The life history of genus *Cycas* :

Systematic Position of *Cycas*:

Division: Gymnospermae
Class: Cycadopsida
Order: Cycadales
Genus: *Cycas*

Distribution of *Cycas*:

Several species of the genus *Cycas* have been found widely distributed from Madagascar to Japan including Australia. The genus includes about sixteen species which are found wild or cultivated in the tropical and sub-tropical regions of the world.

In our country they are distributed in the Andaman and Nicobar Islands, Tamil Nadu, Nepal, Sikkim, Bengal and Assam. About five species have been reported from various parts of our country.

The species found in our country are: (important)

Cycas revoluta, C. beddomei, C. circinnalis, C. rumphii and C. pectinata.

In general, the plants are low and palm-like. The normal size of the plant ranges from 4 to 8 feet in height. *Cycas* media is the tallest species upto 20 feet in height. The stem is un-branched, columnar and covered with persistent leaf bases. The leaves are pinnately compound and aggregated in internal crown.

The distinguishing characters of the genus *Cycas* are as follows:

1. The leaf segment remains circinately involute within the bud.
2. The pinnae are provided with central mid-rib but no lateral veins.
3. The megasporophylls are not aggregated in cones but borne separately like foliage leaves pectinate in their upper part.
4. The megasporophyll bears on its lower margins two or more ovules.
5. The ovules are ascending.

External Morphology of *Cycas*:

Cycas is perennial, slow growing evergreen plant and is referred as living fossil because it occurs as a fossil e.g., *C. fusiana*. It looks like a palm tree. Its main plant body is sporophytic, diploid, dominant and can be differentiated into three parts – roots, stem and leaves. Tallest species of *Cycas is C. media* with 20 feet height.

1. Roots:

They are of two types – normal and coralloid roots. Normal roots grow deep into the soil and form tap root system. Later it is replaced by adventitious roots. The function of these roots is to fix the plant in the soil and to absorb water and other minerals.

From the normal roots develop some small lateral apogeotropic branches near the ground surface. These lateral roots get infected with bacteria, fungi as well as algae. The entry of these organisms is said to be responsible for the characteristic, swollen, knob like or coral like appearance and hence, these roots are called as **coralloid roots** or corallorhiza. These roots have minute pores (lenticels like) which are respiratory in function (aeration). Root cap and root hairs are absent in coralloid roots (Fig. 2). **(important)**

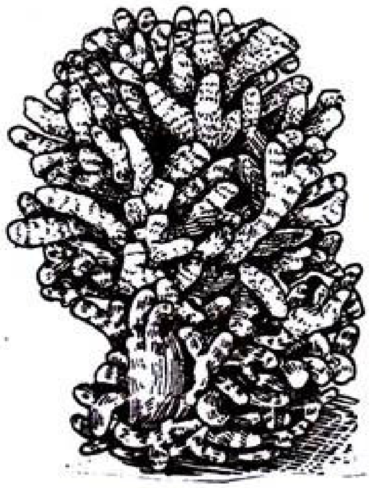


Fig. 2. *Cycas.* Coralloid roots.

2. Stem:

It is thick, erect, woody, aerial and usually unbranched (caudex). Branching is rare and it is due to injury or development of adventitious buds. Surface of the stem is rough due to the presence of persistent woody leaf bases (Fig. 4). These leaf bases form thick armour around the stem. In the armour are distinctly visible the alternating bands of large and small rhomboidal leaf bases. Larger ones are of foliage leaves and smaller ones are of scaly leaves and megasporophylls in the female plant. The leaf bases are spirally and compactly arranged with each other (Fig. 4). At the top is present a crown of leaves.

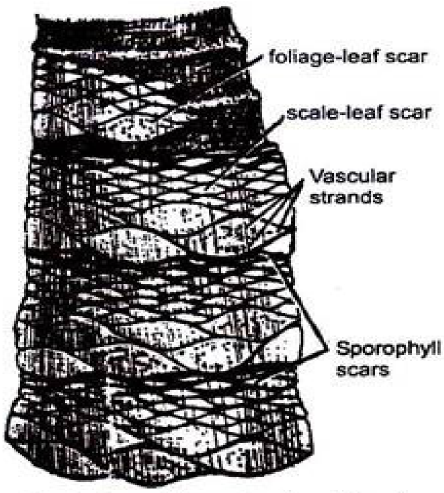


Fig. 4. ***Cycas*, Stem showing alternate bands of larger foliage leaf bases and smaller scaly leaves and megasphorophyll bases.**

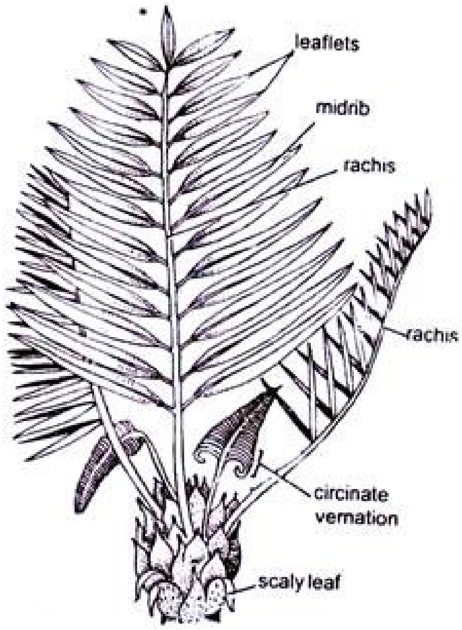
3. Leaves:

Leaves are dimorphic i.e., of two types – scale leaves and foliage leaves. Both these types of leaves form a crown at the top of the stem.

(a) Scale leaves:

These are small, dry, brown, triangular structures with a thick covering of brown hairs or rameta. These leaves alternate with green foliage leaves. These leaves protect the shoot apex and reproductive structures (Fig. 3).

Fig. 3. *Cycas*. A scale leaf



(b) Foliage leaves:

These leaves are also produced in a crown at the apex of the stem. A single foliage leaf is pinnately compound. It is unipinnate and paripinnate. Each leaf has 80-100 pairs of leaflets which are arranged on both the sides of adaxial groove of the rachis in opposite or alternate manner. The rachis is spiny below with the sheathing leaf base (Fig. 6A). these spines are modified leaflets. Each leaflet is leathery in texture, sessile elongated, ovate or lanceolate in shape and has entire margin with acute apex. Each pinna or leaflet contains a midrib without lateral veins.

Margins of the pinnae are flat (Fig. 6B) but sometimes they are curved downwards and inwards (revolute) (Fig. 6C) which give the plant a specific name *C. revoluta.* Young leaves have **circinately coiled leaflets** which are also covered by hairs or ramenta like those of ferns (Fig. 6 D, E)

(important) The **"vernation is circinate in the midrib and pinnules of Cycas.** Leaves, when young, have circinately coiled pinnae like those of ferns (Fig. 8.14). Very young parts of *Cycas* are also covered by fern-like hairs or ramenta.

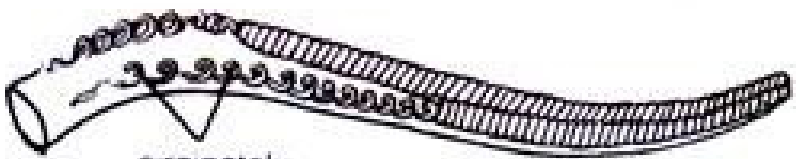


Fig. 8.14. *Cycas* A young leaf showing circinate vernation.

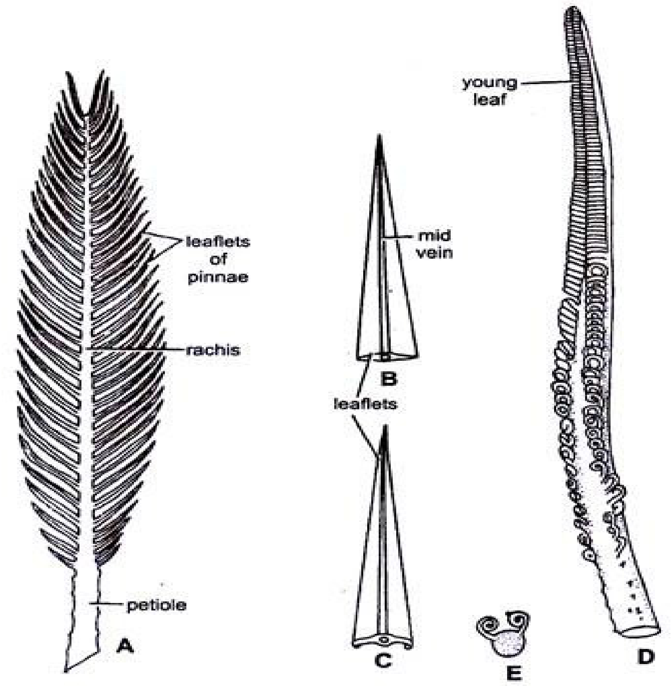
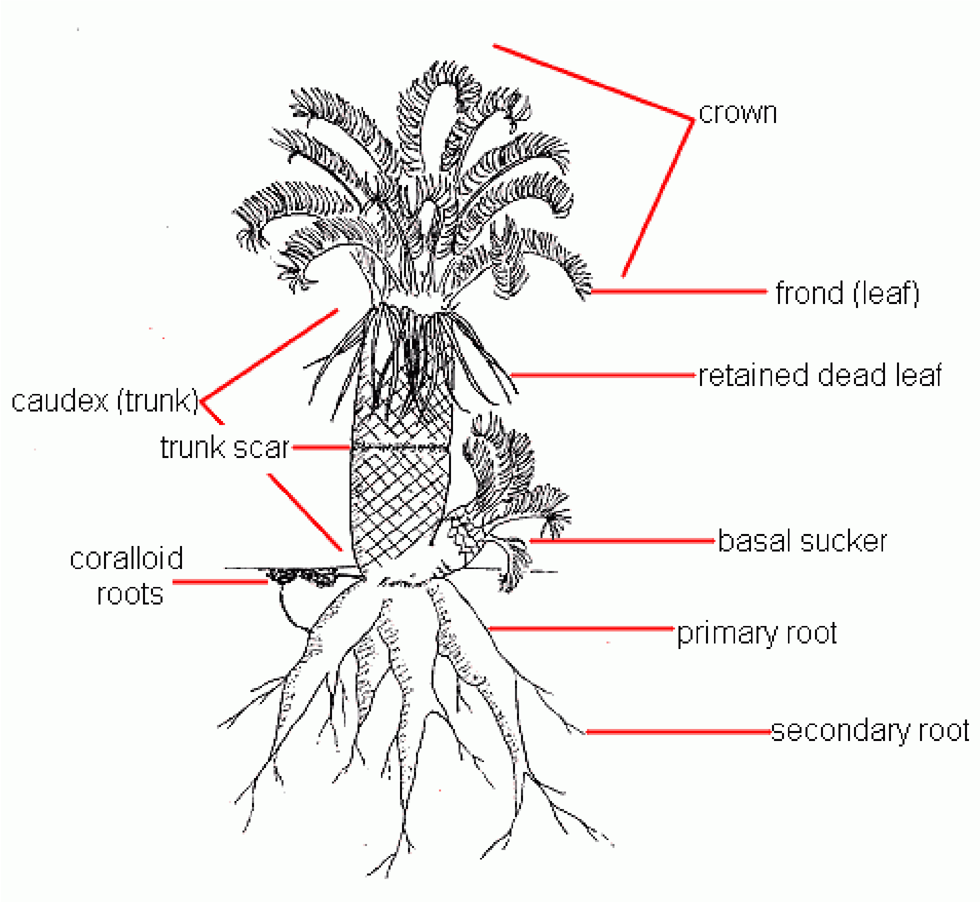


Fig. 6. (A-E) *Cycas*. (A) External features of a normal foliage leaf; (B) Flat leaflet of *C. rumphii*, (C) Revolute leaflet of *C. revoluta*, (D, E) Young foliage leaf showing circinate vernation of leaflets.



External morphology showing the various parts

Internal Structure of *Cycas*:

1. Root:

(i) Normal root:
Its internal structure is exactly similar to that of dicot root. It is circular in outline and can be differentiated into epiblema, cortex and vascular tissue.
a. Epiblema:
It is the outermost limiting layer and consists of single layer of thin walled cells. Some of its cells give rise to root hairs.
b. Cortex:
Epiblema surrounds the multilayered zone of thin walled parenchymatous cortex with numerous intercellular spaces. The cells of the cortex are filled with starch. Some tannin cells, mucilage cells and sometimes sphaeraphides (calcium oxalate crystals) are also present in the cortex. The innermost layer of the cortex forms the endodermis which is characterised by the presence of casparian strips.
c. Vascular tissue:
Endodermis is followed by multilayered parenchymatous pericycle. Vascular bundles are radial. Xylem is diarch and exarch i. e., protoxylem is towards the periphery). The protoxylem consists of spiral tracheids whereas the metaxylem consists of scalariform thickenings. Vessels are absent. Alternating with the protoxylem groups are present phloem cells consisting of sieve tubes and phloem parenchyma. The companion cells are completely absent (Fig. 7A, B).

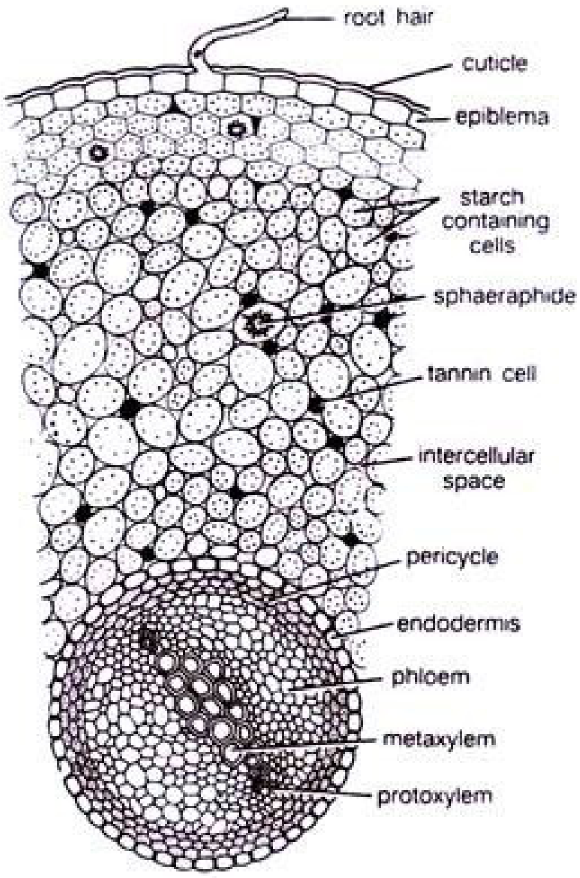


Fig. 8.16. *Cycas revoluta* T.S. normal root (*Young*)

(ii) Coralloid Root:
The transverse section of the coralloid root is similar to that of normal root and it can be differentiated into epidermis, cortex and vascular tissue.
a. Epidermis:
In young root, it is similar to normal root. However, in old root the outermost tissue is periderm. It consists of 2 to 5 layers of dead cells.

b. Cortex:
The cortex is wider in comparison with the normal root. A greenish algal zone is present almost in the middle of the cortex and divides it into outer cortex and inner cortex (Fig. 9A, B).
The algal zone consists of loosely connected, radially elongated thin walled cells occupied by blue green algae (*Anabaena cycadae, Nostoc punctiforme, Oscillatoria*), bacteria (Azotobacter, *Pseudomonas radicicola*) and some fungi. The main function of these roots is nitrogen fixation due to the presence of cyanophycean members. Endodermis is similar to normal root.

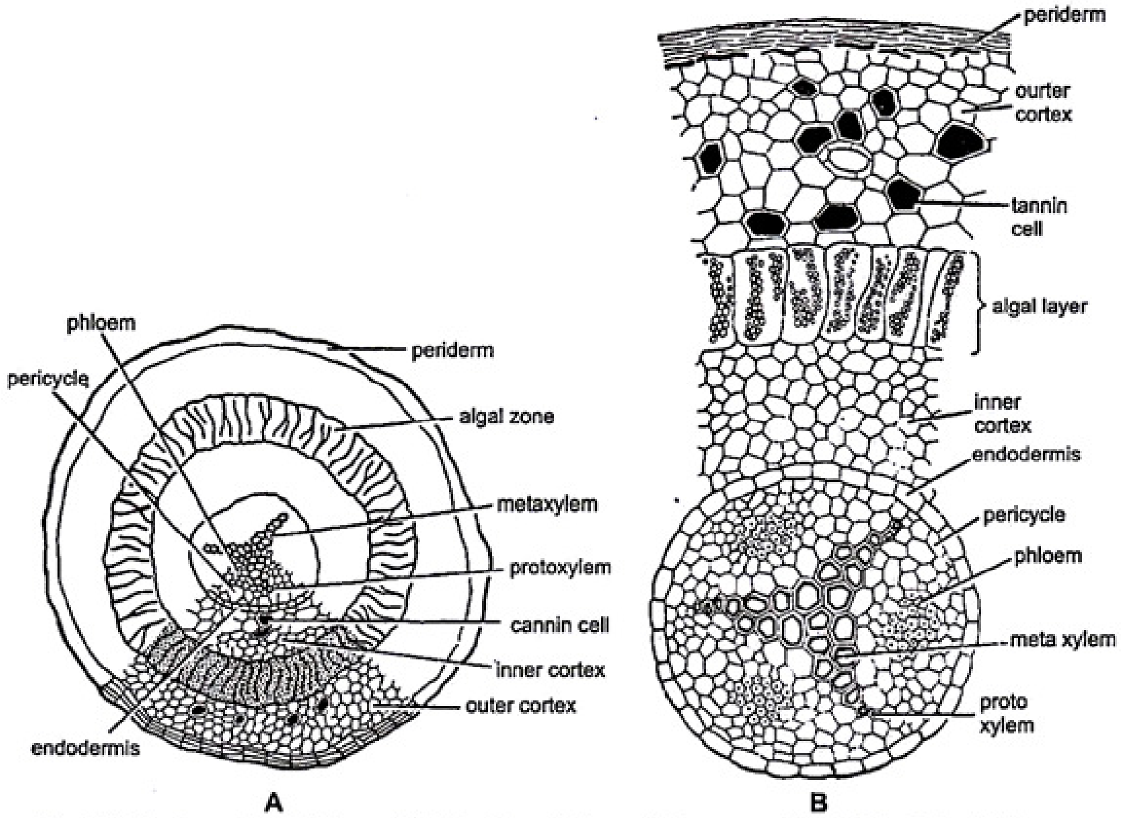


Fig. 9 (A, B). *Cycas.* Coralloid root (A) T.S. of Coralloid root (diagrammatic), (B) T.S. of Coralloid root (a portion cellular)

c. Vascular tissue:
Endodermis is followed by multilayered parenchymatous pericycle. Vascular bundles are radial. Xylem is triarch and exarch.
Secondary growth is very rare or absent. No secondary xylem or secondary phloem are developed although cork and cork cambium are present.

Comparison between Normal Root and Coralloid Root: (important)

Normal root:	Coralloid root:
1. Develops from the radicle, tap root system	1. Develops from the normal roots
2. Geotropic	2. Apogeotropic
3. Such characters are absent	3. Develops from the normal roots
4. Such infection is absent	4. Dichotomously branched and appears like coral
5. Root hairs are present	5. Gets infected with algae, bacteria and fungi
6. Cortex is smaller	6. Absent
7. Such division is absent	7. Cortex is wider in comparison
8. Diarch	8. Due to presence of the algal zone in the cortex, it is differentiated into outer cortex and inner cortex
9. Secondary growth present	9. Very little or absent
10. Main functions are: fixation of plant,	10. Main function is nitrogen fixation

absorption of water and mineral nutrients	

2. Stem:
A transverse section of young stem is similar to dicot stem. It is irregular in outline due to persistent leaf bases. Internally, it can be differentiated into epidermis, cortex and vascular cylinder.

a. Epidermis:
It is the outermost layer of the stem. It is made up of compactly arranged thick walled cells. Epidermis is ruptured due to the armour of persistent leaf bases (Fig. 11A).

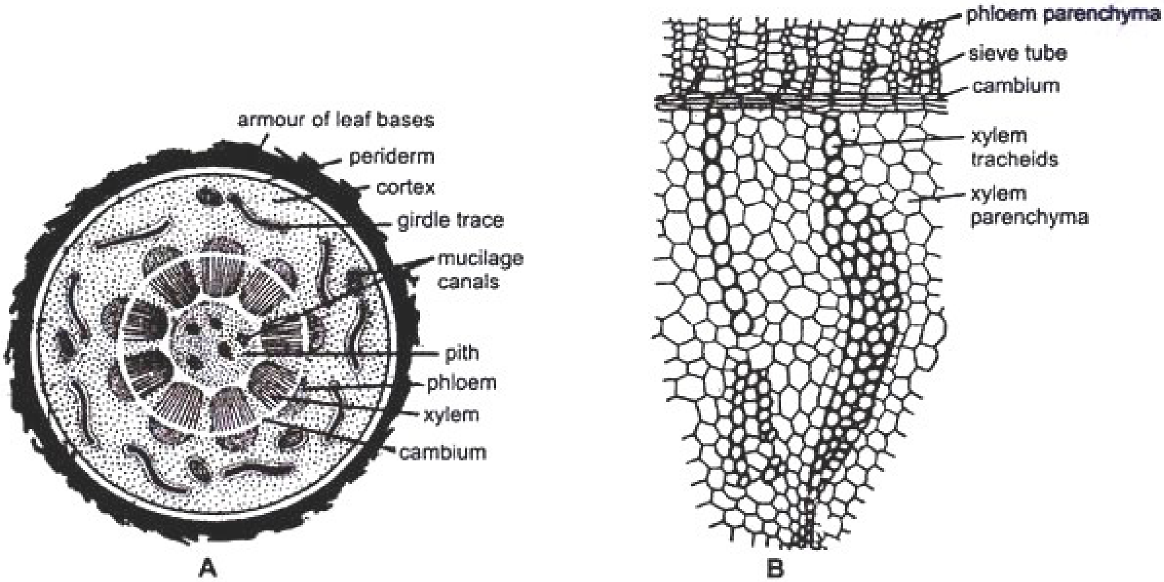


Fig. 11 (A, B) ***Cycas.*** **(A) Diagrammatic representation of T.S. of young stem; (B) A part of vascular bundle.**

b. Cortex:
Epidermis encloses the cortex. It forms the major portion of the stem. It is composed of parenchymatous cells which are filled with large number of starch grains. These starch grains are the source of sago starch. Therefore, *C. revoluta* is popularly known as sago palm.
Scattered in the cortex are various mucilage canals. Each mucilage canal is lined by many radially elongated epithelial or secretory cells (Fig. 10). which secrete mucilage. These canals are connected with those of the pith with the help of the medullary rays. The innermost layer of cortex is endodermis. It is not distinct.

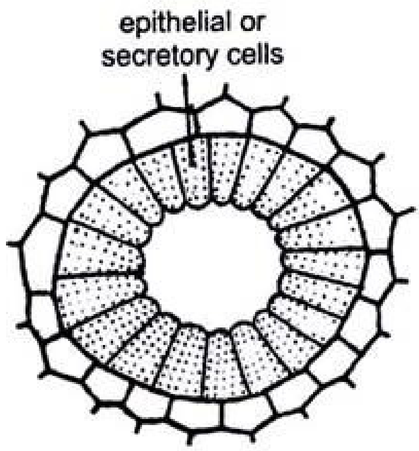


Fig. 10. ***Cycas.*** **A mucilage canal**

c. Vascular Cylinder:
The vascular cylinder is surrounded by not very conspicuous pericycle. Like dicot stems vascular cylinder consists of many conjoint, collateral, open, endarch vascular bundles arranged in a ring (ectophloic siphonostele). The xylem consists of tracheids and Xylem parenchyma (Fig. 11B). Vessels are absent. Outside the xylem is the phloem which consists of sieve tubes and phloem paraenchyma. Companion cells are absent. The Xylem is separated from the phloem with the help of primary combium. The cells of the primary cambium are brick shaped.
The cells lying in between the vascular bundles form the medullary rays. These are parenchymatous and connect the pith with the cortex. Each medullary ray is one celled wide and 1 to 20 cells long.
d. Pith:
In the centre of the stem is present large canals leaf traces massive pith consisting of parenchymatous cells which are rich in starch (sago starch). A large number of mucilage canals are also present, which are exactly similar in structure with the mucilage canals present in the cortex.
e. Leaf Traces and Girdle Traces:
The leaf traces are scattered in the cortex of the stem and constitute the vascular tissue of the leaves from the main vascular cylinder.

Secondary growth:
It is a slow process. At first a complete ring of cambium is formed by the development of interfascicular combium in between the adjacent vascular bundles. The cambium cuts off secondary xylem on the inner side and secondary phloem on the outer side.
Tracheids consist of multiseriate bordered pits. This cambial ring is short-lived and new cambial ring is formed every year in the pericycle of the cortex. Wood formed by this method (more than one) cambium ring is polyxylic and manoxylic (large amount of parenchyma is cut off in the xylem. (Fig. 13).

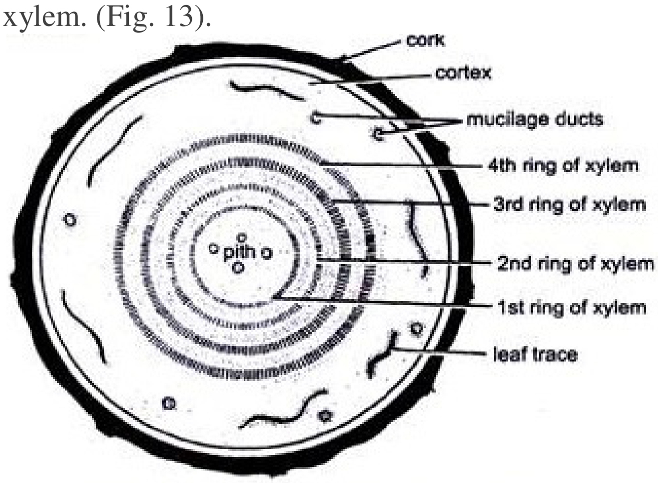
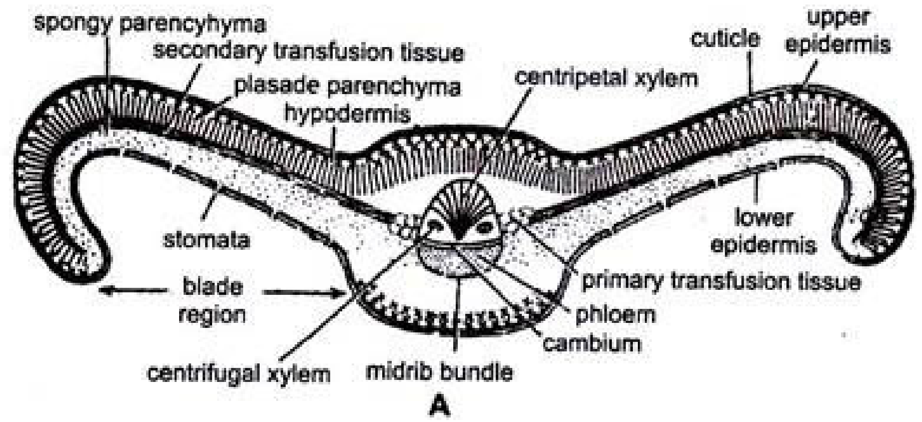


Fig. 13. ***Cycas.*** **T. S of old stem (diagrammatic)**

6. Leaflet:
The leaflet of *Cycas* is dorsiventral and hypostomatic (the stomata are present at the lower surface only). In a transverse section the leaflet can be differentiated into a swollen midrib portion and two lateral wings (Fig. 16A, B).
Its internal structure is as follows:



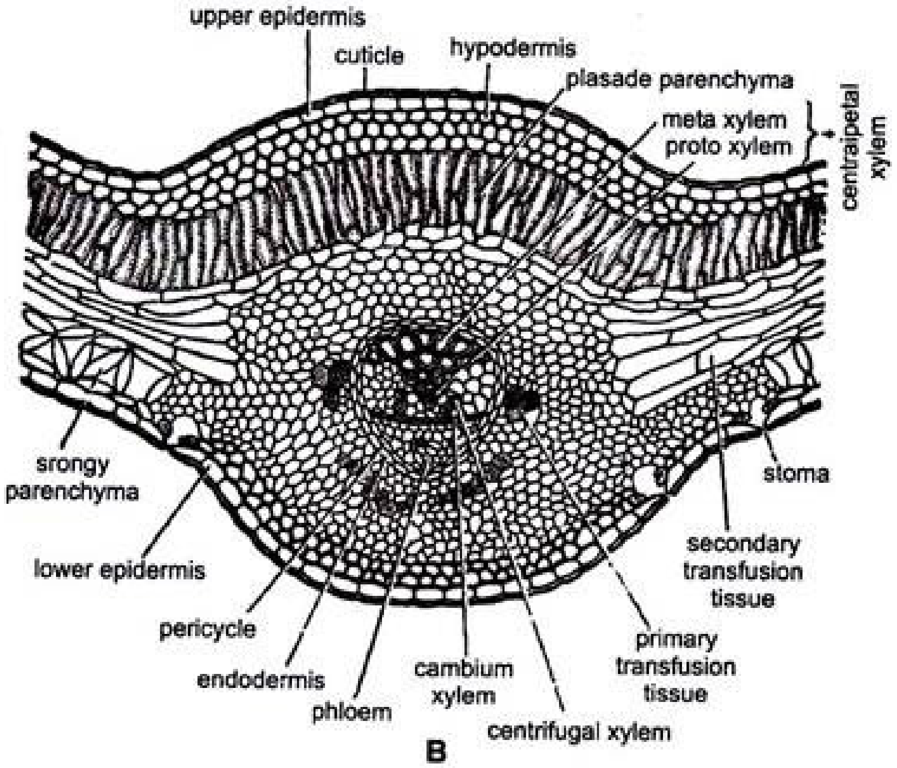


Fig. 16 (A–C). ***Cycas.*** **Transverse section of leaflet (A) diagrammatic; (B) A protion from the mid rib is magnified**

a. Epidermis:

It is the outer most single layer made up of squarish cells. The upper epidermis is complete whereas the lower epidermis is interrupted by several sunken stomata present in the region of the wings. The upper and lower epidermis is covered by a thick layer of culicle.

b. Hypodermis:

Below the epidermis occurs the thick walled sclerenchymatous hypodermis. It is single layered in the region of blade but in the region of mid rib it becomes 2-3 layered thick. Two to five layers of sclerenchymatous cells are also present above the lower epidermis only in the region of the mid rib. It helps in checking the rate of transpiration and protects the tissue from excessive heat.

c. Mesophyll:

A well-developed mesophyll tissue is present in the leaflet. It is differentiated into palisade tissue and spongy parenchyma. Palisade tissue is present in the form of continuous layer below the sclerenchymatous hypodermis. Spongy parenchyma present only in the wings directly above the lower epidermis. It is made up of loosely arranged oval cells filled with chloroplast. These cells have many intercellular spaces filled with air.

d. Vascular bundle:

A single large vascular bundle is present in the mid rib region of the leaflet. It is surrounded by a single layer of sclerenchymatous cells, known as bundle sheath. The vascular bundle is conjoint, collateral, open and diploxylic. Xylem is present towards the dorsal surface and phloem is present towards the ventral surface.

Xylem and phloem are separated by a non-functional strip of cambium. Centrifugal xylem is represented by two small groups on either side of the protoxylem. The remaining space of the vascular bundle is filled with thin walled parenchymatous cells.

e. Transfusion tissue: (important)

Groups of tracheidal cells, separated by some parenchymatous cells, or directly in contact with the centripetal xylem, the bundle sheath are present in the leaflet. It is called primary transfusion tissue. The cells of this tissue are short and wide with are reticulate or bordered pitted walls.

A zone is present on either side of the midrib between the palisade and spongy layers. It is three layered and is composed of elongated colourless cells. These cells run paralled to the leaf surface from the midrib to the margin. This zone is called accessory transfusion tissue or secondary transfusion tissue or hydrostereom or radial parenchyma.

On either side of the leaflet it is connected with the primary transfusion tissue present around centripetal xylem of the vascular bundle. Primary and secondary transfusion tissue help in the lateral conduction of water. The presence of transfusion tissue is to compensate for the unbranched condition of the midrib and it probably serves as a later conducting channel of water.

<u>Reproduction in *Cycas*:</u>

*Cyca*s reproduction by two method – Vegetative and Sexual

1. Vegetative reproduction:

It is the simplest method of reproduction. It takes place by the formation of bulbils or adventitious buds. These buds develop on the stem in the axil of the scale leaves. A bulbil is an oval structure, broad at the base and pointed at the apex. It consists of dormant stem in the centre covered by numerous brown scaly leaves.

On detachment from the stem, a bulbil starts to germinate by producing many roots from the lower side and a leaf towards the upper side. A bulbil from male plant will develop only into male plant while the bulbil from the female plant will form only female plant because cyas is strictly dioecious

2. Sexual Reproduction:

Sexual reproduction in *Cycas* is oogamous (the female gamete i.e., egg cell is significantly larger than the male gamete and is non-motile). *Cycas* is sporophytic and strictly dioecious i.e., male and female sex organs are borne on separate plants.

<u>Male Reproductive Organs:</u>

Male plant *Cycas* produces every year a single male cone (Fig. 1B) at its apex. In the formation of the male cone the apical meristem is used up, and therefore, the growth of the stem checked for some time but later an apical meristem is formed at the base of the cone, which pushes that on one side so that the growth of the stem is resumed again.

Such growth of the stem is called sympodial (Fig. 18 A, B). The male cone is largest in the plant kingdom (approximately 500 cm or more in length).

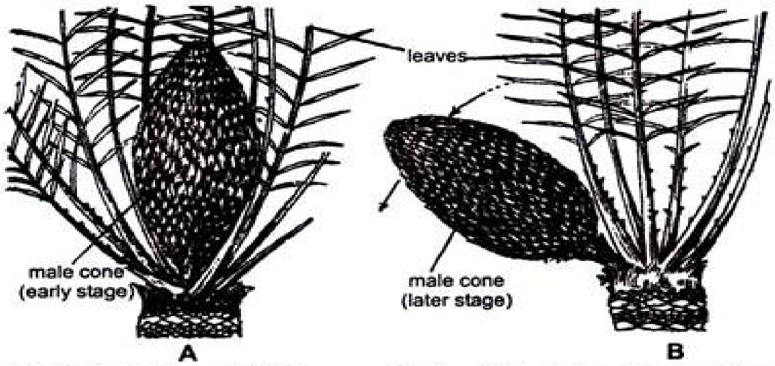


Fig. 18 (A, B). *Cycas.* **(A) Male cone at the top, (B) Apical meristem pushing the cone on one site.**

Longitudinal Section of Male Cone:

Each cone is an ovoid or conical structure (Fig. 19A). A longitudinal section of male cone shows that each one consists of a central axis around which, a large number of leaf like structures called as microsporophylls are attached at right angle in a compact, spiral, acropetal succession (Fig. 19.B). The maturation of the sporophylls takes place in a spiral manner i.e., from apex to base. However, a few sporophlills at the apex and base remain sterile. Fig. 19 B.

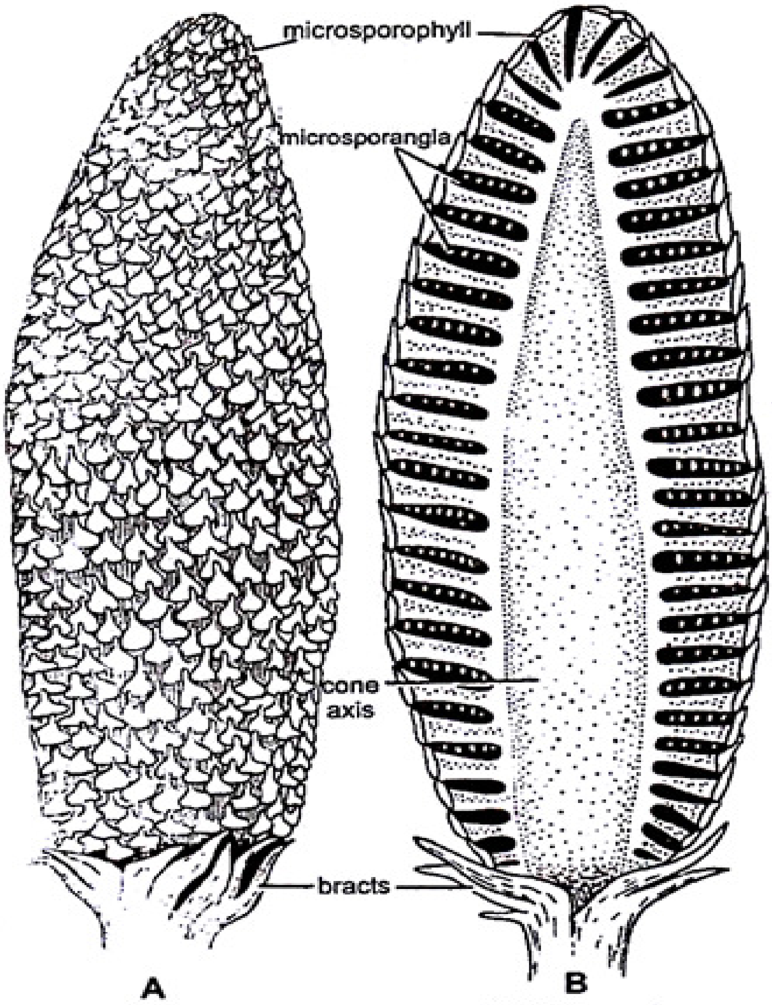


Fig. 19. (A-B). *Cycas.* **Male cone (A) Entire male cone, (B) L.S. of male cone**

Structure of microsporophyll:

Each microsporophyll represents a stamen. It is a flattened, woody and triangular structure. It is differentiated into upper or distal, sterile region called apophysis and proximal wedge shaped fertile part. Each microsporophyll bears several hundred microsporangia (pollen sacs) on its abaxial surface (more than 1000).

Microsporangia are arranged in clusters of 3 to 6. Each cluster or group of microsporangia is called sorus. In between the microsporangia indusial hairs are present which help in the dispersal of the microspores and protect young sporangia.

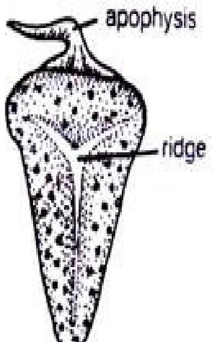


Fig. 8.33. *Cycas*. Adaxial surface of a microsporophyll.

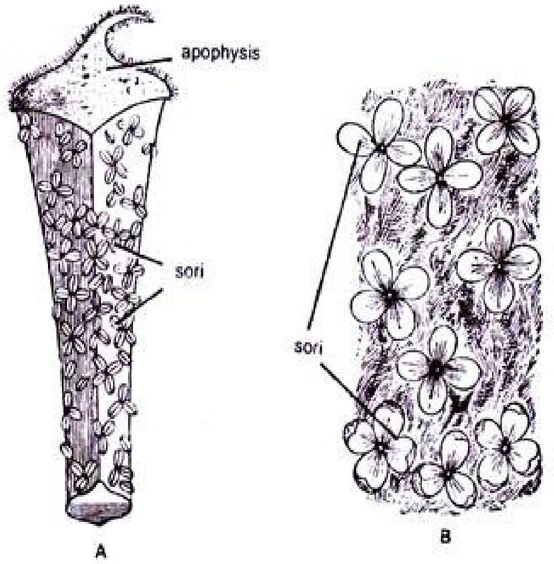


Fig. 8.34. *Cycas*. A, Abaxial surface of a microsporophyll; B, Groups of microsporangia (sori) enlarged

<u>Female Reproductive Organs:</u>

Female reproductive organs are megasporophylls. Each female plant every year produces numerous megasporophylls in acropetal succession above each crown of foliage and scaly leaves. There is no female cone formation. The number of the megasporophylls is much more than the number of the foliage leaves on the stem.

During the formation of the megasporophylls the apical meristem is not used up like that of male cone and therefore, the growth of the stem continues, and thus in female plant growth is monopodial.

<u>Structure of Megasporophyll:</u>

Each megasporophyll (carpel) is regarded as a modified leaf. It is about 12.7 cm to 25.4 cm long and can be divided into 3 parts: upper leafy portion, middle ovule bearing portion and lower stalk. Ovules are formed on the lateral side of the middle portion. The upper portion is pinnate and each pinna is tapering to a point.

Two lateral rows of ovules are present on the lateral side of the middle portion. In *Cycas* there is a great variation regarding the pinnate character of megasporophyll and the number of ovules per sporophyll as a result of which in various species of *Cyca*s gradual reduction in megasporophylls can be traced.

The megasporophylls of *C. revoluta (Fig*. 22A) are pinnate whereas those of C. circinalis C. rumphii and C. beddomei (fig 22 B-D) are ovate lanceolate structures. In C. pectinata and C. siamensis they are orbicular or rhomboidal structures (Fig. 22B, F).

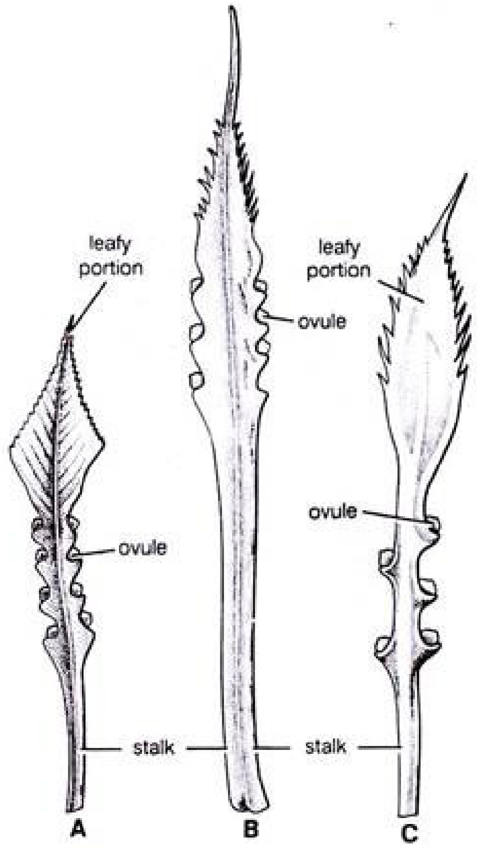


Fig. 8.42 Megasporophylls of *Cycas*. A, *C. circinalis;* B, *C. rumphii;* C, *C. beddomei.*

<u>Structure of ovule (megasporangium):</u>
The ovules are sessile and are borne laterally on the stalk. The ovules of Cycas are largest in plant kingdom (7 cm long in C. thoursaii, 6 cm long x 4 cm diameter in C. circinalis) and can be seen by naked eye. The ovule is green when young and is covered by hairs. At maturity its colour changes to orange and hair also fall off.
The ovules are orthotropus (short and straight) and unitegmic (with one integument).
The integument is very thick and consists of three distinct layers:
(i) Outer, green or orange fleshy layer called outer sarcotesta
(ii) Middle, yellow stony layer called sclerotesta and
(iii) Inner fleshy layer or inner sarcotesta.
The parenchymatous tissue inside the integument is called nucellus. The integument encloses all the nuclellus except at one point. This point or opening is called micropyle. Just below the micropyle, the cells of the nucellus form the nucellar beak.
Some of the cells of the nucellar beak dissolves and forms a cavity like structure called pollen chamber. Just below the pollen chamber is present an archegonial chamber. Micropyle leads into the pollen chamber. Just below the floor of the archegonial chamber 3-6 archegonia are present towards the micropylar end.
The ovule is supplied by three vasular traces (Fig. 23). The central vascular trace enters the chalazal end of the nucellus. The inner and outer vascular traces divide into two each, one branch supplies the outer fleshy layer and the inner fleshy layer. Thus, the outer and inner fleshy layers receive the vascular supply but the middle stony layers get no vascular supply (Fig. 23).

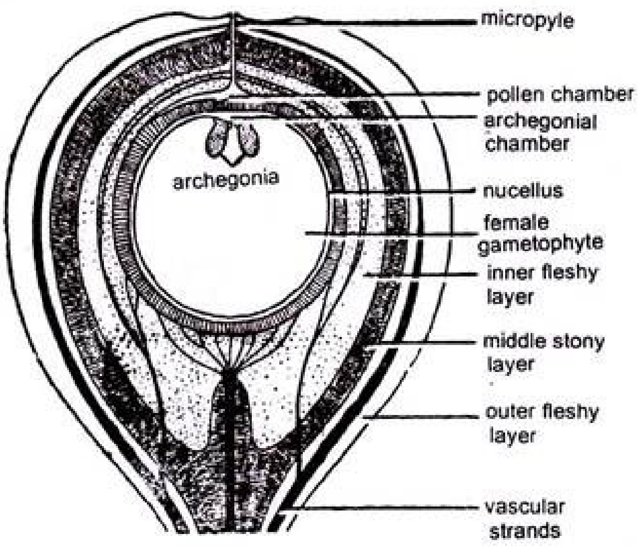


Fig. 8.43 *Cycas.* L.S. ovule showing two archegonia and female gametophyte.

Pollination:
The pollination is anemophilous. The cells of nucellar beak present in the pollen chamber disintegrate and form a viscous fluid. This fluid is cohesive in nature. This fluid oozes out of the micropyle and collects in the form of a pollination drop.
The pollen grains present in the air current at their 3-celled stage, are entangled in the pollination drop. Gradually the pollen drop dries up and the pollen grains are sucked into the pollen chamber through micropyle. Further drying of this drop seals up the micropyle. Pollen drop helps in collecting the pollen grains at the micropyle in all gymnosperms.

Fertilization:
At the time of fertilization, the nucellar tissue between the pollen chamber and the archegonial chamber disorganise and simultaneously the venter canal nucleus also disintigrates. The pollen tube reaches the archegonial chamber. The tip of the pollen tube ruptures releasing two male gametes and fluid contents.
Due to this archegonial chamber becomes moist and the sperms move freely in it with the help of cilia. Only a single sperm enters violently in each archegonium through neck. Only the male nucleus of the sperm fuses with the egg nucleus to form a zygote or oospore (2x). The fertilization in Cycas takes place with the help of motile sperms.
This process is known as zooidogamy. It is accompanied by pollen tube formation, a phenomenon known as siphonogamy. Sometimes more than one sperm enter the archegonium but the male nucleus which first reaches near the nucleus fertilizes the egg. Rest male nuclei degenerate. It is called polyspermy.

Embryogeny:
The fertilized egg, zygote or oospore is the first cell of the sporophyte. The zygote contains dense cytoplasm and a large nucleus. It enlarges in size and finally forms the embryo. In this whole process one year time is utilised. The nucleus moves at the base and starts dividing by free nuclear divisions to form about 256 free nuclei.

Structure of seed:
After fertilization, the ovule is transformed into seed. The nucellus and the inner layer of integument are used up as nourishment by developing embryo. The mature seed appears as orange-red or reddish brown structure.

It comprises the following structures:
a. Testa or seed coat:
It is formed by the outer brightly coloured fleshy layer and the middle layer of the integuments.
b. Micropyle:
It is present in the form of small opening at the top of the seed.
c. Endosperm:
Inner to the seed coat lie the wall tissues called endosperm. The cells store a large amount of food material.
d. Embryo:
Embedded in the endosperm lies the embryo. It consists of two cotyledons, plumule and radicle. The embryo remains suspended in the endosperm by a long spirally coiled suspensor (Fig. 32).
Thus, a mature seed of Cycas represents three parts:
Seed Coat:
It is formed by the integument and represents parent-sporophytic generation.
Endosperm:
Represents the gametophytic generation.
Embryo:
It represents the new sporophytic generation.
Testa is sweet in taste and emits pleasant odour. The two characteristics i. e., red colour and pleasant odour are responsible for their zoochorus (orinthochorous) dispersal.

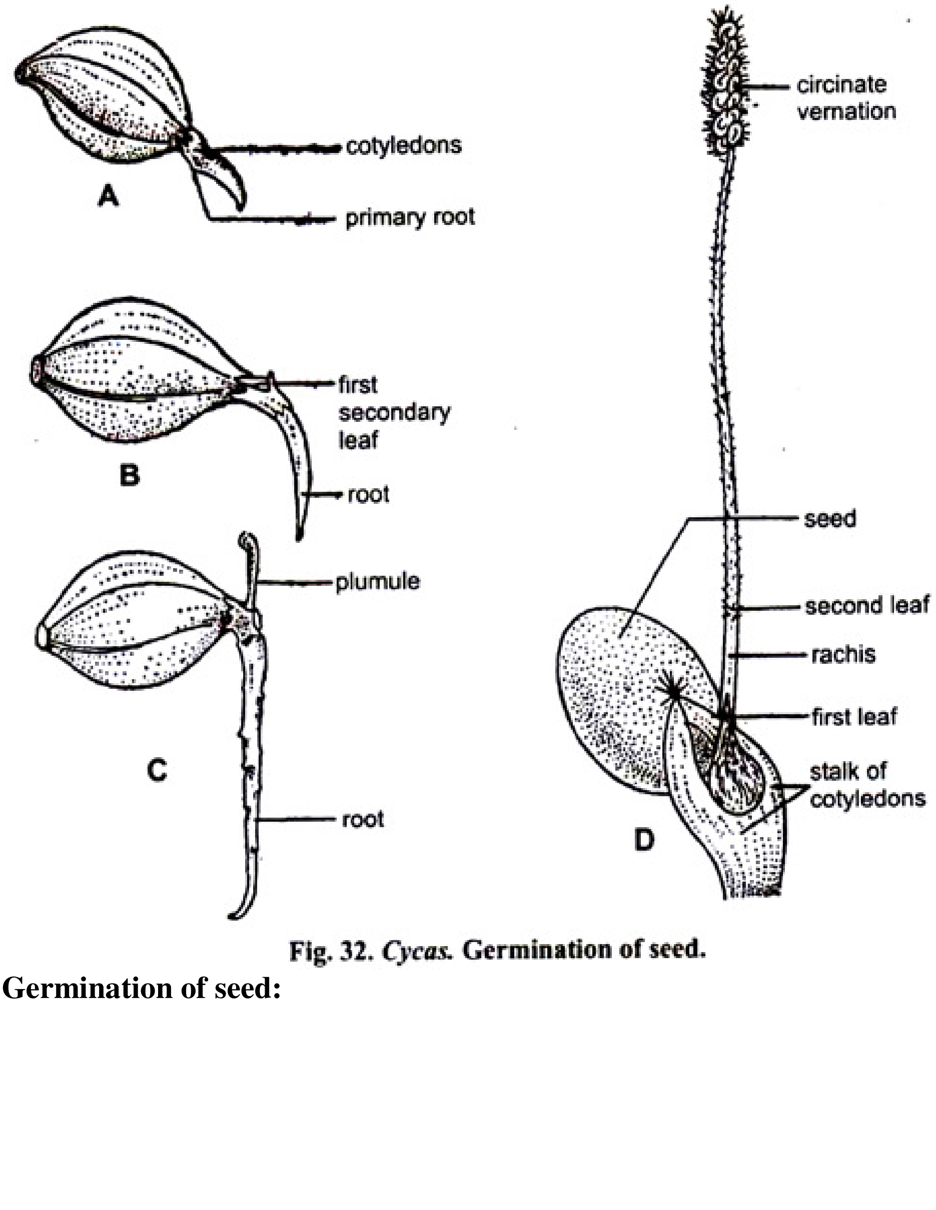


Fig. 32. *Cycas.* Germination of seed.

Germination of seed:

Seeds remain viable for not more than a few months. Under suitable conditions the seed starts germination. It absorbs water and embryo expands. The expansion of the embryo breaks open the hard seed coat.

The coleorhiza protrudes out and is pierced by the growing radicle which grows down and forms the tap root or primary root (Fig. 32A). The cotyledons do not come out of the seed coat but they absorb food from the endosperm for the growing embryo which matures in due course of time.

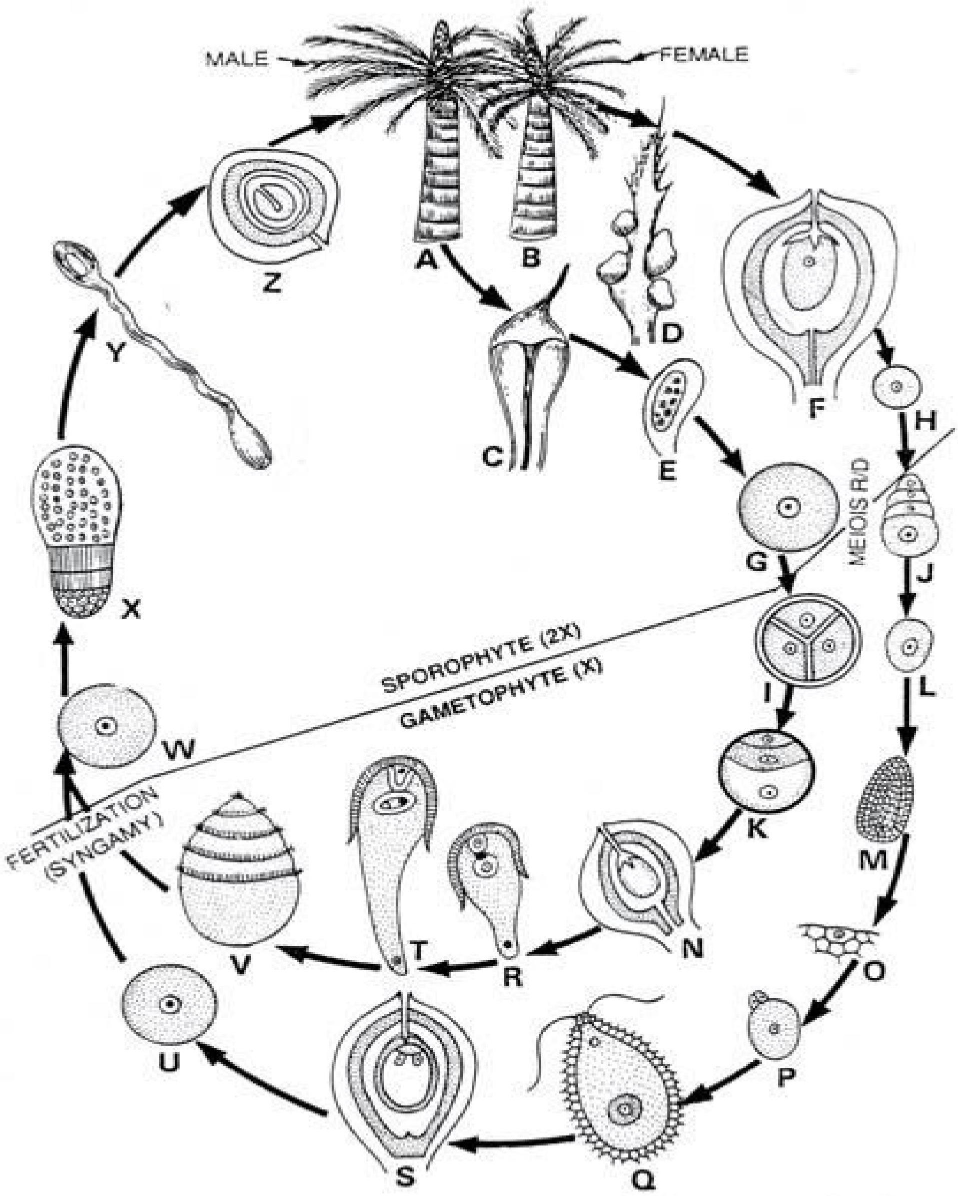


Fig. 3.51. *Cycas* sp. Diagrammatic life-cycle, A, male plant; B, female plant; C. microsporophyll, D, female strobilus; E, microsporangium; F, ovule; G, microspore mother cell; H, megaspore mother cell; I, microspore tetrad; J, megaspore linear tetrad; K, male gametophyte; L, megaspore; M, female gametophyte; N, ovule; O, archegonial initial; P, young archegonium; Q, mature archegonium; R, geminating pollen; S, germinating pollen in pollen chamber; T, geminating pollen; U, egg; V, spermatozoid; W, oospore; X, young embryo; Y, embryo; Z, seed.

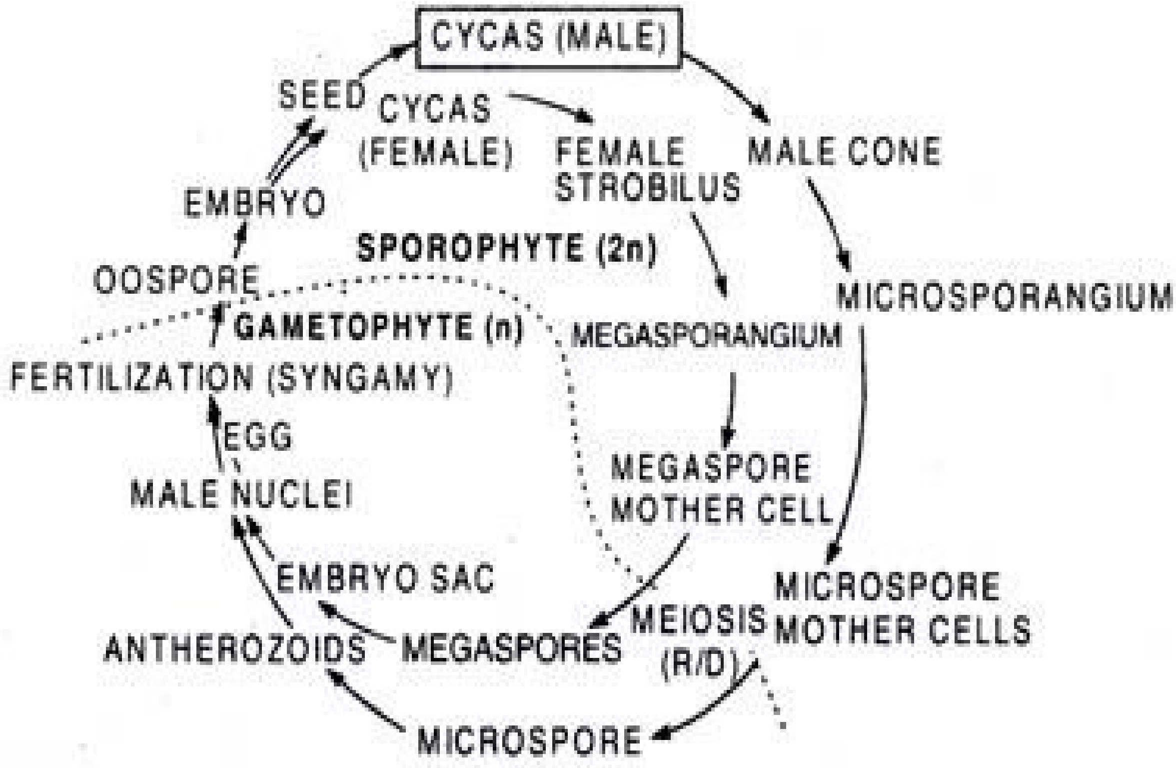


Fig. 3.52. *Cycas*. **Graphic life-cycle.**

Economic Importance of *Cycas*:

The pith of *Cycas revoluta* yields sago and the fruits can be eaten, being rich in protein and soluble non-nitrogenous substances. In Europe, the leaves of *Cycas revoluta* after silvering and treatment in various ways are made into funeral wreaths, there the leaves are called 'palm leaves'. The leaves *of C. circinnalis* are used in making mats in South India.

The young shoots of *C. circinnalis* are eaten, and sago is also obtained from the trunk.

For obtaining the sago, the trunk is cut into disks which when dry are pounded into flour and thereafter thrown into water where the starch settles down. The large fruits of C. circinnalis yield annually about the same quantity of starch. The hill tribes of Assam eat the seeds and tender fleshy shoots of *Cycas pectinata*.

The fleshy stem of *C. pectinata* is pounded and used as a hair wash for diseased root hair. The sago is also extracted from the trunk of *Cycas rumphii*. The cooked fruits of *C. rumph*ii are eaten by Andamanese tribes while the uncooked fruits are poisonous.

The fern characters found in *Cycas*. **(important)**

The characteristics of genus *Cycas* that resembles that of ferns are:

1. Like, ferns *Cycas* does not produce flowers. Both are non-flowering plants. Instead of flowers the *Cycas* produces cones.
2. Like, ferns *Cycas* leaves possess circinate venation which means young leaves shows circular arrangement in growth.
3. Ramentum which is a covering present over the roots and shoots can be found in both ferns and *Cycas.*
4. Multicialiated male sperms are found in both ferns and *Cycas.*
5. Archegoniate is present in both ferns and *Cycas.*