CLASSIFICATION OF GYMNOSPERMS CYCADOPSIDA

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THEOPHRASTUS

- The term "GYMNOSPERM" was first used by Theophrastus.
- He wrote a books "HISTORIA PLANTARUM" and "ENQUIRY INTO PLANTS".
- In these books he mentioned "GYMNOSPERM" and "ANGIOSPERM".

ROBERT BROWN(1827)

- Further analysis was made by Robert Brown in 1827.
- He for the first time recognized gymnosperms as a group distinct from Angiosperms due to presence of naked ovules .

BENTHAM AND HOOKER (1862-83)

- Bentham and Hooker considered Gymnosperms equivalent to dicotyledons and monocotyledons .
- They divided them into three groups as;

1. CYCADACEAE
2. CONIFERAE
3. GNETACEAE

- They placed them in between dicots and monocots.

VAN TIEGHEM (1898)

- gave the status of major Divisions to the Gymnosperms.

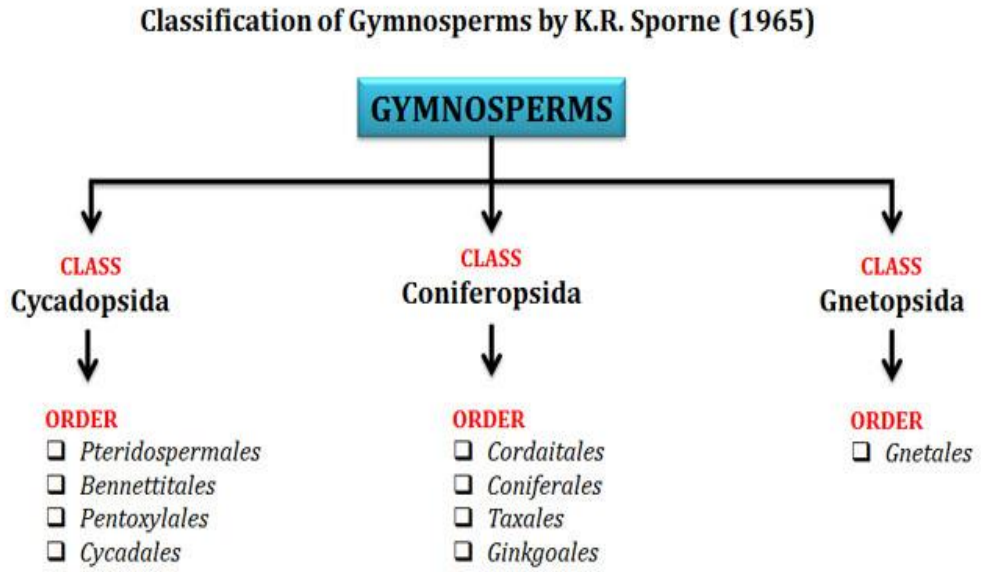
- Tieghem also divided the spermatophyta (seed plants) in to **two divisions** namely;
    1. GYMNOSPERMS (Astigmate).
    2. ANGIOSPERMS (Stigmata).

COULTER AND CHAMBERLAIN 1912

- Divided the division Gymnosperm directly into **seven orders** namely;
    1. Cycadofilicales
    2. Bennettitales
    3. Cycadales
    4. Cordaitales,
    5. Ginkgoales
    6. Coniferales
    7. Gnetales

SPORNE (1965)

- Classified gymnosperms into **3 classes, 9 orders and 31 families.**
- The classes include;
    1. Cycadopsida
    2. Coniferopsida
    3. Gnetopsida.



CYCADOPSIDA

GENERAL FEATURES

- Mostly xerophytes.
- The plants are low and palm-like in habit.
- The stem is short, un-branched, columnar and covered with dense persistent leaf bases.
- The leaves are pinnately compound and arranged in a terminal crown.
- The plants grow very slowly but they live for ages.
- Comparatively the pith is large and cortex is broad.
- There is a narrow zone of conducting tissue is present.
- The conducting strand is conjoint, collateral, endarch and open.

- Vascular bundles around the pith separated from each other by medullary rays.
- The cycads are strictly dioecious.
- Except the female strobilus of *Cycas* the sporophylls are arranged in definite cones.
- The ovules are straight and usually sessile.
- Male gametes are motile.

CYCAS

Division : Cycadophyta
Class : Cycadopsida
Order : Cycadales
Suborder: Cycadinae
Family : Cycadaceae
Genus : *Cycas*

GENERAL FEATURES

- Occurs wild or cultivated in tropical and subtropical regions.
- *Cycas* is a palm-like, evergreen plant.
- Stem unbranched, columnar and covered with persistent leaf bases.
- Leaf segment remains circinate within the bud.
- Leaves are dimorphic.
- Female reproductive structures the megasporophylls are not aggregated in cones.
- Ovules borne on the lower margins in ascending order.

ROOTS – MORPHOLOGY

- Roots in *Cycas* are of two types- normal tap roots and coralloid roots.
- Normal tap-roots are positively geotropic, grow deep into the soil and generally possess no root hairs.
- Their function is to fix the plant in the soil and to absorb water and other minerals.

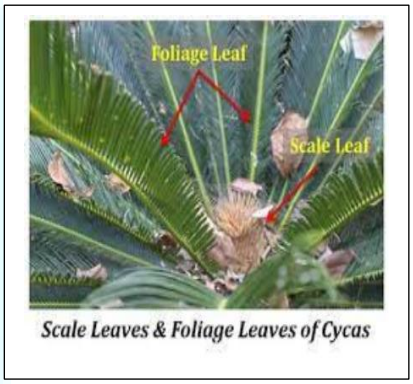
CORALLOID ROOTS

- Apogeotropic Coral like in appearance.
- They divide dichotomously, come out of the soil on the ground surface and are phototrophic in nature.
- Shows symbiotic association with cyanobacteria for nitrogen fixation- *Nostoc*, *Anabaena*.
- Young plants bear more coralloid roots than the older ones.

STEM- MORPHOLOGY

- The stem- thick, woody,un-branched.
- It is tuberous when young but columnar, erect and stout at maturity.
- The aerial part of the trunk remains covered by a thick armour of large and small rhomboidal leaf bases.
- The age of the plant can be calculated by counting the number of crowns of leaves and megasporophylls which are produced every year.
- *Cycas media* is tallest, attaining a height up to 20 metres

LEAVES



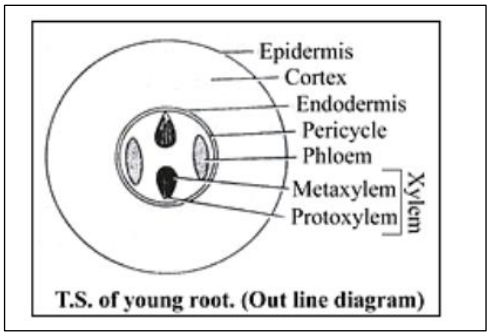
Scale Leaves & Foliage Leaves of Cycas

- Two types of leaves are present in *Cycas*.
- These are green, assimilatory or foliage leaves, and scaly leaves or cataphylls.
- Foliage Leaves or Assimilatory Fronds Green, large, pinnately compound Spiny petiole and large, strong rachis.
- They are produced at the apex of the stem in the form of crown. The rachis bears many leaflets.
- Scaly Leaves or Cataphylls.
- These are dry, brown-coloured, somewhat triangular leaves with their one end pointed.
- They are present at the apex of the stem and remain covered with several ramental hairs

ANATOMY – ROOT

- Young root shows typical structure like that of a dicotyledonous root, shows secondary thickening.

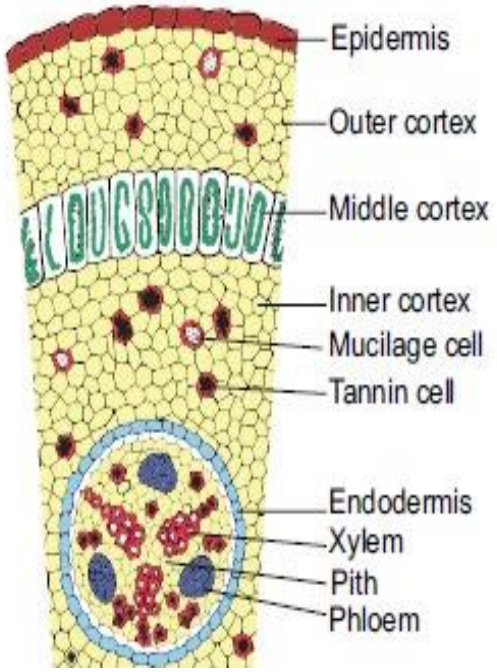
- Outermost layer,epiblema, encloses the parenchymatous cortex.
- Cells of the cortex remain filled with starch, Some tannin-filled cells, mucilage cells are also present.
- Endodermis with casparian thickening.
- Vascular tissue - Radial arrangement
- The roots are usually diarch to tetrarch, rarely polyarch.
- Vessels are absent
- Pith is absent or reduced.



T.S. of young root. (Out line diagram)

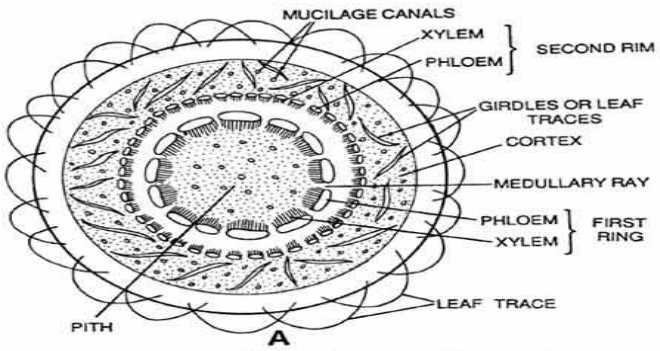
CORALLOID ROOT

- Anatomically, the coralloid roots resemble normal roots except some under mentioned differences:
  - ➢ The secondary vascular tissue in coralloid roots is either totally absent or poorly-developed.
  - ➢ The cortex is wider in comparison with the normal root.
  - ➢ Presence of a greenish algal-zone in the middle of the cortex.



STEM – ANATOMY

- Show irregular outline due to the presence of leaf bases, therefore epidermis is not a continuous layer.
- Broad cortex contains simple and girdle leaf traces
- Numerous mucilage canals, starch grains are present
- Vascular tissues-narrow
- Vascular bundles are open and endarch
- V.B are arranged in ring and separated by medullary rays.
- Pith - large, parenchymatous and having mucilaginous canal And starch grain.



Cycas Stem T.S. Primary Structure

ANATOMY – RACHIS

- Woody and thick
- Hypodermis is sclerenchymatous
- Characteristic feature is omega shaped outline of numerous vascular bundles.

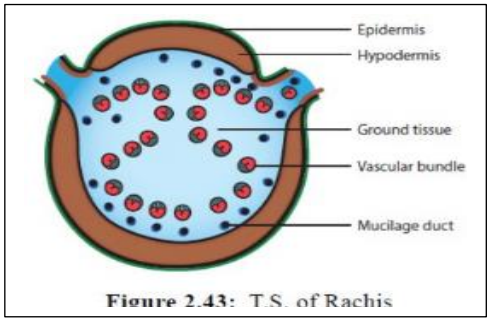
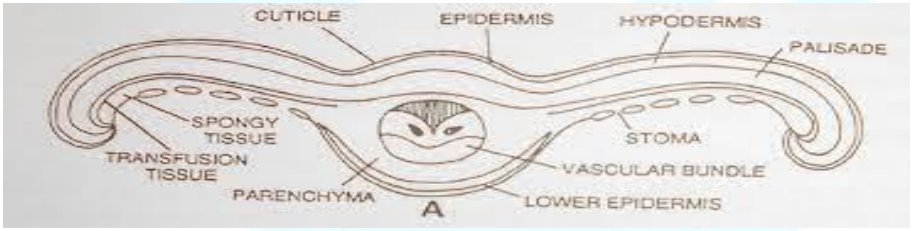


Figure 2.43: T.S. of Rachis

- Each bundle has sclerenchymatous bundle sheath and is open and collateral.

ANATOMY OF LEAFLET

- Leaflet is thicky cutinized and leathery
- Sunken stomata and thickened hypodermis present.
- Well developed palisade layer in mesophyll
- Between the palisade and lower mesophyll layers, there are transversaly running long colourless cells in 3-4 layers extending from mid-rib to near leaf margin -Transfusion tissue.
- Mid rib bundle consist of a broad triangular centripetal xylem and two small patches of centrifugal xylem is present
- Phloem is abaxially placed.



VEGETATIVE REPRODUCTION

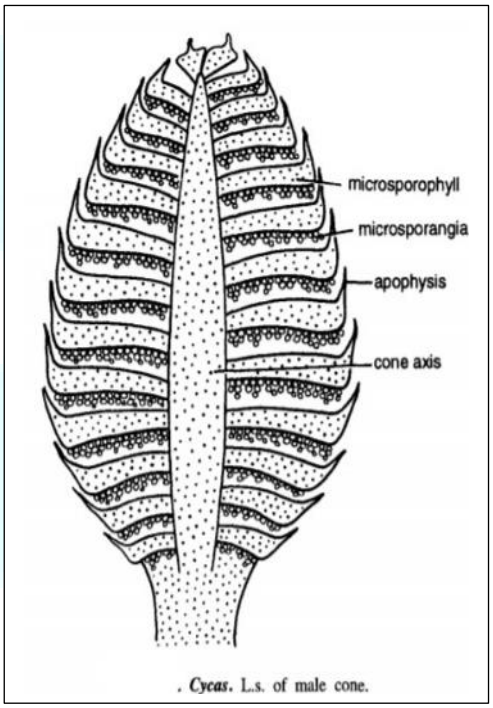
- Vegetative reproduction is by means of bulbils.
- Develop in crevices of scale leaves and leaf bases at the basal part of an old stem.
- Produces new plant on detachment.

SEXUAL REPRODUCTION

- Dioecious plant.
- Male strobilus or cone borne singly at the apex of the trunk.
- Apical shoot apex utilized in the development of male cone, hence branching sympodial.
- Large, conical or ovoid, compact, solitary and shortly-stalked structure.

MICROSPOROPHYLLS

- Numerous micro-sporophylls spirally arranged around the central axis.
- Each microsporophyll is narrow below and broad above terminating into projection – the apophysis.
- Microsporangia confined to abaxial (lower) surface.
- Usually present in sori – each with 2-6 sporangia.
- They contain a large number of haploid microspores (pollen grains).



. *Cycas*. L.s. of male cone.

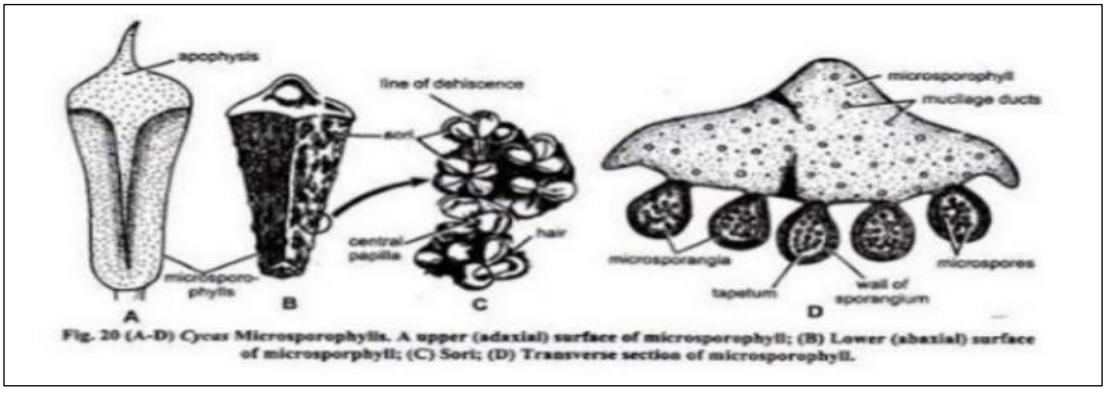
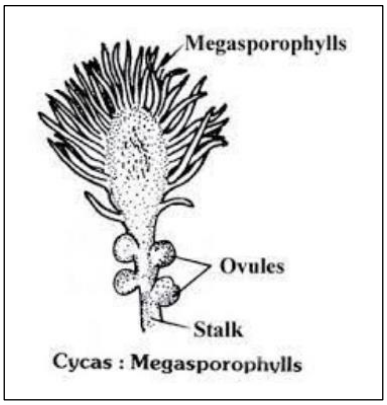


Fig. 20 (A-D) *Cycas* Microsporophylls. A upper (adaxial) surface of microsporophyll; (B) Lower (abaxial) surface of microsporphyll; (C) Sori; (D) Transverse section of microsporophyll.

MEGASPOROPHYLL

- Female plant do not produce definite cones.
- A whorl of spirally arranged megasporophylls arise around the short apex.
- Each megasporophyll resembles the foliage leaf and approximately 10-23 cm.
- Long, lower petiolar part bears the naked ovules on the margins.



Cycas : Megasporophylls

MEGASPORANGIUM

- The megaspore develops in the nucellus by meiotic division and goes on to form female gametophyte tissue.
- 2-3 archegonia are formed in this haploid tissue.
- Egg cell in the venter of archegonia, undergoes fertilization by the motile spermatozoid forming diploid zygote.

STRUCTURE OF OVULE

- Largest ovule (6cms.x 4 cms.) seen in *C.circinalis*.
- Ovules are orthotropous, sessile, ovoid or spherical in shape and unitegmic.
- The thick integument is differentiated in three layers- outer and inner fleshy layers, middle stony.
- The integument remains fused inside with nucellar tissue except at the position where it forms the micropylar opening.
- Ovule is well supplied with vascular bundles

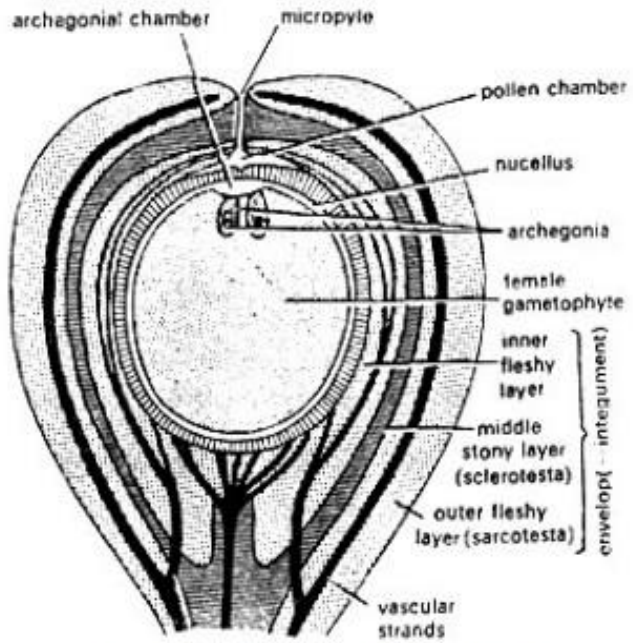


Fig. Structure of ovule LS

POLLINATION

- The pollen grains are carried by wind (Anemophily) and caught by pollination drop secreted by ovule.
- The 3-celled microspores liberate from microsporangia are blown away by wind.
- The pollination drop (ooze) of micropyle. As the ooze dries up, the microspores are drawn into the pollen chamber.
- Pollination is direct.
- Pollen grains take rest for some time in the pollen chamber.

DEVELOPMENT OF MICROSPORE

- During the germination of pollen grain the exine is ruptured and the inner intine comes out in the form a tube like structure known as pollen tube.

- At this time the generative cell divides and forms a larger, upper body cell and smaller, lower stalk cell.
- The pollen tube acts as haustorium to absorb food materials from the nucellus besides as sperm carrier.
- The body cell divides and forms two naked, top shaped, motile, multiciliated antherozoids.
- The cilia are in 4 – 5 spirals.
- The male gametes of Cycas are 180 – 210 μ in size and largest in the plant kingdom.
- The pollen tube apex is ruptured and the male gametes are released into the archegonial chamber.
- Presence of multiciliated male gametes is the fern character shown by Cycas male gametophyte.

FERTILIZATION

- In the archegonial chamber, the tip of pollen tube burst to discharge its contents.
- One of the sperms enters the archegonium.
- When moving towards egg, the sperm lost cilia and cytoplasmic membrane.
- So the fusion of a male nucleus and egg nucleus occurs to form a zygote.
- (2n) It is noted that in *Cycas* fertilization exhibits both siphonogamy (i. e. formation of pollen tube) and zoidogamy (i.e. participation of ciliated male gametes).

EMBRYO DEVELOPMENT

- Embryo development is meroblastic.

- Proembryo shows upper haustorial part, middle elongating suspensor and the basal meristematic embryonal region.

SEEDS

- A mature embryo is straight and has a short hypocotyl.
- Embryonal axis has plumule at one end and radicle at the other.
- Radicle is covered by coleorhiza.
- Number of cotyledons maybe 2-3.
- Nucellus is completely absorbed in the seed.
- Mature seed is large 2.5–5 cm wide and usually orange or red in colour.
- Germination is hypogeal type.

LIFE CYCLE

- The sexual life cycle of *Cycas* is diplohaplontic.
- It shows heterologous or heteromorphic type of alternation of generations.

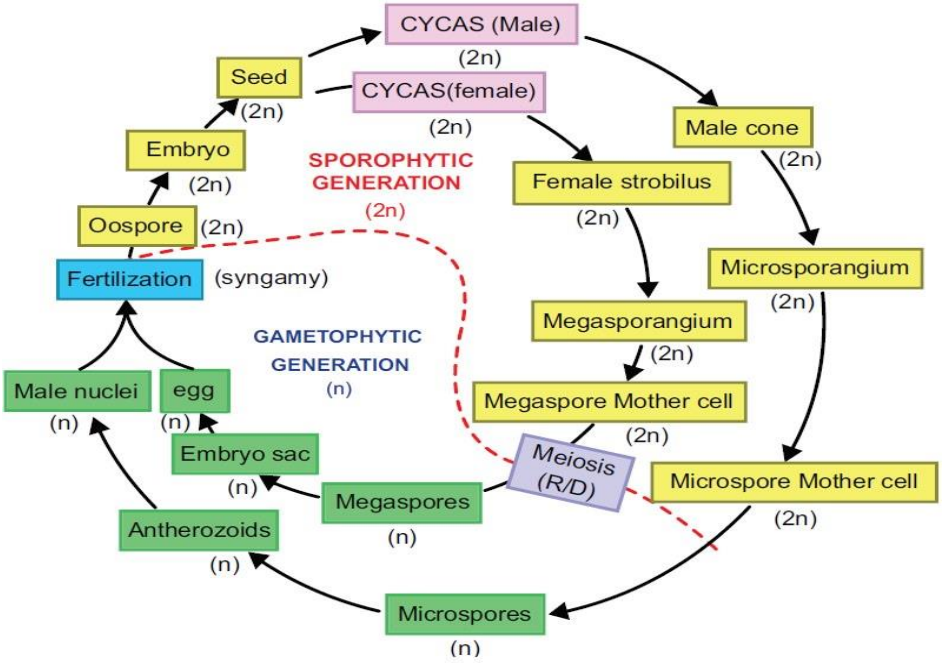


Figure 2.47: Life cycle of *Cycas*