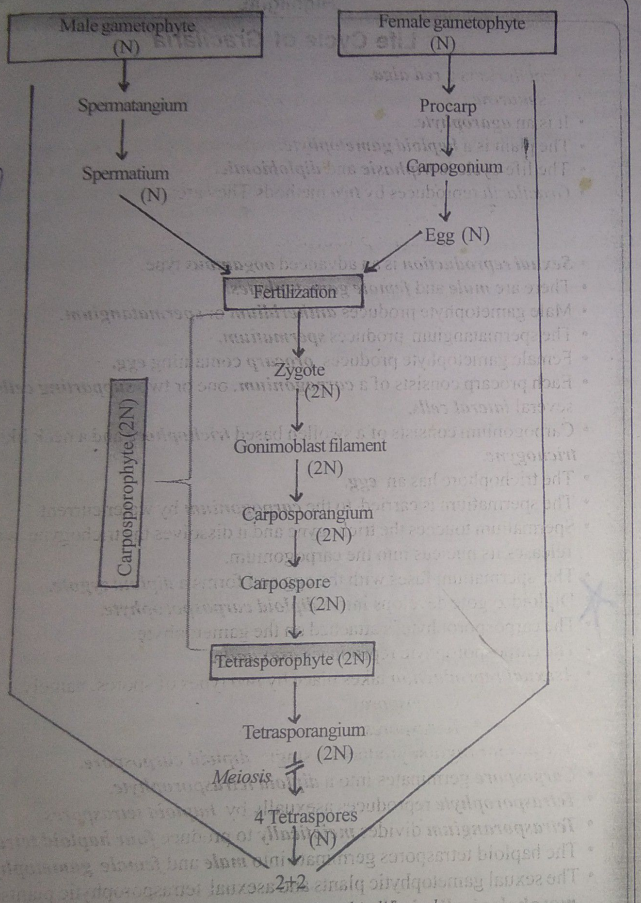
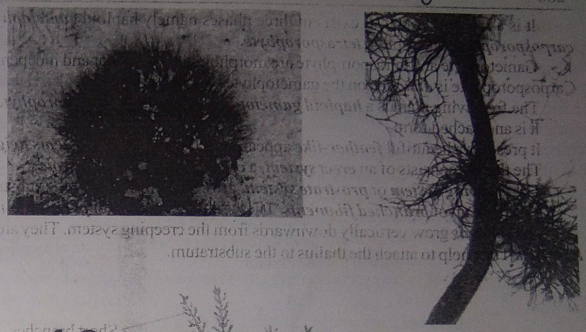


Fig.18.11: Gracilaria - Graphic life cycle.



19 *Polysiphonia*

Class	*Rhodophyceae*
Sub-class	*Florideae*
Order	*Ceramiales*
Family	*Rhodomelaceae*
Genus	*Polysiphonia*

Polysiphonia is a ***red alga***.
It is included in the class ***Rhodophyceae***.

Occurrence

Polysiphonia is a ***red alga***.
It is included in the class ***Rhodophyceae***.
All species are ***marine***.
Polysiphonia is ***world-wide*** in distribution.
It includes 900 species.
The thallus is usually attached to ***rocks*** or ***stones***.
Polysiphonia violacea is an ***epiphyte*** which grows on large brown algae.
Polysiphonia urceolata is ***saprophyte***. *Polysiphonia elongata* is a ***lithophyte***.
Some species of *Polysiphonia* are growing along the ***shores*** of ***Tuticorin*** and ***Rameswaram***. The common Indian species are-
Polysiphonia fastigata *Polysiphonia variegata*
Polysiphonia platycarpa *Polysiphonia elongata*.

Thallus Structure

Polysiphonia is a ***red alga***.
It is included in the class ***Rhodophyceae***.
All species are ***marine***.

It is a ***triphasic*** plant. It exists in three phases namely haploid ***gametophyte***, diploid ***carposporophyte*** and diploid ***tetrasporophyte***.

Gametophyte and tetrasporophyte are morphologically similar and independent plants. Carposporophyte is ***attached*** on the gametophyte.

The free living plant is a ***haploid gametophyte*** and ***diploid tetrasporophyte***.

It is an attached form.

It presents a beautiful ***feather-like*** appearance. It grows upto ***5-35 cms height***.

The thallus consists of an ***erect system***, a ***creeping system*** and ***rhizoids***.

The ***creeping system*** or ***prostrate system,*** grows ***horizontally*** on the substratum.

It is made up of ***branched filaments***. These filaments serve for ***perennation***.

The ***rhizoids*** grow vertically downwards from the creeping system. They are also called ***hold fast***. They help to attach the thallus to the substratum.

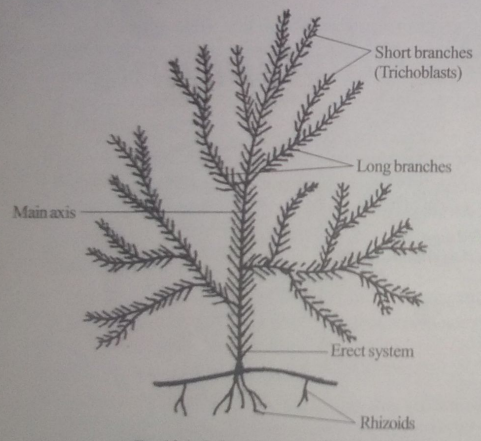


Fig.19.1: Polysiphonia thallus.

The ***erect system*** grows upwards from the creeping system.

It is made up of profusely branched ***filaments*** and it has a feathery appearance.

The filaments are ***heterotrichous*** and are of ***three*** types, namely ***main axis, long branches*** and ***short branches***.

The ***main axis*** is ***polysiphonous*** or ***multiaxial*** because it is made up of many parallel ***siphons (filaments)***.

It consists of a ***central siphon*** or ***axial siphon*** surrounded by 4 to 20 ***pericentral siphons***.

The long branches have ***unlimited growth***. They are similar to ***main axis***. Each long branch consists of a ***central siphon*** surrounded by 4 to 20 ***pericentral siphons***. So the long branches are also ***polysiphonous*** or ***multiaxial***.

The ***short branches*** are commonly called ***trichoblasts***. The trichoblasts are ***short*** and have ***limited growth***.

They are made up of only ***central siphons*** and the ***pericentral siphons*** are ***absent***. So they are ***monosiphonous***.

The trichoblasts are ***dichotomously branched***. Trichoblasts are ***colourless*** due to the absence of chromatophores. Some trichoblasts bear the ***sex organs***. They are known as ***fertile trichoblasts***.

The fertile branches may be male or female. The male branch is called ***male trichoblast***. The female branch is called ***female trichoblast***.

The male branches bear a cluster of ***antheridia***. The female branches bear the female sex organ called ***carpogonium***.

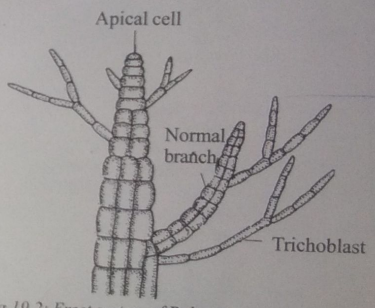


Fig.19.2: Erect system of Polysiphonia.

Highlights

Trichoblasts

- Trichoblasts are dichotomous, monosiphonous short branches with limited growth present in *Polysiphonia*.
- They are ***short branches***.
- They have ***limited growth***.
- They are ***dichotomously branched***.
- They are ***monosiphonous***.
- They are ***colourless*** due to the absence of chromatophores.
- Some branches bear ***sex organs***. They are called ***fertile branches***.
- The fertile branches may be ***male*** or ***female***.

- The male branch is called ***male trichoblast***.
- The female branch is called ***female trichoblast***.
- The male branches bear a cluster of ***antheridia***.
- The antheridium produces ***male gametes***.
- The female branches bear the ***female sex organ*** called ***carpogonium***.
- The carpogonium has a basal swollen part with an ***egg*** and an upper elongated neck called ***trichogyne***.
- The sperm is released into the water and it enters the carpogonium.
- The male and female gametes fuse together in the carpogonium to produce a ***zygote***.
- The zygote develops into a ***diploid carposporophyte***.

Highlights

Polysiphonia

- *Polysiphonia* is a ***marine, attached, red alga***.
- It is included in the class ***Rhodophyceae***.
- It is a ***triphasic*** plant. It exists in three phases namely haploid ***gametophyte***, diploid ***carposporophyte*** and diploid ***tetrasporophyte***.
- Gametophyte and tetrasporophyte are morphologically similar and independent plants. Carposporophyte is ***attached*** on the gametophyte.
- The thallus consists of a ***creeping system, rhizoids*** and an ***erect system***.
- The creeping system ***grows horizontally*** on the ***substratum***.
- The creeping system is made up of ***branched filaments***. They serve for ***perennation***.
- The ***rhizoids*** fix the thallus to the ***substratum***.
- The erect system ***grows upwards*** from the creeping system.
- The erect system consists of ***branched filaments***.
- The filaments are ***heterotrichous*** and are of three types.
  - * *Main axis*
  - * *Long branches*
  - * *Short branches*
- Main axis is ***polysiphonous***.
- The long branches have ***unlimited growth***.
- The short branches are commonly called ***trichoblasts***.
- The trichoblasts are ***short*** and have ***limited growth***.
- Trichoblasts are ***monosiphonous.***
- The trichoblasts are ***dichotomously branched***.
- Trichoblasts are colourless due to the absence of chromatophores.
- Some trichoblasts produce ***sex organs,*** called ***fertile trichoblasts***.
- The fertile branches may be male or female. The male branch is called ***male trichoblast***. The female branch is called ***female trichoblast***.

- The male branches bear a cluster of antheridia. The female branches bear the female sex organ called ***carpogonium***.
- The cell of the thallus consists of
  - * *Cell wall*
  - * *Plasma membrane*
  - * *Cytoplasm*
  - * *Central vacuole*
  - * *Chromatophores*
  - * *Nucleus*
- The cell wall is composes of ***two layers***.
- ***Outer layer*** is made of ***pectin*** and the ***inner layer*** is made of ***cellulose***.
- The plasma membrane surrounds the ***cytoplasm***.
- Cytoplasm enclosed a ***central vacuole***.
- The chromatophores contain pigments like ***chlorophyll-a*** and ***-c, β-carotenes, xanthophylls, phycocyanin-R*** and ***phycoerythrin-R.***
- ***Floridean starch*** and ***floridoside*** are the ***reserve food materials***.
- The growth is ***apical***.
- *Polysiphonia* reproduces both by ***sexual*** and ***asexual*** methods.
- The life cycle of *Polysiphonia* produces three types of individuals, they are
  - * *Gametophyte*
  - * *Carposporophyte*
  - * *Tetrasporophyte.*
- The gametophyte is an ***independent, haploid plant***.
- The gametophytic plant ***reproduces sexually***.
- The sexual reproduction is ***oogamous*** type.
- The gametophytic plants are ***heterothallic.***
- Male gamete is produced by ***male gametophyte***.
- Female gamete is produced by ***female gametophyte***.
- The ***male*** and ***female gametes*** fuse together to form a ***zygote(2N)***.
- The zygote develops into ***carposporophyte(2N)***.
- The carposporophyte is attached on the ***female gametophyte***.
- The carposporophyte reproduces ***asexually.***
- The carposporophyte produces ***diploid carpospores(2N)***.
- The carpospores germinate into ***diploid tetrasporophyte***.
- The diploid tetrasporophyte produces ***haploid tetraspores*** by ***meiosis***.
- The tetraspores germinate into ***haploid gametophytes***.
- The life cycle is ***diplo-diplohaplontic***.
- ***Two diploid phases*** alternate with ***one haploid phase***.
- It shows ***alternation of generation.***

Cell Structure

The cells of the central siphon are ***larger*** in size. They are known as ***axial cells*** or ***central cells***.

The cells of the pericentral siphons are smaller in size. They are known as ***pericentral cells***.

The cells of the siphons are interconnected by ***pit connections.***

The cell is bounded by a ***cell wall.*** The cell wall is composed of ***two layers.*** The ***outer layer*** is made of ***pectin substances*** and the inner layer is made of ***cellulose.***

Inside the cell wall, there is a ***plasma membrane.*** The plasma membrane surrounds the layer of ***cytoplasm*** enclosing a ***central vacuole.***

In the cytoplasm there are many ***discoid chromatophores.***

The chromatophores contain pigments like ***chlorophyll-a,*** and ***-c,*** ***α***-and ***β-carotenes, xanthophylls, phycocyanin -R*** and ***phycoerythrin -R.***

The ***reserve food*** materials are found in the form of ***floridean starch*** and ***floridoside.***

The ***cytoplasm*** contains a ***haploid nucleus.***

Growth

The growth takes place by the division of a ***single apical cell*** at the growing tip of the axis. The apical cell by ***transverse division*** forms the cells of central siphon. These cells then undergo ***periclinal divisions*** to form ***pericentral cells*** around the central siphon.

Reproduction

Polysiphonia reproduces both by ***sexual*** and ***asexual*** methods.

In the life cycle of ***Polysiphonia***, there are ***three*** kinds of plants. They are:

1. *Gametophyte*
2. *Carposporophyte*
3. *Tetrasporophyte.*

The gametophyte is a ***free-living, haploid plant.*** It ***reproduces*** sexually by means of ***gametes.*** The resulting ***zygote*** develops into a ***carposporophyte.*** It is a ***diploid plant*** and remain attached to the ***gametophytic plant.***

The carposporophyte reproduces ***asexually*** by producing ***diploid carpospores.***

The ***tetrasporophyte*** is an independent plant developed by the germination of carpospore. It is a ***diploid plant.*** It reproduces asexually by ***tetraspores.*** The tetraspores are ***haploid,*** and develop into ***haploid male*** and ***female gametophytes.***

Sexual Reproduction

The free-living *Polysiphonia* plant is a ***haploid gametophyte.***

In *Polysiphonia,* the sexual reproduction is an advance ***oogamous type.***

The gametophytic plant is ***heterothallic*** or ***dioecious.*** There are ***separate male*** and ***female plants.***

The ***male gametophyte*** produces the ***male sex organ*** called ***spermatangium*** or ***antheridium.***

The female gametophyte produces the ***female sex organ*** called ***carpogonium.***

The male and female plants are ***morphologically similar.***

The spermatangia are produced in ***clusters*** on a ***fertile male trichoblast,*** which is produced near the tip of ***male thallus.***

The male trichoblast is ***dichotomously branched.***

One arm of the trichoblast produces ***spermatangial cluster,*** but the other arm is ***sterile.***

In the fertile arm of the trichoblast, the lower most ***two cells*** are ***sterile*** and form ***stalk cells.***

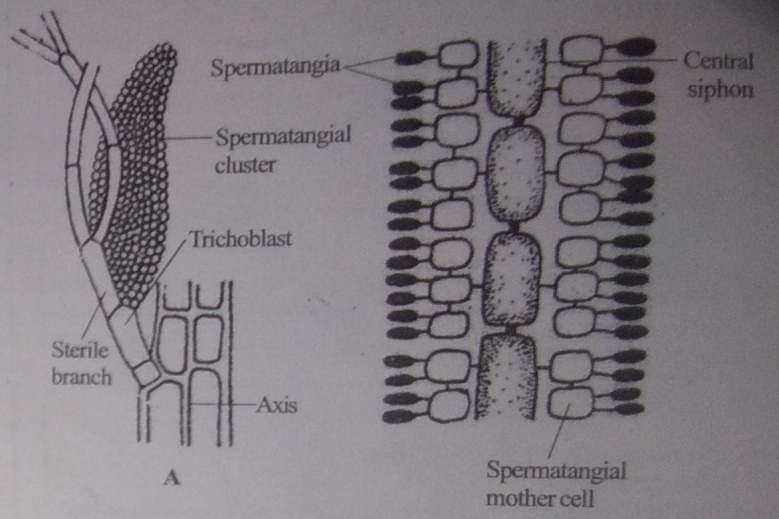


Fig.19.3: Polysiphonia - A. A male trichoblast showing a cluster of spermatangia: B-L.S. of the spermatangial cluster.

The other cells divide and form sterile pericentral cells, becoming ***polysiphonous.*** These pericentral cells divide and form ***spermatangial mother cells*** at the free ends.

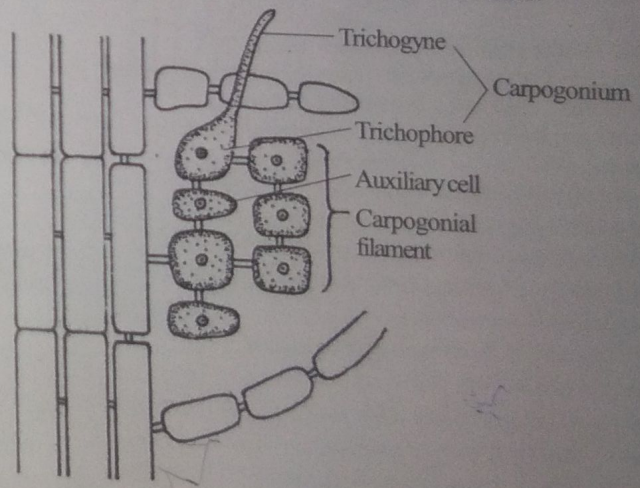


Fig.19.4: Polysiphonia - A mature carpogonium of Polysiphonia.

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spermatangial mother cell divides and forms 2 to 4 ***spermatangia***.
ch spermatangium develops into a ***single***, ***round***, ***non-motile*** and ***non-ciliated sper-m***. It is the ***male gamete***. It is ***haploid***.
The ***wall*** of the ***spermatangium breaks*** and the ***spermatium*** is liberated out. The sper-atium is carried by ***water current***.
The female plant produces the ***female sex organ*** called ***carpogonium***. The carpogonium is produced on the ***female trichoblast***.

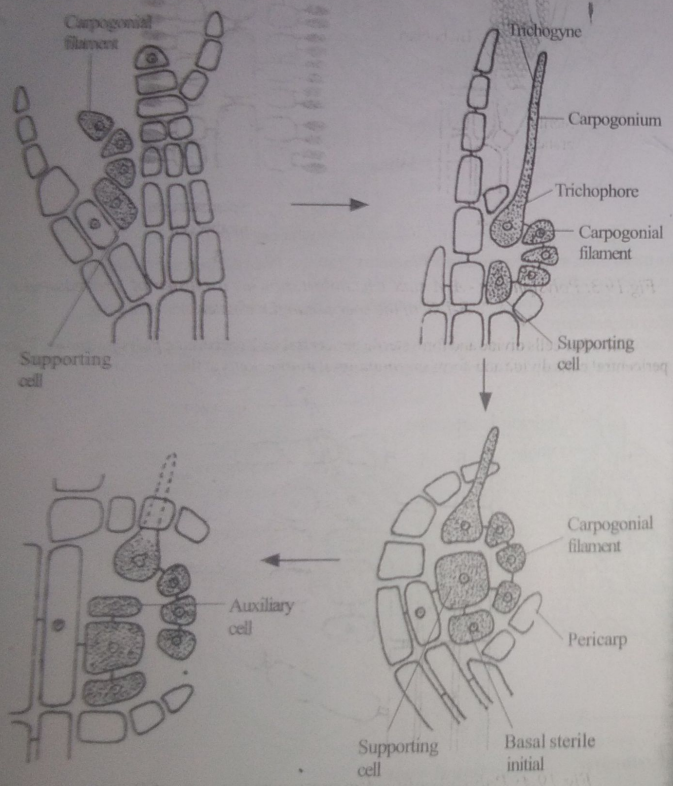

Fig. 19.5: Polysiphonia - Different stages of the development of carpogonium.

The carpogonium develops from a ***fertile pericentral cell*** on the upper side of the ***female trichoblast.***
This fertile cell is called ***supporting cell.***
The supporting cell divides and forms a ***four-celled filament*** called ***carpogonial filament.***
The terminal cell of the carpogonial filament develops into the ***female sex organ***, the ***carpogonium.***

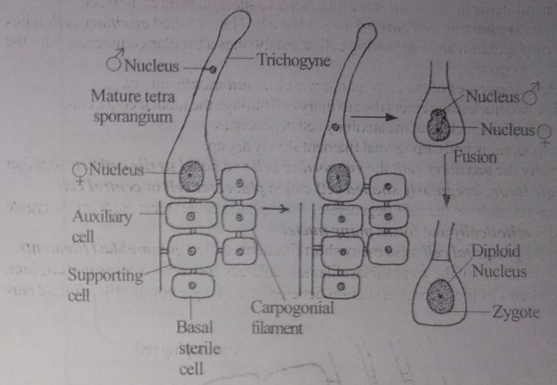

Fig. 19.6: Polysiphonia - Different stages leading to fertilization.

The carpogonium has a basal swollen ***trichophore*** and an upper elongated neck called ***trichogyne.***
The ***carpogonium*** and ***carpogonial filament*** together known as ***procarp.***
In the meantime, the supporting cell cuts off a ***basal sterile initial*** and a ***lateral sterile initial.*** These initials divide only after fertilization.
The ***released spermatia*** are carried by ***water current*** and they reach the ***carpogonium***. One spermatium adheres to the trichogyne and dissolves the wall of the trichogyne. The male nucleus passes into the trichogyne. The male nucleus fuses with the female nucleus of the trichophore and a diploid ***zygote*** is formed. The zygote undergoes post-fertilization changes and develop into a ***carposporophyte***.

Asexual Reproduction

Asexual reproduction takes place by,

1. Carpospores
2. Tetraspores.

Carpospores

(Post-fertilization **Changes**)

Carpospores are ***diploid spores*** produced by ***carposporophyte***. The carposporophyte develops from the ***zygote***.

The carposporophyte remains attached to the ***gametophytic plant***.

The changes that convert ***zygote*** into ***carposporophyte*** constitute ***post-fertilization changes***.

The important post-fertilization changes are listed below:

1. Immediately after fertilization, the basal sterile initial divides and forms two-celled ***basal sterile filament.***
2. The lateral sterile initial, at the same time, forms a short filament of 4-10 cells.
3. Now, the ***supporting cell cuts off*** a cell above it. This is called ***auxiliary cell.*** It lies between the carpogonium and supporting cell. It establishes a tubular connection with the trichophore of carpogonium.
4. The ***diploid nucleus*** of the carpogonium divides ***mitotically*** into two.
5. Of these two nuclei, one enters the auxiliary cell through the tubular connection.
6. Original haploid nucleus of the auxiliary cell degenerates.
7. The carpogonium and carpogonial filament slowly dry up.
8. Gradually the ***auxiliary cell***, the ***supporting cell*** and ***basal sterile cell*** fuse together to form a ***single large, irregularly shaped*** cell called ***placental cell*** or ***central cell***.
9. The haploid nuclei of the cells degenerate. The diploid nucleus received from the ***zygote nucleus*** divides ***mitotically*** and forms ***many nuclei***.
10. From the ***placental cell*** arise many short filaments called ***gonimoblast filaments***.
11. The terminal cell of the gonimoblast filament enlarges and forms a ***carposporangium.***
12. The contents of the carposporangium develop into a single non-motile, ***diploid carpospore.***

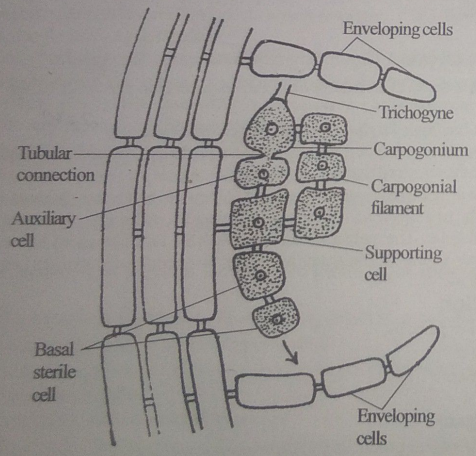

Fig.19.7: Post-fertilization changes in Polysiphonia.

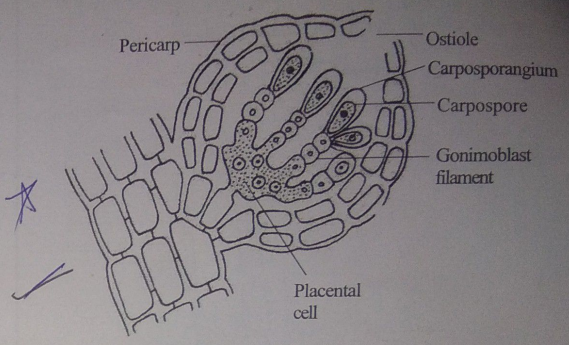

Fig.19.8: Polysiphonia - V.S. of cystocarp early stage.

13. In the mean time, a number of ***sterile filaments*** grow out from the pericentral cells, adjoining the supporting cells.
14. These sterile filaments grow around the placental cell and gonimoblast filaments forming a covering called the ***pericarp***.
15. The entire body, thus formed by the placental cell, gonimoblast filaments with carposporangia and the pericarp is known as ***carposporophyte*** or ***cystocarp.***

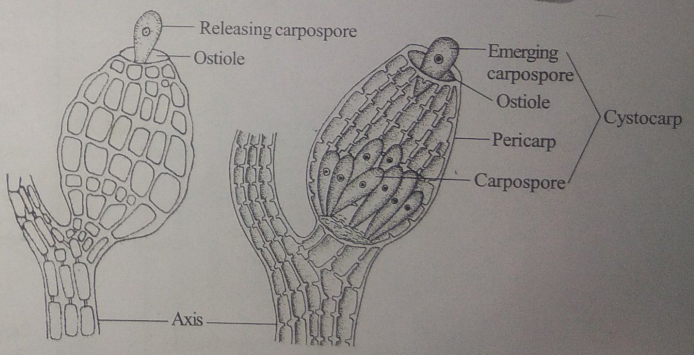

Fig.19.9: Polysiphonia.

carposporophyte is ***diploid***. It is attached on the female gametophyte. It is an ***urn***-structure.

The wall of the cystocarp is called ***pericarp***. It is ***haploid***. It has an opening called ***ostiole***.

The diploid carpospores are non-motile and are liberated out through the ostiole.

The ***diploid carpospore*** germinates into a ***diploid plant*** called ***tetrasporophyte.***

2. Tetraspores

Tetrasporophyte is an ***independent, diploid plant*** developed from ***carpospore.*** It is morphologically similar to the ***haploid gametophyte***.

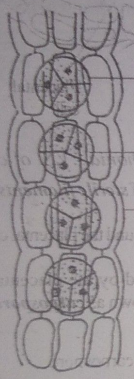

Fig.19.10:Polysiphonia - L.S. of part of tetrasporophyte showing tetraspores.

It reproduces ***asexually*** by means of ***haploid tetraspores***.

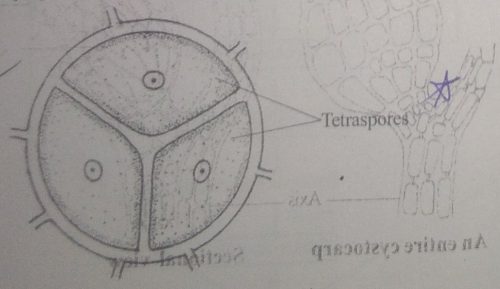

Fig.19.11: Polysiphonia - Tetrasporangium.

The tetraspores are produced inside the ***tetrasporangia***. The tetrasporangium is developed from a ***pericentral cell***.

A ***single pericentral cell*** acts as a ***sporangial mother cell***. The ***diploid spore mother cell*** undergoes ***reduction division (meiosis)*** to produce ***four haploid nuclei***.

Around each haploid nucleus cytoplasm collects and a tetraspore is formed.

These spores are arranged ***tetrahedrally*** in linear rows in the apical part of the ***thallus***.

The tetraspores are ***haploid*** and ***non-motile***. Each tetrasporangium produces ***4 haploid tetraspores***.

Two of the ***tetraspores*** of a tetrasporangium give rise to the ***male gametophytic plants*** and the other ***two tetraspores*** give rise to the ***female gametophytic plants***.

Conclusion

Polysiphonia shows ***isomorphic alternation of generation***. The life cycle of *Polysiphonia* is ***triphasic*** and ***diplobiontic***.

In the life cycle there are ***three*** different types of plants, namely-

1. *Haploid gametophytic plant*
2. *Diploid carposporophytic plant*
3. *Diploid tetrasporophytic plant.*

The gametophytes and tetrasporophytes are ***independent*** plants. They look morphologically similar and hence the alternation of generations is known as ***isomorphic***.

The carposporophyte is attached on the ***female gametophyte***. The male and female gametophytes reproduce sexually by means of ***spermatangia*** and ***carpogonia.***

The male gamete, the spermatium fuses with the female gamete to form a ***diploid zygote*** (2N).

The zygote develops into the ***diploid carposporophyte*** (2N). It is attached on the female gametophyte.

It reproduces asexually by means of ***diploid carpospores*** (2N). The carpospores develop into the third plant ***tetrasporophyte.***

The tetrasporophyte is an ***independent, diploid plant*** and it reproduces asexually by ***haploid tetraspores***.

The tetraspores are produced in the ***tetrasporangia*** after ***reduction division***.

The tetraspores germinate into ***male*** and ***female*** gametophytes.

So, in the life cycle there are ***two diploid phases*** namely ***carposporophyte*** and ***tetrasporophyte*** alternating with a haploid phase namely ***gametophyte.***

So the life cycle is ***triphasic*** and ***diplobiontic.*** It is also known as ***diplo-diplo-haplontic life cycle.*** The sexual and asexual plants are morphologically ***similar*** and so the ***alternation of generation is isomorphic.***

Table.19.1:Difference between carpospore and tetraspore.

Carpospore	Tetraspore
1. ***Single, non-motile***.	***Four spores*** arranged in a tetrahedral manner, non-motile.
2. It is ***diploid***.	It is ***haploid***.
3. It is produced by ***carposporangium***.	It is produced by ***tetrasporangium***.

4. It develops from ***carposporophyte***.	It develops from ***tetrasporophyte***.
5.It is an ***asexual spore***.	It is an ***asexual spore***.
6. It germinates into ***diploid tetrasporophyte***.	It germinates into ***haploid gametophytes***.

Highlights

Tetrasporophyte

Tetrasporophyte is an ***asexual, independent, diploid plant*** *of Polysiphonia producing tetraspore.*

- It is a ***diploid plant***.
- It reproduces ***asexually*** by ***tetraspores***.
- It is a free living ***individual***.
- The tetrasporophyte produces ***tetrasporangia***.
- Each tetrasporangium produces four haploid tetraspores by ***meiosis***.
- Two tetraspores develop into two ***male gametophytes***.
- The remaining two tetraspores develop into ***two female gametophytes***.

Life Cycle of *Polysiphonia*

Polysiphonia is a ***red alga***. All species of *Polysiphonia* are marine.

It is a ***triphasic*** plant. It exists in three phases namely haploid ***gametophyte***, diploid ***carposporophyte*** and diploid ***tetrasporophyte***.

Gametophyte and tetrasporophyte are morphologically similar and independent plants. Carposporophyte is ***attached*** on the gametophyte.

The plant body consists of repeatedly ***branched filaments*** and ***rhizoids.*** The filament is ***heterotrichous.*** It has a ***creeping system*** and an ***erect system.*** The creeping system is a repeatedly branched ***multiaxial filament.*** It is growing over the substratum ***horizontally.*** it is attached to the substratum by means of ***rhizoids.***

The erect system arises from the ***creeping system.*** It is a ***repeatedly branched, multiaxial filament.*** It consists of a ***central siphon*** surrounded by ***several pericentral siphons.***

The erect system has ***two types*** of branches, namely ***long branches*** and ***short branches.*** The long branches are also known as ***branches of unlimited growth*** or ***polysiphonous branches*** and are similar to the main axis.

The short branches are small, ***dichotomously branched, monosiphonous branches.*** They are also known as ***branches of limited growth*** or ***trichoblasts.*** They are produced near the tip of the long branches. Some trichoblasts bear sex organs so that they are known as ***fertile trichoblasts.***

The cell is bounded by a ***cell wall***. Inner to this, there is a ***plasma membrane*** which surrounds the ***protoplasm.*** The cells are interconnected by ***pit connections***. The cytoplasm contains an ***eukaryotic nucleus,*** a ***vacuole***, many ***chromatophores*** and ***reserve food***.

The chromatophores have pigments like ***chlorophyll-a*** and ***-c,*** α- and β- ***carotenes, lutein, zeaxanthin, violaxanthin, phycocyanin -R*** and ***phycoerytrin-R. Floridean starch*** is the reserve food.

Polysiphonia reproduces both by ***sexual*** and ***asexual*** methods. It has ***three types*** of individuals in the life cycle-

1. *Gametophyte*
2. *Carposporophyte*
3. *Tetrasporophyte.*

The gametophyte is an ***independent, haploid plant.*** It reproduces sexually by means of ***gametes*** and the resulting zygote develops into a ***carposporophyte.*** The carposporophyte is ***diploid*** and ***attached*** on the female gametophyte. It reproduces asexually by producing ***diploid carpospores.*** The carpospores germinate into ***tetrasporophytes***.

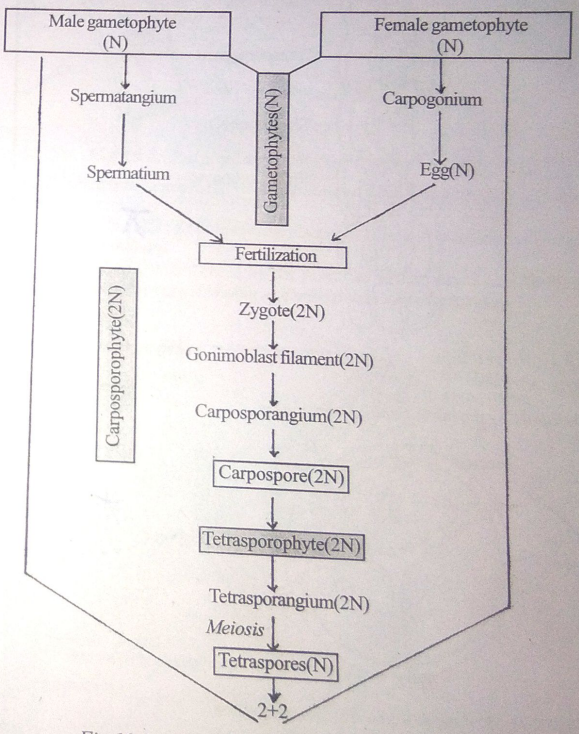

Fig.19.12: Graphic life cycle of Polysiphonia