PART II
The genus *Gracilaria* R. K. Greville was classified in the family *Spherococcaceae* by Schmitz (1889). Kylin (1930) created the family *Gracilariaceae* under the order *Gigartinales*, on the basis of the presence of a large fusion cell formed after fertilization and giving rise to gonimoblast filaments. Dawson (1949) added a new genus *Gracilariopsis* to the family *Gracilariaceae*, differentiating the new genus from *Gracilaria* by the absence of nutritive filaments in the cystocarp. However, recently Papenfuss (1966) has reduced *Gracilariopsis* to synonymy with *Gracilaria*.

There have been very few studies on the germination of spores and early stages of development in species of *Gracilaria*. Killian (1914) first reported the formation of a new shoot from a "germinal disc" with a three sided apical cell. This was confirmed by Kylin (1930) who has demonstrated three sided apical cells in old shoots of *Gracilaria verrucosa*, *Gracilaria compressa* and *Gracilaria sjoestedtii*. However, Sjostedt (1926) described a bunch of apical cells below the apex of the young thallus. Later, in *Gracilaria verrucosa* details of early stages of germination of tetraspores and carpospores were described by Sasaki (1957) and by Oza and Krishnamurthy (1968) respectively. Information on this is not available.
for other species of *Gracilaria*.

Fragmentary studies have been made on the development of carposporophyte in species *Gracilaria* by Bonnet and Thuret (1878) and Johnson (1887). Later on, Phillips (1925) studied the structure of the cystocarp in *Gracilaria confervoides* (= *Gracilaria verrucosa*), *Gracilaria foliifera* and *Gracilaria compressa*. He has reported that a true auxiliary cell is absent and that the carpogonium is a single cell with an apical papilla. There is no carpogonial branch. Sjostedt (1926) made a renewed investigation of *Gracilaria verrucosa*, *Gracilaria compressa*, *Gracilaria robusta* and showed that Phillips' (1925) observations were inaccurate.

Absence of a true auxiliary cell was reported by Sjostedt (1926) in *Gracilaria verrucosa*. He further stated that one or two vegetative cells function as generative auxiliary cells and additional vegetative cells are later on incorporated in the fusion cell. Kylin (1930) reported a two-celled carpogonia branch on a supporting cell which also bears two vegetative branches. He has further described that the fertilized carpogonium fuses with many adjacent cells and these do not form gonimoblast directly. Therefore, they cannot be described as typical auxiliary cells but as cells comparable to the auxiliary cell. Greig-Smith (1954)
reported that in *Gracilaria multipartita* there is an auxiliary cell borne directly on the supporting cell. The fertilized carpogonium sends out a short tube, which becomes connected to the auxiliary cell.

In the present imperfect state of our knowledge, particularly regarding post fertilization events in *Gracilaria* Papenfuss (1953, 1966) has rightly stated that more information is needed on the details of development in additional species of *Gracilaria*.

In India, the family Gracilariaceae is represented by twelve species of *Gracilaria* (Krishnamurthy and Joshi, 1970). Of these, *Gracilaria corticata* is a common alga growing on the rocky intertidal zone. Apart from its record in India by J. Agardh (1876), Boergesen (1933, 1938) and Dixit (1964), no other study of this species is available so far.

In view of this lack of information, it was decided to undertake a study of the morphology of *Gracilaria corticata*. 
2:1 Culture of sporelings:

The germination and early stages of development of the carpospores and the tetraspores were studied by allowing spores to shed on the glass slides. After the sporelings became firmly attached to them, the slides were transferred to one of the following media:

1) Pasteurised sea water:
   Prepared by heating filtered sea water quickly to 70°C and maintaining at that temperature for one hour each day for three consecutive days (Provasoli, 1963).

2) Erd-Schreiber solution (Provasoli, 1963)
   Sea water 1 L
   $\text{NaNO}_3$ 200 mg
   $\text{Na}_2\text{HPO}_4\cdot12\text{H}_2\text{O}$ 30 mg
   Soil extract 50 ml

3) Enriched sea water:
   Prepared by adding 0.025 g disodium hydrogen phosphate and 0.2 g sodium nitrate to one litre of sterile sea water.

The cultures were maintained under continuous illumination ranging from 700 to 800 lux and a temperature of $20 \pm 1^\circ\text{C}$. The culture medium was replenished every day.
and aerated for about one hour.

The slides were examined under the microscope every day and drawings were made of the sporelings. Some of the slides were stained with eosin and saffranin and were made permanent by adopting the dehydration method given by Johansen (1940).

For morphological studies the reproductive material of *Gracilaria corticata* was fixed for 24 hours in formalin - alcohol (Drew, 1934) or formalin - acetic - alcohol (Westbrook, 1928) and preserved in 70 percent alcohol.

For microtomy the material was softened for 2 to 3 minutes at 55°C in a small quantity of a mixture of 90 ml of 70 percent alcohol and 10 ml hydrochloric acid (Drew, 1945).

For preparing squashes the material was placed in 10 percent hydrochloric acid for ten minutes. Microtome sections were cut at 10 μ to 15 μ and were stained with Harris' hematoxylin according to the procedure described by Johansen (1940). The squashes were stained with 1 percent aqueous eosin and were made permanent as per method described by Johansen (1940).

The drawings were made with the aid of a Zeiss camera lucida.
RESULTS AND OBSERVATIONS

3: STUDIES ON SPORE GERMINATION AND EARLY STAGES OF DEVELOPMENT:

3:1 Carpospore germination and subsequent stages of development in Gracilaria corticata:

The carpospores are generally liberated in the form of a small white mucilagenous vesicle containing from 200 to 250 spores protruding through the ostiole of the mature cystocarp. Subsequently, the vesicle gets detached from the ostiole and settles on the substratum. The mucilage then dissolves, liberating the carpospores. These then become attached to the substratum. The whole process of liberation and settlement takes about 4-5 hours.

The carpospores begin to germinate without going into any resting period. However, germination of the carpospores within the cystocarp or before their liberation was not observed.

Before germination, the carpospores are spherical in shape, 18 - 22 μ in diameter with dense pigments and a single nucleus. The first division takes place in a median plane, forming a two celled sporeling (Fig. 30A). This is followed by a slightly oblique division in one of the resultant cells, thus
Germination and early stages of development of carpospores in *Gracilaria corticata* J. Ag.

A. First median division forming two-celled sporeling (2 days old).

B. Three-celled sporeling (2 - 3 days old).

C. Four-celled sporeling (2 - 3 days old).

D. Five-celled sporeling (3 days old).

E. Formation of six-celled sporeling (3 days old).

F. Nine-celled sporeling showing periclinal division in the outermost cells and differentiation of a triangular apical cell in the centre of the primary disc.

G, I. Many-celled, primary disc showing periclinal divisions in the outermost cells and an apical cell in the centre.

H. Side view of dome shaped sporeling showing apical cell and rhizoidal cells.
Fig. 31

Formation of the primary shoot from the carpospores in *Gracilaria corticata* J. Ag.

A. Surface view of advanced stage of sporeling showing apical cell and divisions in the peripheral cells of the disc.

B. Side view of dome shaped sporeling showing a formation of the primary shoot and a triangular apical cell.

C, D. Advanced stage of young sporeling showing the formation of holdfast and primary shoot.
Fig. 32 Sporelings raised from the carpospores of *Gracilaria corticata* J.Ag. under the laboratory culture conditions showing the formation of primary disc.

Fig. 33 Sporelings raised from the carpospores of *Gracilaria corticata* J.Ag. showing the formation of primary shoot and holdfast.
forming a three celled stage (Fig. 30B). The third division take place in the undivided cell perpendicular to the first median one forming the four celled sporeling (Fig. 30C). After the four-celled stage, each cell divides transversely or parallel to the first median plane forming an eight-celled primary disc which is about 28 μ to 30 μ in diameter. The cells of the primary disc are arranged in two superimposed tiers of cells (Figs. 30D, F). Subsequently, the peripheral cells of the primary disc divide periclinally. At this stage the centre of the disc is slightly arched, forming a dome shaped structure (Figs. 30F, G). The establishment of an apical cell takes place at the summit of the dome at this stage (Figs. 30F, G, I and 31A, B). The initiation of rhizoids takes place in the lower half of the sporeling from the outermost cells which are in contact with the substratum (Fig. 30H).

3:2 Tetraspore germination and subsequent early stages of development in Gracilaria corticata:

The mature tetraspores in Gracilaria corticata are cruciate, 25 - 30 μ in length and 20 - 22 μ in breadth, surrounded by a thin mucilaginous sheath enclosing four spores. At the time of liberation, these spores get separated by the dissolution of the mucilaginous sheath.
Germination and early stages of development of tetraspores of *Gracilaria corticata* J. Ag.

A. Three-celled sporeling (2 days old).
B. Four-celled sporeling (2 days old).
C. Formation of six-celled sporeling (3 days old).
D. Eight-celled sporeling showing differentiation of a triangular apical cell.
E. F. Young sporeling showing a triangular apical cell and divisions in the outermost cell of the primary disc.
H. Side view of dome shaped sporeling.
Fig. 35 Sporelings raised from the tetraspores of *Gracilaria corticata* J.Ag. under the laboratory conditions showing the formation of primary disc and erect shoot.
The liberated tetraspores are spherical in shape. The germination of the spore starts without a resting period. The first division is transverse, forming a two-celled sporeling. This is followed by perpendicular divisions in the two cells giving rise to the formation of three and four-celled sporelings (Fig. 34A). At the four-celled stage, each cell divides to give rise to an eight to nine-celled sporelings (Fig. 34D). The cells are arranged in two superimposed tiers, forming a primary disc. At this stage, the establishment of a triangular apical cell takes place (Fig. 34G). The peripheral cells surrounding the apical cell divide periclinally forming a dome shaped structure (Fig. 34H).

4. **VEGETATIVE MORPHOLOGY**

The thallus consists of a number of flattened predominantly divaricate dichotomously branched fronds arising from a holdfast (Figs. 36A, 37A). The frond may be as long as 14 - 15 mm; it is narrow at the base, gradually increasing in width to 2 - 4 mm upto the first dichotomy and then repeatedly dichotomously branched, the branches at the base of the plant growing horizontally. One of the branches grows along the substratum and, at a short distance from the parent frond, gives rise to a secondary holdfast. From this, new erect
Fig. 36

A. Young plant of *Gracilaria corticata* J. Ag. showing creeping axis and formation of secondary holdfast.

B. Formation of secondary holdfast from the creeping axis.

C. Transverse section of axis of *Gracilaria corticata* J. Ag.

D. Longitudinal section through axis showing a triangular apical cell.

E. Transverse section of a branch showing cortical photosynthetic cells and medullary cells.
fronds may arise (Fig. 36A). Several branches spread out horizontally in a similar manner becoming anchored by new secondary holdfasts (Fig. 36B). If the horizontal branches become severed accidently, the new frond arising from the secondary holdfast continues as a new individual.

At the apex of the main axis or of a branch, a single apical cell has been observed (Fig. 36A). This cell divides and gives rise to segments successively on three sides towards the base, so that the segments of the apical cell appear to be arranged in three vertical series. Each of the three segments gives rise to laterals of repeatedly dichotomosing cells which form a fairly wide medulla and a very narrow cortex. The cells are progressively smaller from the medulla to the cortex. The cortex is very distinct from the medullary region because of the small size of its cell and dense photosynthetic pigments (Fig. 36C).

A longitudinal section of the older part of the frond shows that the cells in the centre are the largest. From the central region outwards, the cells are progressively shorter, those of the peripheral region being more or less circular in outline and dense in contents (Fig. 36D).

A transverse section of the thallus show a clear demarcation between a medulla of large cells,
140 - 200 u in diameter, and a cortex of small cells 10 - 15 u in diameter. The outermost layer of the thallus consists of densely pigmented cells measuring 6 - 7 u in length and 4 - 5 u in breadth. Internally, the cells become progressively larger with fewer chromatophores and merge with the large celled medulla (Fig. 36C). Occasionally, a few peripheral cells produce colourless hairs which are deciduous, measuring 150 u to 200 u in length and 4.5 u in thickness and possessing a thin gelatinous sheath.

5. DEVELOPMENT OF TETRASPORANGIA:

The mature tetrasporic plant is relatively robust and 14 - 15 cm in length (Fig. 37A). The tetrasporangia are densely scattered on both surfaces of the frond except at the apex and the lowermost portion of the frond. The tetrasporangial mother cell is differentiated in the cortical portion of the thallus (Fig. 37B). Morphologically, the mother cell of a lateral system. The mother cell accumulates reserve food materials and becomes densely pigmented (Figs. 37B-E). The contents of each sporangium divide to form four tetraspores arranged in a cruciate manner (Figs. 37F, G). The tetrasporangium is embedded in the thallus and is surrounded laterally by radially elongated cells (Fig. 37F). In surface view, the tetrasporangium is
Developmental morphology of tetrasporangium in *Gracilaria corticata* J. Ag.

A. Tetrasporic plant of *Gracilaria corticata* J. Ag.

B. Transverse section of young apical branch of *Gracilaria corticata* J. Ag. showing differentiation of tetrasporangial mother cell in the cortical layer. Note the pit connection between tetrasporangial mother cell and end cell of the branchlet.

C-E. Successive stages in the formation of tetrasporangium.

F. Transverse section of tetrasporic plant showing cruciately divided tetrasporangium with radially elongated cortical cells.

G. Mature, cruciate tetrasporangium.
circular or oblong in shape. The mature tetrasporangium is bright red in colour ranging in size from 25.6 \( \mu \) to 38 \( \mu \) in length and 14.4 \( \mu \) to 20 \( \mu \) in width (Fig. 37G).

6. DEVELOPMENT OF THE SPERMATANGIAL CLUSTER:

The spermatangial plant (Fig. 38A) can be readily distinguished from the tetrasporic and the cystocarpic plants as well as from the vegetative plants by its pale red colour. The spermatia are found in clusters inside globular or avoid cavities, 25 - 30 \( \mu \) wide and 50 - 60 \( \mu \) deep (Fig. 38F), scattered all over the surface of the thallus (Figs. 38A, B). The cavities have openings which are surrounded by a definite raw of marginal cells which are different from the surface cells of the thallus (Fig. 38B). This gives a characteristic blistered appearance to the cavities (Figs. 38A, B).

The origin or the spermatangial cavity can be traced to the young parts of the thallus near its apex. A surface view of the thallus in this portion shows that the superficial cells of the thallus are interrupted at places (Fig. 38A). Lining these depressions are one or a group of two to eight spermatangial mother cells (Fig. 38C). These are morphologically end cells of lateral systems. These mother cells 6 to 10 \( \mu \) in diameter then undergo
Fig. 38

Developmental morphology of spermatangial sori in *Gracilaria corticata* J. Ag.

A. The portion of spermatangial branch showing blistered like appearance of spermatangial sori.

B. Surface view of spermatangial plant showing confluent spermatangial sori.

C. Transverse section of young spermatangial branch to show the origin of spermatangial mother cells.

D-F. Successive stages in the formation of spermatangial sori.

spm = spermatangial mother cell
sp = spermatangium
**Fig. 39**

A. Transverse section of spermatangial plant of *Gracilaria corticata* J.Ag. showing mature spermatangial sori.

B. A group of spermatium of *Gracilaria corticata* J.Ag.

C. Transverse section of spermatangial plant showing dehisced confluent, spermatangial sori.

spr = spermatium
Fig. 40 Transverse section of the spermatangial plant of *Gracilaria corticata* J.Ag. showing mature, confluent spermatangial sori
division such that a cluster of spermatangia each of 2 - 3 μ diameter are formed from each mother cell (Fig. 38D).

Presumably, as the number of spermatangia increases, the spermatangial cluster becomes immersed in a cavity which gradually deepens (Figs. 38F, 39A).

In older parts of the thallus, adjacent spermatangial cavities may fuse and give rise to confluent spermatangial cavities (Figs. 39C, 40).

7. DEVELOPMENT OF THE PROCARP AND THE CYSTOCARP:

In Gracilaria corticata, the procarps are produced near the apices of the branches. The procarp consists of a two-celled carpogonial branch borne on a supporting cell. The supporting cell is an ordinary vegetative cell in the outer region of the cortex. The supporting cell also bears a sterile lateral branch consisting mostly of two cells (Figs. 41B, C). The mature procarp soon becomes surrounded by the nutritive cells which are dense in protoplasmic contents. These are the modified cortical cells in the vicinity of the procarp. No true generative auxiliary cell could be recognised in this species (Fig. 41D).

The mature carpogonium shows a more prolonged trichogyne (Fig. 41C). After fertilization,
Fig. 41

A. Habit of cystocarpic plant of *Gracilaria corticata* J.Ag. from the coast of Veraval.

B. Detail of young procarp of *Gracilaria corticata* J. Ag. showing two-celled carpogonial branch developed externally on the supporting cell.

C. Post-fertilisation stage of *Gracilaria corticata* J.Ag. showing reduced carpogonium and young fusion cell.

tr = trichogyne
op = carpogonium
l.b.= sterile lateral branch
s.c.= supporting cell
f.c.= fusion cell
the trichogyne shrivels up and the carpogonium fuses with the lower cell of the carpogonial branch, the supporting cell and the sterile cells, resulting in a large fusion cell (Figs. 41D and 42A, B). The fusion cell is an irregular, lobed structure (Figs. 42B, C). During later stages, a number of cells surrounding the procarp become enlarged and irregular in shape. These might also establish prominent pit connection with the fusion cell, with result that the fusion cell appear to be ramified.

The gonimoblasts are initiated from the fusion cell (Fig. 42C) as a number of lobes. These become delimited as cells which give rise to dichotomous branching filaments (Fig. 42F). These filaments form a compact pseudoparenchymatous tissue. From the end-cells of these filaments, carpospores are formed in chains, borne on slightly enlarged stalk cells. The carpospores are more or less spherical, 18 - 20 μ in diameter and have granular contents and a single nucleus (Fig. 42G).

Concurrently with the growth of the carposporophyte, the associated gametophytic tissue of the outer cortex proliferates considerably and forms the pericarp consisting of many layers of radially elongated cells. A mature cystocarp shows the presence of irregular filaments extending from the
**Fig. 42**

*Gracilaria corticata* J. Ag.

A-D. Post-fertilisation stages in *Gracilaria corticata* J. Ag.

E. Details of nutritive cell arising from gonimoblast.

F. Cells of pseudoparenchymatous tissue.

G. Detail of chains of carposporangia arising from gonimoblasts.

H. Nutritive filament from pericarp of cystocarp.

- **gon** = gonimoblast
- **f.c.** = fusion cell
- **n.f.** = nutritive filament
- **g.f.** = gonimoblast filament
- **cs** = carpospore
gonimoblasts to the base of the pericarp (Fig. 42H). These are the so-called "nutritive filaments".

The mature cystocarps are globose, ostiolate and constricted at the base (Fig. 43). They are borne profusely all over the surface of the thallus (Fig. 41A).
Fig. 43 Longitudinal section of a mature cystocarp of *Gracilaria corticata* J. Ag.
Germination and early stages of development of carpospores and tetraspores in *Gracilaria corticata*:

In the present investigation it has been found that carpospores and tetraspores of *Gracilaria corticata* germinate without undergoing a resting period. The germination of the spores, however, takes place only after their liberation. Similar observations have been reported by Jones (1956) on *Gracilaria verrucosa*.

Studies on the germination of the carpospores and tetraspores in species of *Gracilaria* are very scanty. Except for the work of Sasaki (1957b), no information is available on the germination of the tetraspores in species of *Gracilaria*.

The observations on the germination of the carpospores in *Gracilaria corticata* has shown that a primary disc is formed from the germinating spore and subsequently in the 8 celled stage, the cells are arranged in two tiers of 4 cells each, the whole forming a slightly dome shaped structure. At this stage, the establishment of an apical cell takes place. Similar observations were reported by Killian (1914) on *Gracilaria confervoides* (= *Gracilaria verrucosa*) and Oza and Krishnamurthy (1967) on
Gracilaria verrucosa. However, Killian (1914) has not shown the details of germination from the spore up to the eight-celled stage. These details have been observed by Oza and Krishnamurthy (1967) for Gracilaria verrucosa earlier, but presented for the first time here for Gracilaria corticata.

It has been observed that in Gracilaria corticata, the tetraspore divides first by a median partition wall resulting in a two-celled sporeling. This is followed by further divisions in the two cells by means of walls perpendicular to the first partition wall resulting in a four-celled sporeling. The four cells divide further to give rise to a disc of eight cells. At this stage, the cells appear to be arranged in two tiers, the centre of the disc being slightly arched. A triangular apical cell of the future thallus is differentiated at the summit of the arch. Similar stages have been observed in the germination of the carpospores in Gracilaria corticata (Figs. 31A, B).

Sjostedt (1926) has reported that in Gracilaria compressa, growth takes place by means of a bunch of apical cells. This has not been confirmed by other workers in other species of Gracilaria.

Kylin (1930) has reported a single apical cell in Gracilaria confervoides, Gracilaria sjoestedtii
and *Gracilaria compressa* and Dawson (1949) in *Gracilaria spinigera*. *Gracilaria corticata* is similar to these species in possessing a single apical cell, which is differentiated very early in the sporeling.

**Tetraspore development:**

Sjostedt (1926) has reported that in *Gracilaria confervoides*, *Gracilaria compress* and *Gracilaria robusta*, the "tetrasporic mother cell" is cruciately divided and is developed from a primary cortical cell.

It has been shown for the first time in the present investigation that in *Gracilaria corticata*, the tetrasporangial mother cell is differentiated in the cortical layer and is the end cell of a lateral system. The tetraspore mother cell enlarges, accumulates food materials and is densely pigmented. The contents of each sporangium divide to form four tetraspores arranged in a cruciate manner.

**Spermatangial development:**

In the genus *Gracilaria* the spermatangia are generally grouped in sori and two types of sori may be distinguished. Sori forming patches in shallow depressions and sori lining a simple or confluent cavity (Sjostedt, 1926; Dawson, 1949).
In *Gracilaria corticata*, spermatangia are found in cavities which may be derived from spermatangial sori which become confluent. It has been shown in the present investigation that in *Gracilaria corticata*, a group of spermatangial mother cells 2 to 8 in number, is formed in the outer cortex of the thallus. These cells are morphologically end-cells of laterals and are 6 to 10 in diameter. These undergo division, forming clusters of globular spermatangia, 2 to 3 \( \mu \) in diameter. These spermatangia soon become sunk in a conceptacle like cavity. The spermatangial cavities are separated by radially elongated cells of the cortex (Fig. 39A). On maturation, the spermatangial cavities fuse together forming a confluent structure.

Similar spermatangial cavities have been reported by Thuret and Bornet (1878) and Buffam (1893) in *Gracilaria confervoides*, by Ohmi (1955, 1958) in *Gracilaria textorii* and *Gracilaria arcuata* and by Dawson (1949) in *Gracilaria cunninghamii*. However, these authors have not studied the origin and development of the spermatangia and the spermatangial cavity.

Spermatangial plants have been recorded in 22 species of *Gracilaria* by earlier authors (Dawson, 1949; Kim, 1970 and Ohmi, 1955, 1958). The present
investigation adds one more record, viz. of *Gracilaria corticata*. The origin and development of spermatangia and their subsequent aggregation in cavities are traced for the first time in the genus.

**Development of the procarp and the cystocarp**:

The earliest report of the procarp in *Gracilaria* was by Sjostedt (1926). He observed that the procarp in *Gracilaria confervoides* (=*Gracilaria verrucosa*) and *Gracilaria robusta* is two-celled and is developed from the stalk cell from a primary cortical cell. The stalk cell also bears a two to three-celled sterile branch and no auxiliary cell could be recognised. These observations were later confirmed by Kylin (1930) in *Gracilaria sjostedtii*; *Gracilaria remisecunda*; Dawson (1949) in *Gracilaria vivesii* and *Gracilaria turgida* and by Ohmi (1958) in *Gracilaria verrucosa*. However, Greig-Smith (1954) has reported that in *Gracilaria multipartita*, there is a true auxiliary cell, borne on the supporting cell and it is from this that the fusion cell develops. The connection between the auxiliary cell and the carpogonium is by "a sporogenous filament."

The present observations on *Gracilaria corticata* has shown that the procarp consists of a two-celled carpogonial branch arising from a supporting cell. In the young procarp, the carpogonium is a conical cell with
a trichogyne which is not prominent. In an older stage, the trichogyne becomes prolonged into a cylindrical organ. These observations agree with those of Dawson (1949) on Gracilaria ramisecunda.

After fertilisation, the trichogyne shrivels up and the carpogonium fuses with the lower cell of the carpogonial branch, the supporting cell and the sterile cells, thus resulting in the fusion cell (Figs. 42A, B). This observation confirms the findings of Sjostedt (1926) on Gracilaria robusta and Gracilaria arcuata and by Kylin (1930) on Gracilaria sjoestedtii. No true auxiliary cell has been observed in Gracilaria corticata as described by Greig-Smith (1954) in Gracilaria multipertita.

In the present investigation on Gracilaria corticata, it has been observed that the pericarp formation takes place very early, probably just after fertilisation. This agrees with the observations of Dawson (1949) on Gracilaria veleroae.

According to Kylin (1930) in Gracilaria sjoestedtii, the carpogonium after fertilisation fuses with many adjacent cells, resulting in a large irregular fusion cell. In the present investigation, there is some evidence to show that the fertilised carpogonium fuses with the carpogonial branch,
the supporting cell and the sterile branch. Moreover, nutritive cells in *Gracilaria corticata* are shown to be definitely derived from vegetative cells surrounding the fusion cell.

The gonimoblasts are initiated from the fusion cell as a number of lobes. These lobes give rise to dichotomously branching filaments which form the mature gonimoblasts and these become a compact pseudo-parenchymatous tissue from which arise elongated cells bearing carpospores in chains. At this stage, branched nutritive filaments have been observed arising from the gonimoblast filaments and extending to the base of the cystocarp, which, by this time, is well developed.

The above observations on *Gracilaria corticata* have brought out a number of new points regarding the post-fertilisation development. These are 1) the constitution of the fusion cell, 2) the initiation of the gonimoblasts, 3) the formation of the nutritive cells as a distinct tissue at the base of the cystocarp and 4) the structure of the mature gonimoblast.
Observations on the germination and early stages of development of carpospores and tetraspores have shown that the pattern of germination is more or less similar. An apical cell of the future thallus is established at the eight celled sporeling stage.

Studies on the origin and development of the tetraspores have shown that the tetrasporangial mother cell is an end cell of a lateral. The arrangement of tetraspores in *Gracilaria corticata* is cruciate.

Studies on the origin and development of the spermatangium has shown that the spermatangial mother cells are end cells of lateral branches. The mature spermatangia are found in confluent spermatangial cavities. The spermatangia are globular 2 u to 3 u in diameter.

The procarp of *Gracilaria corticata* consists of a two celled carpogonial bears a branch borne on a supporting cell, which also sterile branch of 2 to 3 cells. Auxiliary cell could not be recognised. The post-fertilisation stages leading to the formation of the cystocarp and the carpospores are described in detail.