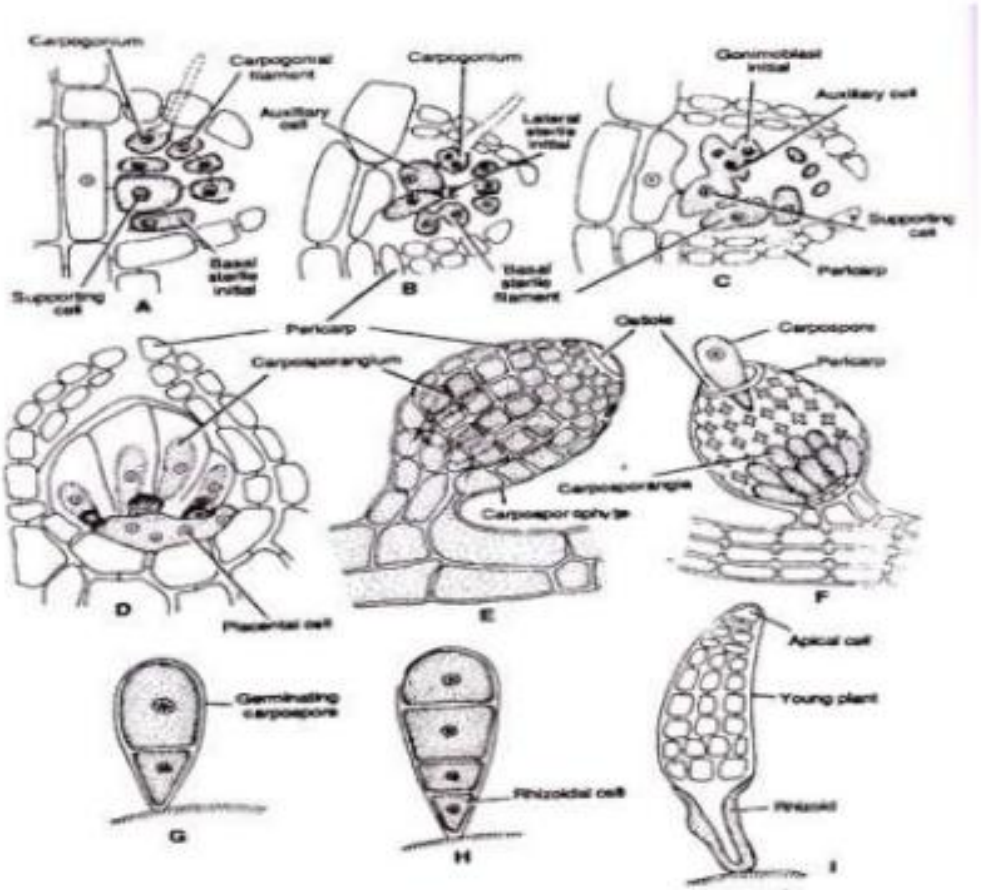


Fig. 6. (A–I). *Polysiphonia*. Post fertilization changes

Polysiphonia : Life Cycle

- The life cycle of *Polysiphonia* is triphasic and haplo-diplobiontic.

Three different phases in the life cycle :

i) Haploid phase represented by the male and female gametophytes

ii) Diploid phase represented by carposporophyte (Cystocarp)

iii) Diploid phase represented by tetrasporophyte.

i) Haploid phase

- The gametophytes reproduce sexually - The male gametophyte produce spermatangia which produce the non - motile male gametes spermatia .

  The female gametophyte produce the female gamete. The fusion of the male gamete spermatium and the female gamete results in the formation of diploid zygote.

ii) Diploid phase

- Represented by carposporophyte
- Second phase in the life cycle of *Polysiphonia*. This phase is developed from the diploid zygote. Post fertilization events include the development of gonimoblast initials, carposporangium and the diploid carpospore. These whole structures and the placental cell is protected by a two layered pericarp.
- This phase is dependent on the female gametophyte.

iii) Diploid phase

- Represented by tetrasporophyte.
- The diploid carpospore develops into the diploid tetrasporophyte. It is a free living plant and is morphologically similar to the gametophytic plants.
- The diploid tetrasporophyte produce tetrasporangium which undergoes meiosis and form 4 haploid tetraspores . The germination of haploid tetraspores produce haploid gametophytic plants.

- Thus in the life cycle of *Polysiphonia*, there are one haploid phase represented by the gametophytic plants and two diploid phase represented by the carposporophyte (cystocarp) and the tetrasporophyte. Hence the life cycle is said to be triphasic and haplo-diplobiontic type.

Polysiphonia : Life Cycle

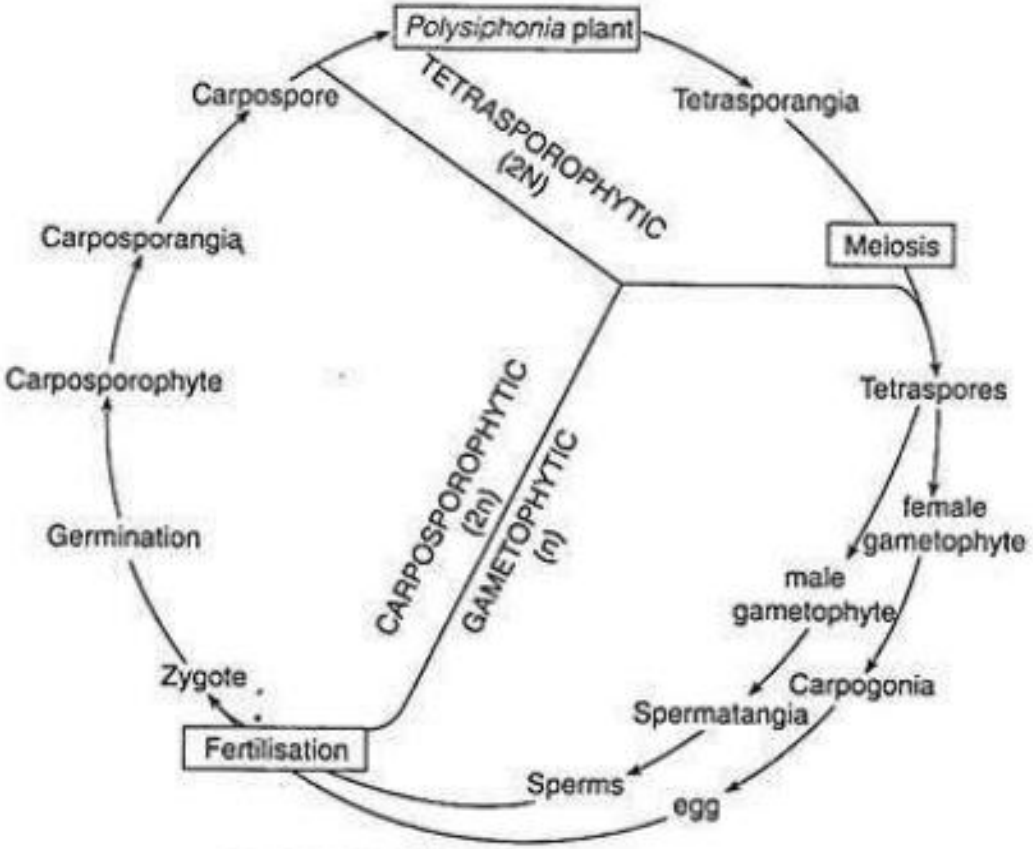


Fig. 3.138 : Graphic life cycle of *Polysiphonia* sp.

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