Cycas

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Source

- A textbook of botany (Singh, Pandey, Jain)
- Botany for degree students (P.C Vashishta)

- Division-

Spermatophyta=sperma (seed)+phyton (plant)

Sub-division

- Gymnosperms= Gymnos (naked)+ Sperm (seed)

Sub-division

- Gymnosperms= Gymnos (naked)+ Sperm (seed)

- Term “Gymnosperm” coined by Theophrastus (in book “Enquiry into Plants”,300 B.C)

- Most ancient group of seed plants
- Dominant during

Jurassic and cretaceous periods= Mesozoic era

- extint now = Cycadofilicales
- living and fossil members= Cycadales,

- Members called Cycads
- Originated from Cycadofilicales (towards end of Carboniferous period)- dominant vegetation- called" age of cycads"
- Cycadales include 11 living genera and 100 sp
- All woody trees (except Zamia pygmea)
- Stem unbranched, covered with persistent leaf bases.
- Leaves arranged in whorl at apex of stem (forming "crown") and pinnately compound

Cycas

Zamia pygmea

-smallest gymnosperm

Classification

Division Cycadophyta
Class Cycadopsida
Order Cycadales
Family Cycadaceae
Genus Cycas

Cycas

- Most widely distributed tree of Cycadales
- Confined to tropical and subtropical countries.
- Countries- China, Japan, Australia, Africa, Nepal, Bangladesh, Burma, India.
- India- Assam, Orissa, Meghalaya, Andaman and Nicobar, Karnataka, Tamil Nadu

C.circinalis.
C.siamensis,
C.revoluta

Called "living fossils" as they have retained ciliated sperms, show circinate vernation.

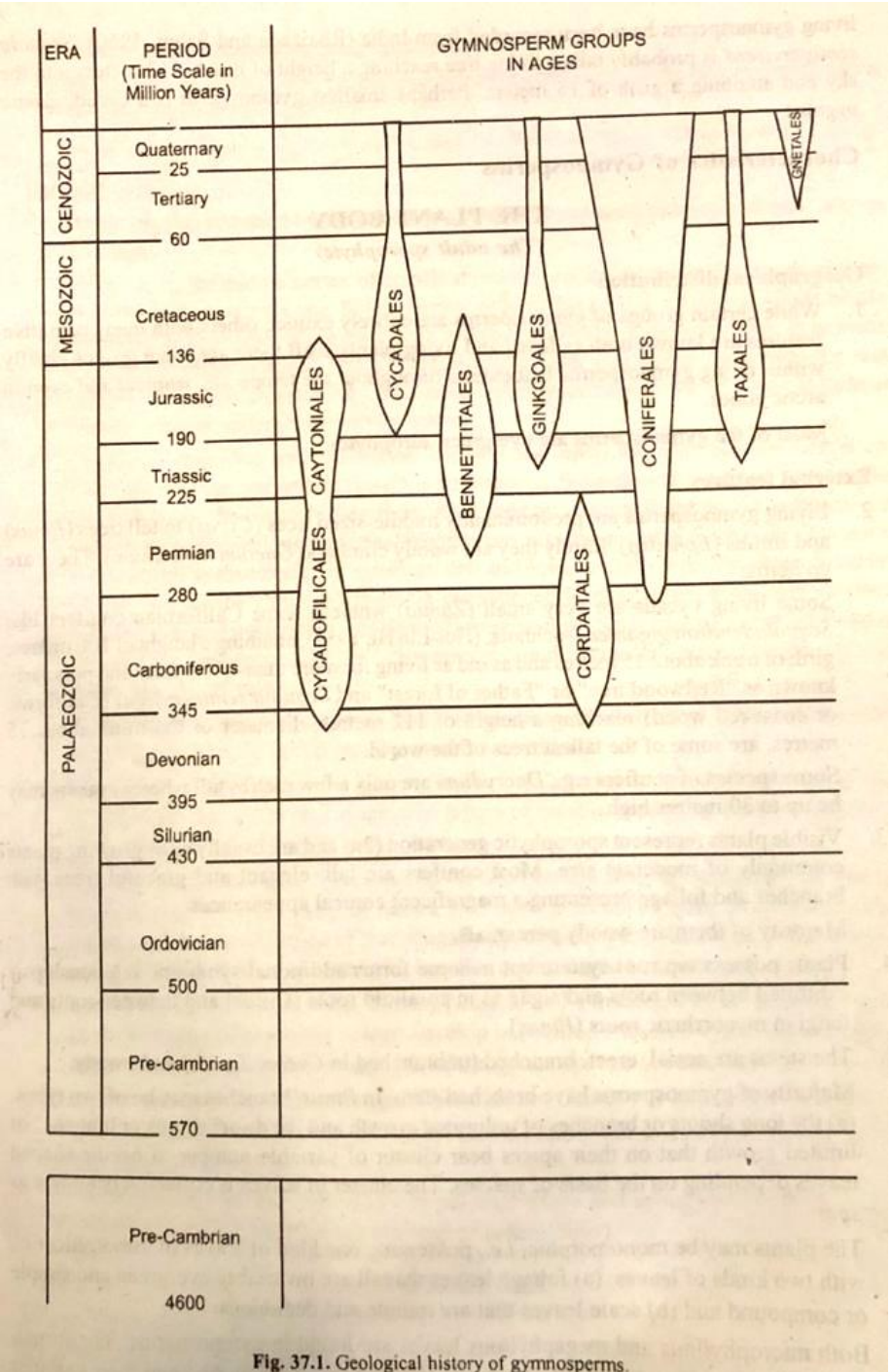


Fig. 37.1. Geological history of gymnosperms.

- **Cycadofilicales, Cordiatales = extinct**
- **Cycadales originated in Jurassic**
- **Coniferales originated in Carboniferous age**

Sporophyte

External Morphology

- Evergreen
- Slow growing
- Palm like
- Averae height= 1.5-3m
- Found commonly in xerophytic habits
- Body differentiated into Root, stem. Leaves.

Root

2 types:

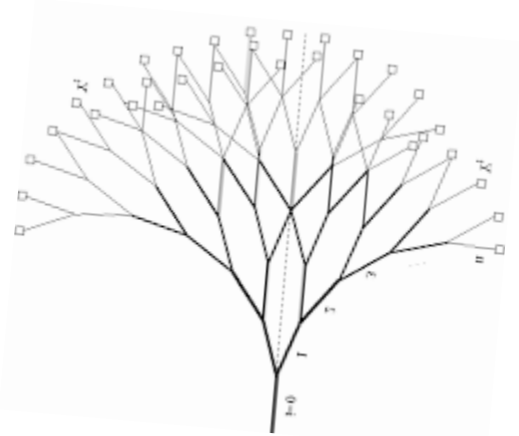
A) Normal tap root:

- Positively geotropic
- Long lived, primary root
- Thick
- Main functions-Anchorage, absorption of water and minerals

B) Coralloid root:

- Apogeotropic roots
- Repeatedly dichoto,ous;y branched
- Appear as corraline masses
- Have blue green algae in cortex-Algae helps in nitrogen fixation
- Roots posses lenticels also-help in resoiration

Coralloid root



Dichotomous brancing

Stem

- In young plants-stem is Tuberous, covered with brown scale leaves
- In older plants- stem is thick, columnar, woody, covered with persistent leaf bases

LEAF

Dimorphic leaves

Fig. 4. Cycas. A single foliage leaf.

Leaf/Frond

80-100 pairs of leaflet

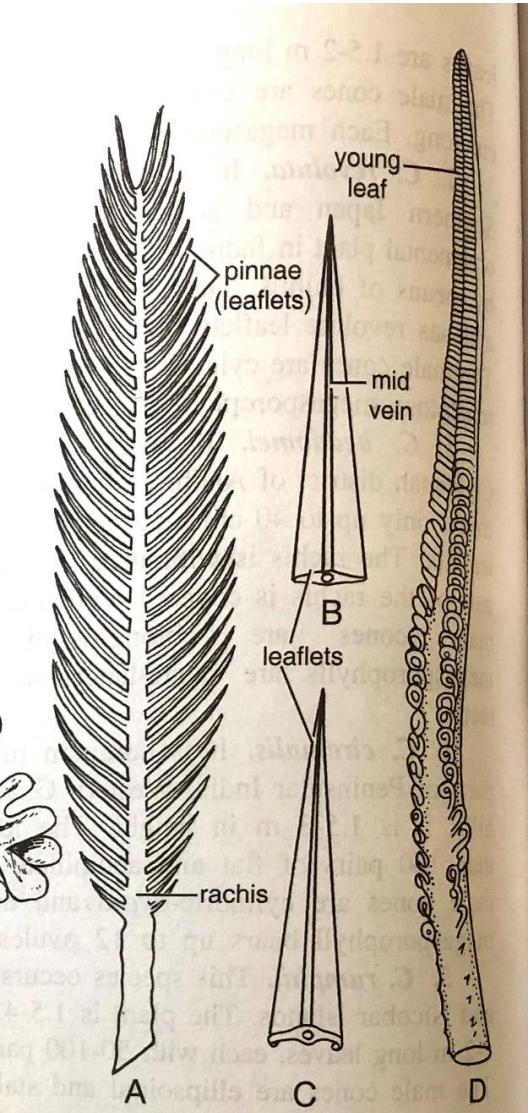


Fig. 3 A-D. *Cycas*: A. A foliage leaf, **B.** A part of leaflet of *C. rumphii,* **C.** A part of leaflet of *C. revoluta,* **D.** A young foliage leaf showing circinate vernation of leaflets.

Dimorphic leaf-

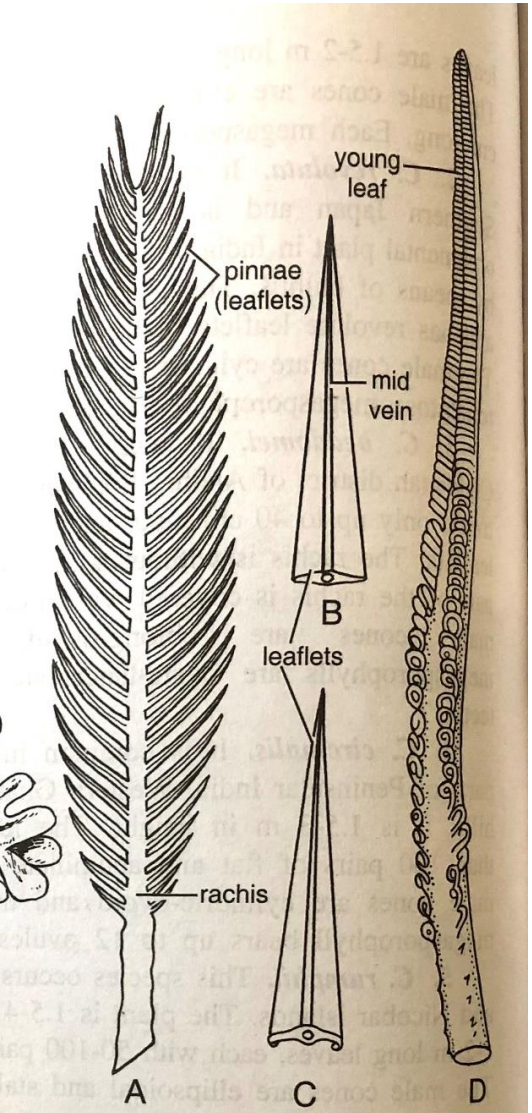
1. Foliage leaf
2. Scale leaf

Foliage leaf/ Assimilatory leaves-

- large, pinnately compound.
- Forms crown at top
- Each leaf has80-100 pairs of leaflets (opp./alt.)

- Leaflets-

sessile, elongated, ovate/lanceolate with flat/revolute margins.
Apex acute
Single mid vein
Lateral veins absent



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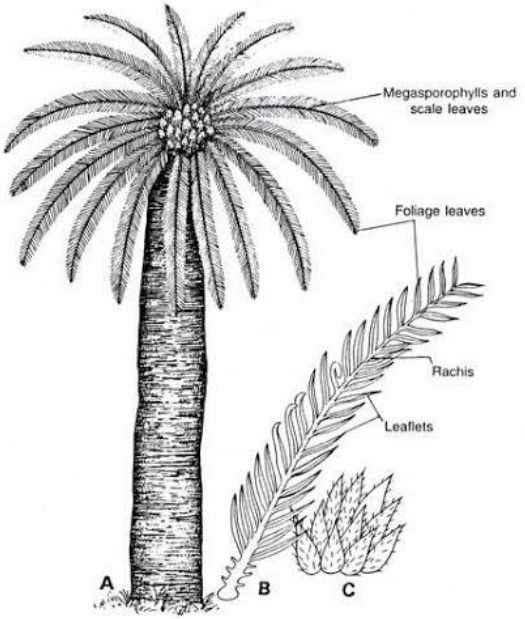


Fig. 3.6. *Cycas.* External structure. A, a female plant of *Cycas revoluta;* B, leaf of *C. revoluate;* C, scale leaves of *C. revoluta.*

Dimorphic leaf-

1. Foliage leaf
2. Scale leaf

Scale leaves-

- small, rough, dry, triangular.
- Thickly covered with ramenta
- Function-protection of apical meristem and other parts
- Scale leaves too have persistent leaf base and forms part of armour of old stem

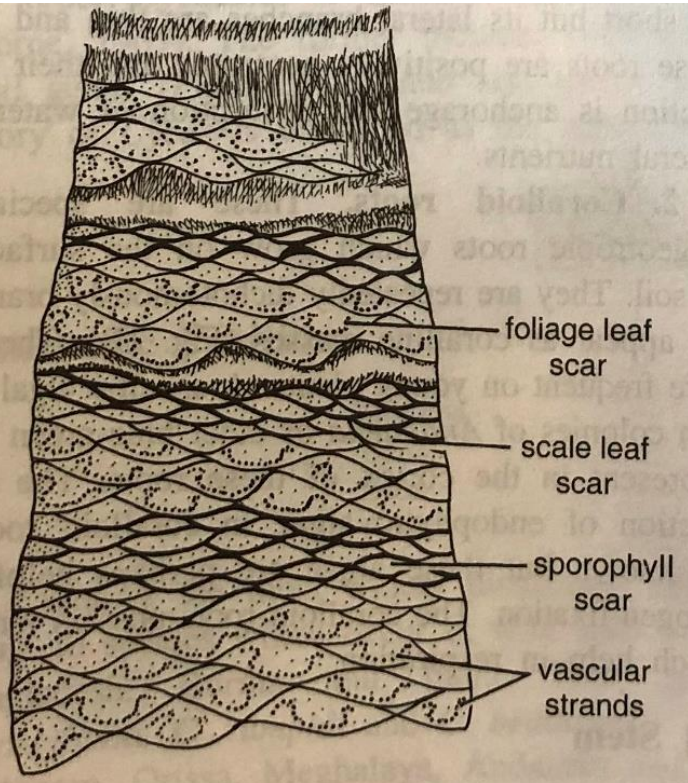


Fig. 2. ***Cycas*****:** A part of mature stem surrounded by armour of leaf bases.

times due to injury shoot apical

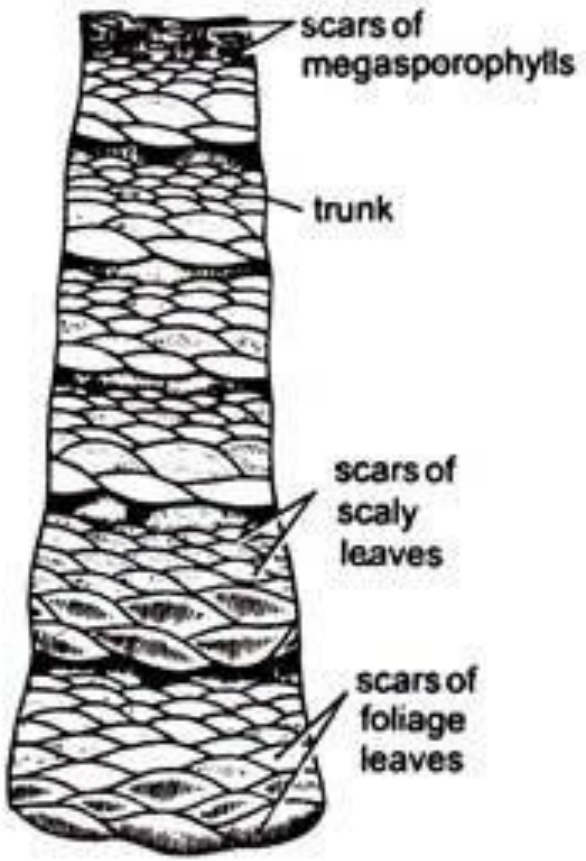


Fig. 3. *Cycas. A part of stem showing leaf scars.*

Cycas-Circinate vernation

ANATOMY-Root

Epiblema- single layer, thin walled cells, some cells give rise to hair.

Cortex- multi-layered zone, thin walled parenchymatous cells filled with starch. Inner most layer forms endodermis (cells have casparian thickening).

Vascular tissue-
Central diarch stele.
Exarch xylem

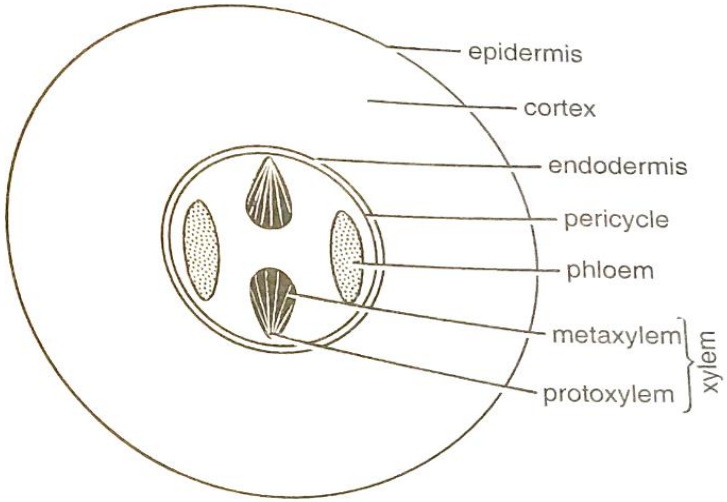


Fig. 4. ***Cycas*****:** Diagrammatic representation of transverse section of normal young root.

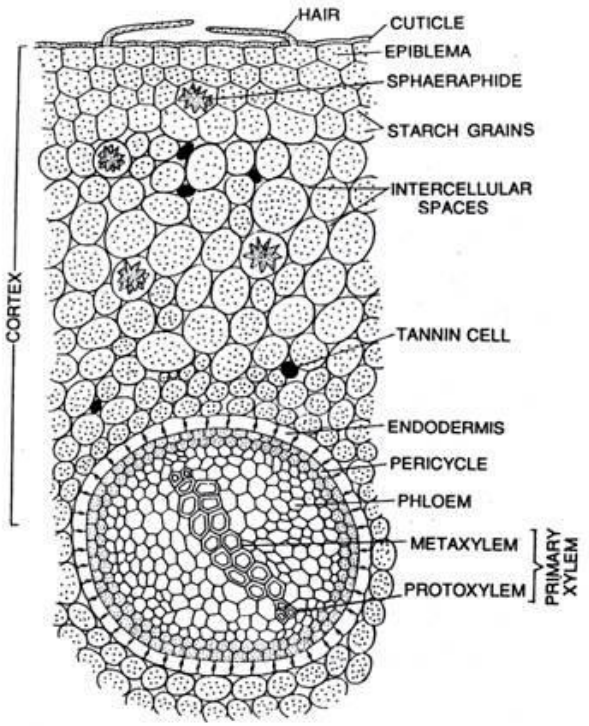


Fig. 3.11. *Cycas revoluta*. Transverse section showing details of primary root (diarch).

ANATOMY-Secondary Root

Vascular tissue- cambium arise inner to primary phloem.

Cortex- cork cambium **(phellogen**) arise in cortex: a) forms **cork** outer side

b) sec cortex or **phelloderm** on inner side

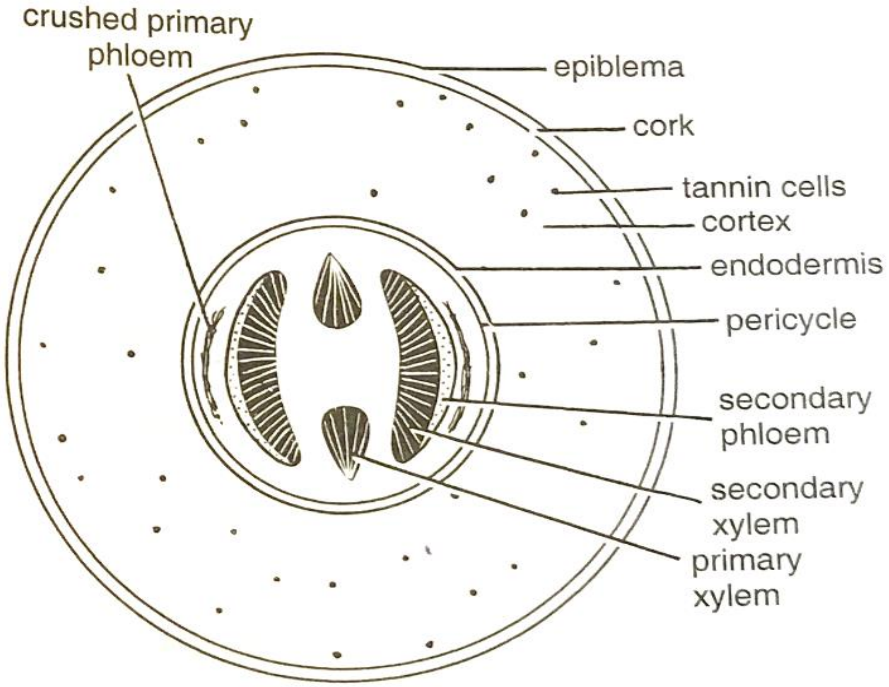


Fig. 5. ***Cycas*****:** Diagrammatic representation of transverse section of normal old root.

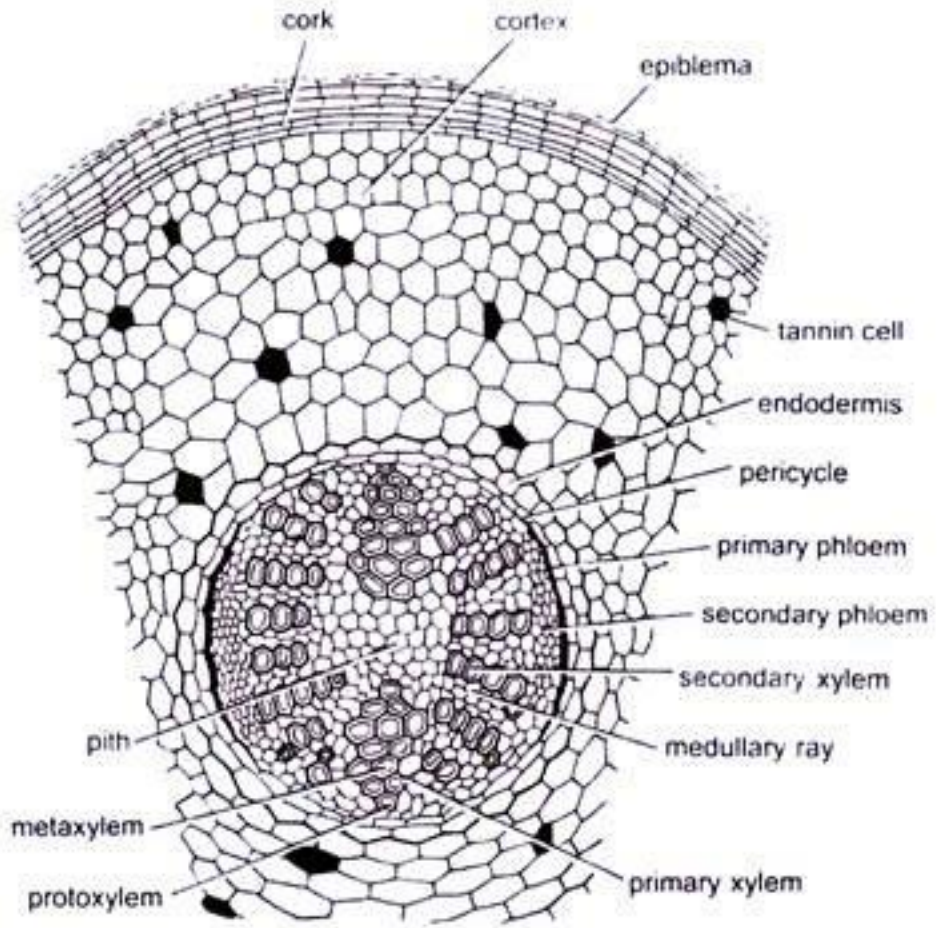


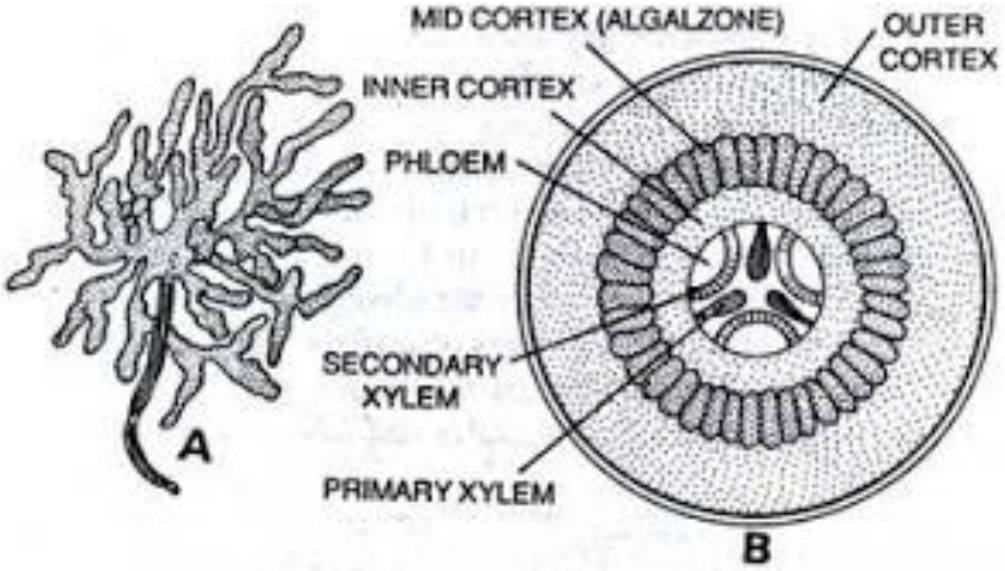
Fig. 8.17. ***Cycas revoluta***. T.S. normal root (old).

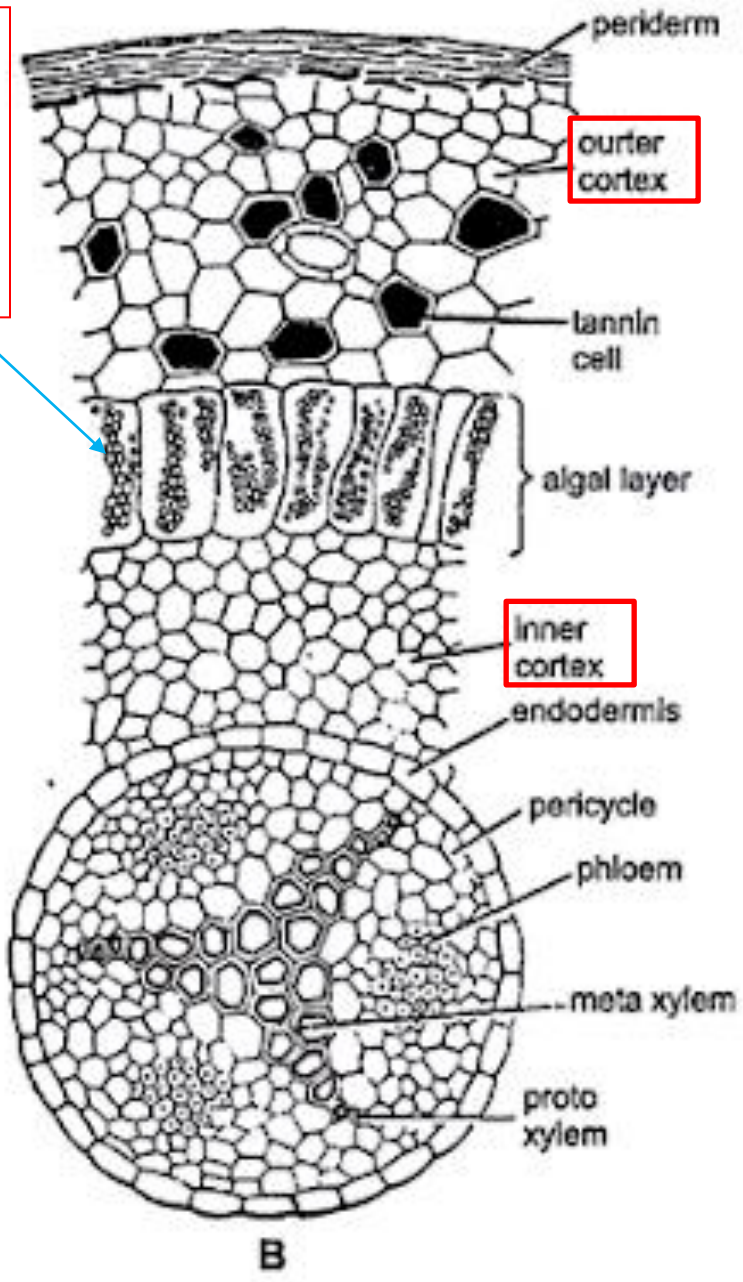
ANATOMY-Coralloid Root

Middle cortex=thin walled, loosely connected, radially elongated cell

BGA= *Anabaena cycadae, Nostoc punctiforme, Oscillatoria*

Bacteria= *Pseudomonas, Azotobacter*





- Anatomy similar to normal root root.
- Cortex divided into 3 regions- outer, middle, inner.
- No sec growth

ANATOMY Young STEM

- Irregular outline (due to persistent leaf bases)
- Internal structure is like dicot stem:
- Differentiated into:

Epidermis- outermost layer, thick cuticle, discontinous

Cortex- Major part, parenchymatous, rich in starch grains, mucilage canals (inner walls made of secretory cells). Innermost layer is endodermis

Vascular system- Pericycle cannot be distinguished from endodermis
several VB arranged in a ring forming ectophloic siphonostele

VB= conjoint collateral, endarch, open

Xylem=tracheids+xylem parenchyma (vessels absent)

Tracheids of protoxylem= have spiral thickening,

Tracheids of metaxylem= scalariform thickening

Phloem = Sieve tubes+ phloem parenchyme
(companion cells absent)

Pith= in center of stem, cells rich in starch,
may contain tannin and mucilaginous substances.

Ring of VB

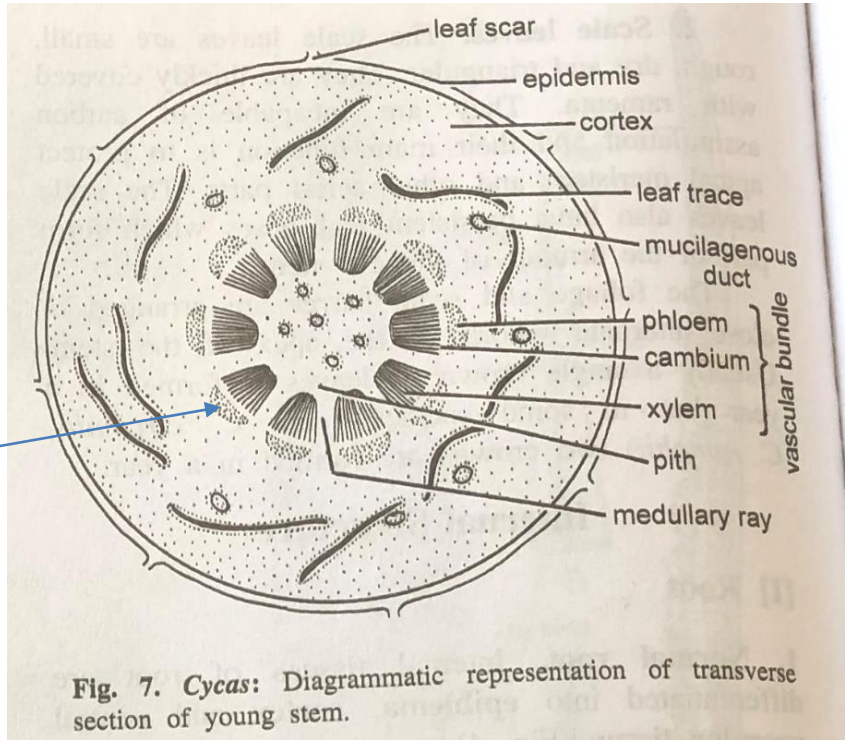


Fig. 7. *Cycas*: Diagrammatic representation of transverse section of young stem.

ANATOMY old STEM

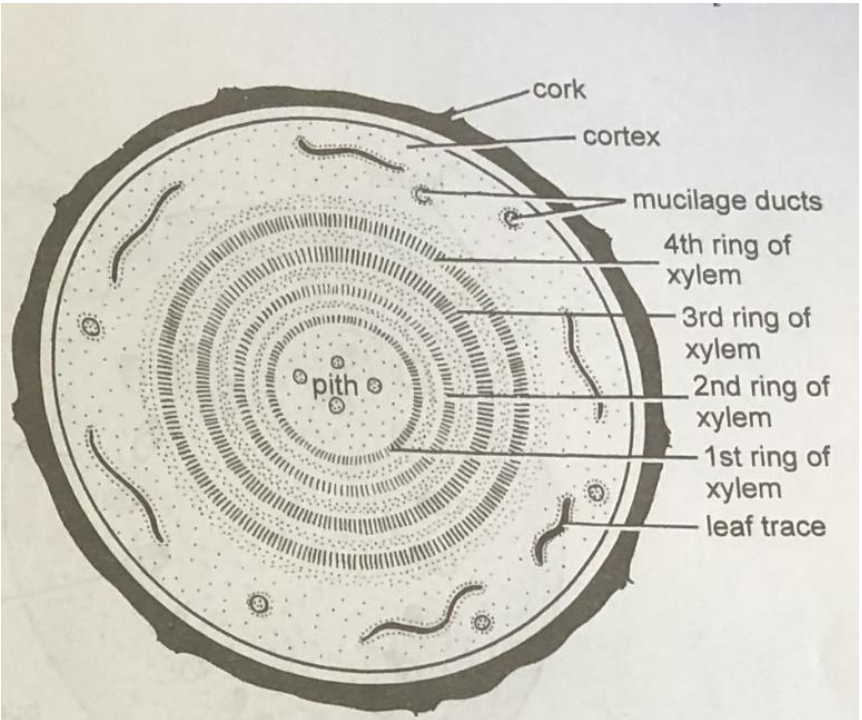


Fig. 9. ***Cycas*****:** Diagrammatic representation of transverse section of mature stem.

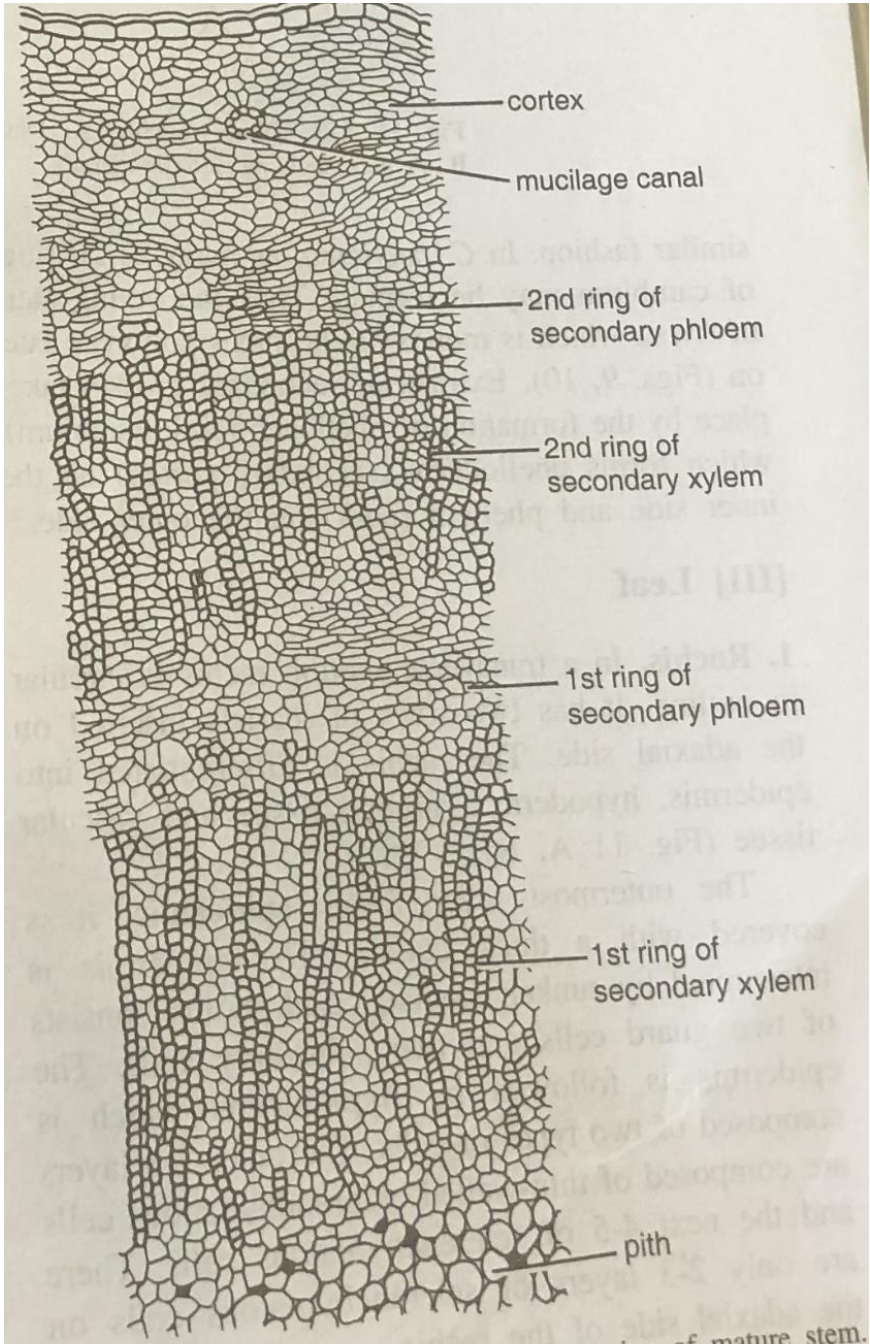


Fig. 10. ***Cycas*****:** A part of transverse section of mature stem.

Leaf: rachis and leaflet

Rachis

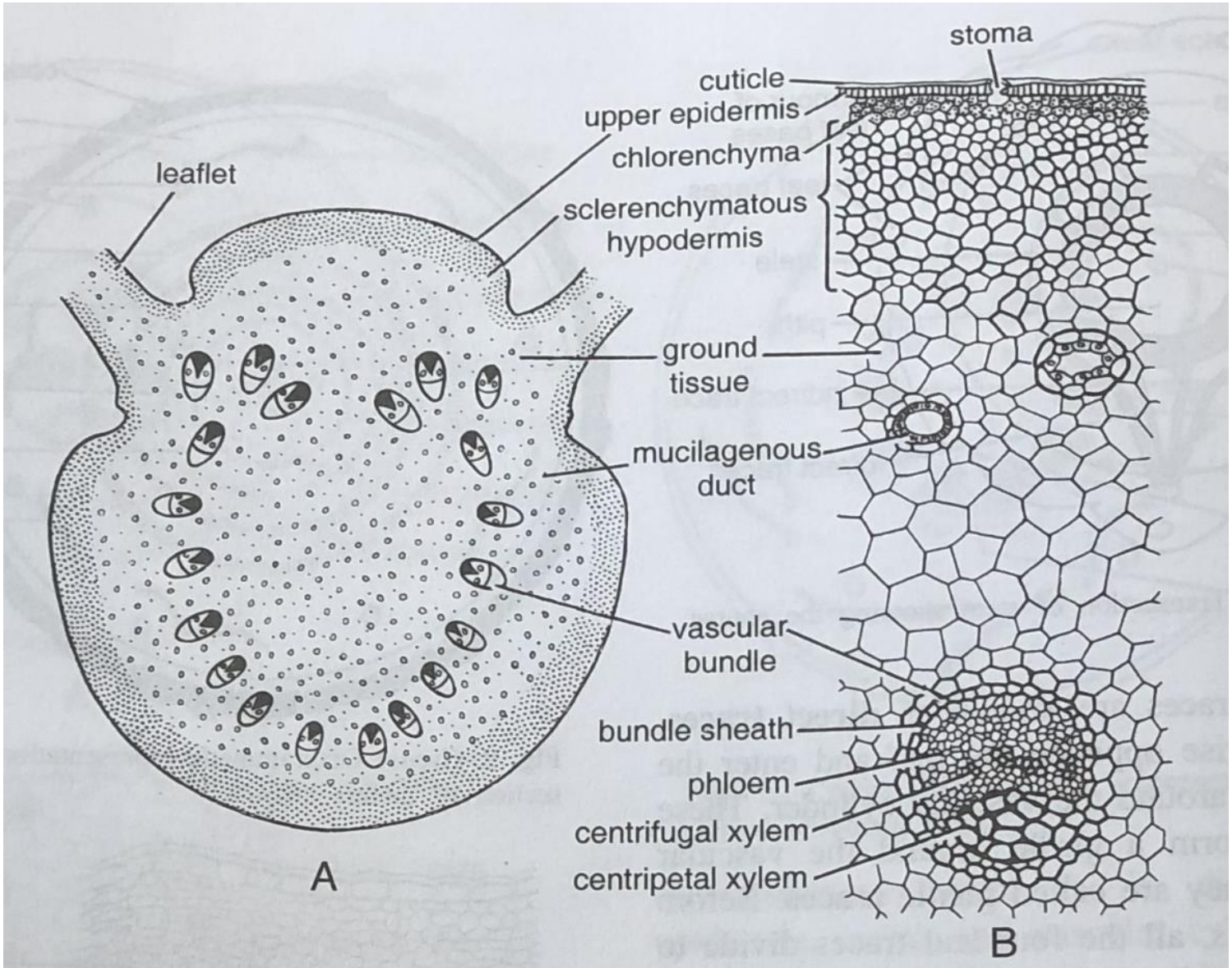


Fig. 11 A-B. ***Cycas*****: Rachis**; **A.** Diagrammatic representation of transverse section, **B.** A part showing cellular details

RACHIS

At base:

Cfx only protoxylem lie towards centre of rachis (endarch)

Little higher:

Cfx is reduced (only few protoxylem remain endarch…rest begin moving laterally)

Cp-centripetal xylem-protoxylem lie towards centre of rachis

At middle:

Groupsnof thick walled cells develop just behind protoxyme elements… differentiate into centripetal xylem

At top:

More centripetal xylem than centrifugal.

Here,

Cfx lies in small patches on both sides of cpx.

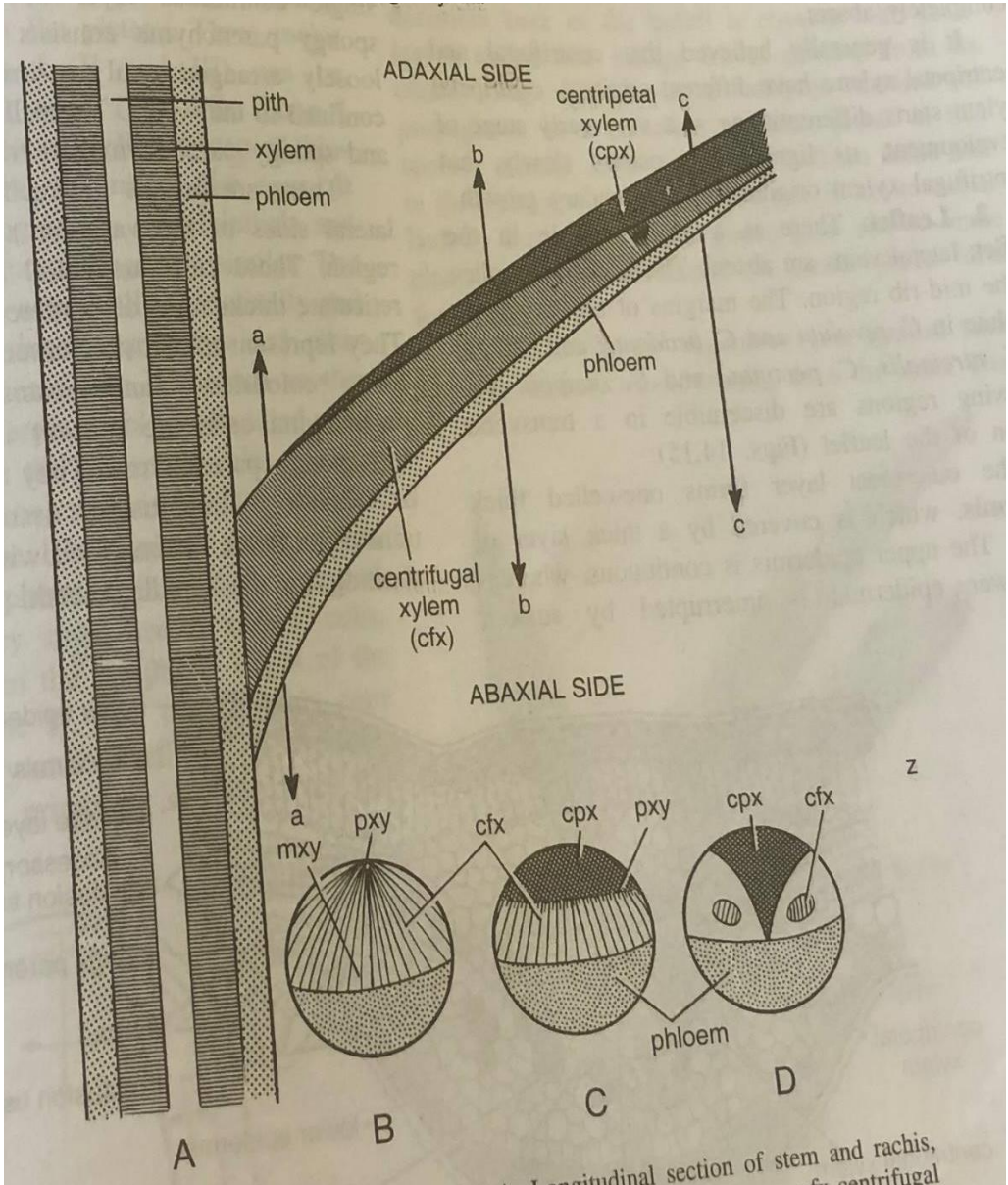


Fig. 13 A-D. *Cycas*: Anatomy of rachis; A. Longitudinal section of stem and rachis, **B-D.** Vascular bundles at different heights in the rachis (a-a, b-b, c-c, cfx-centrifugal xylem, cpx-centripetal xylem, mxy-metaxylem, pxy-protoxylem).

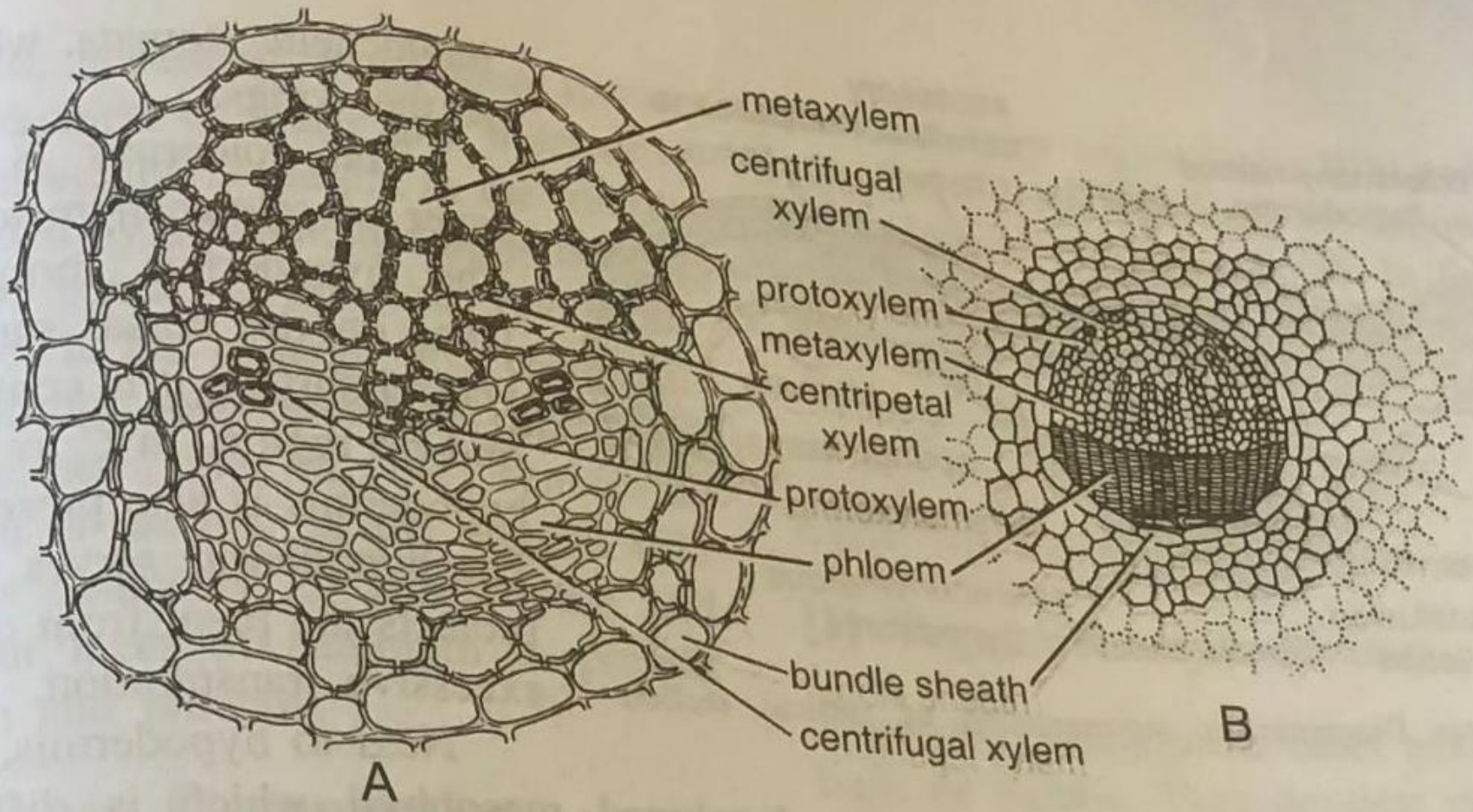


Fig. 12 A-B. *Cycas*: Vascular bundles; **A.** Vascular bundle with both centrifugal and centripetal xylem, **B.** Vascular bundle with only centrifugal xylem.

LEAF

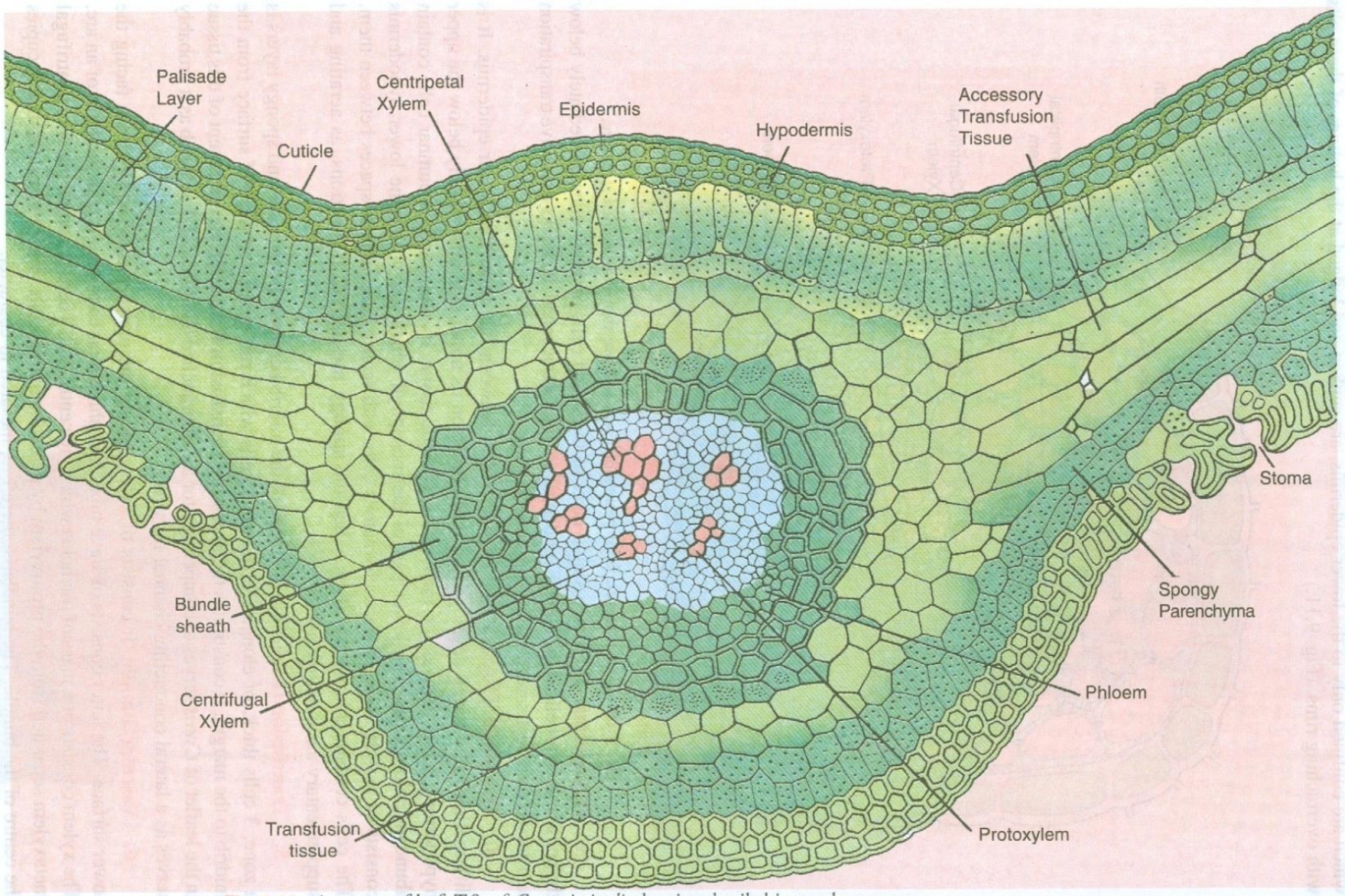
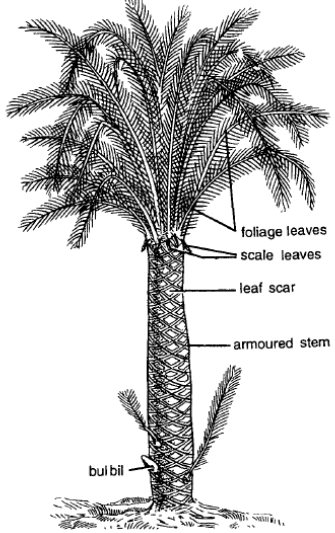


Fig. 9.11. Anatomy of leaf, T.S. of *Cycas circinalis* showing detailed internal structure.

REPRODUCTION



Vegetative reproduction : Bulbil

- Adventitious buds/ bulbils
- Develop from basal part of stem
- From parenchymatous cells of cortex.
- Decurrent base of bulbil is covered with scale leaves.
- Few foliage leaves develop from centre of bulbil.

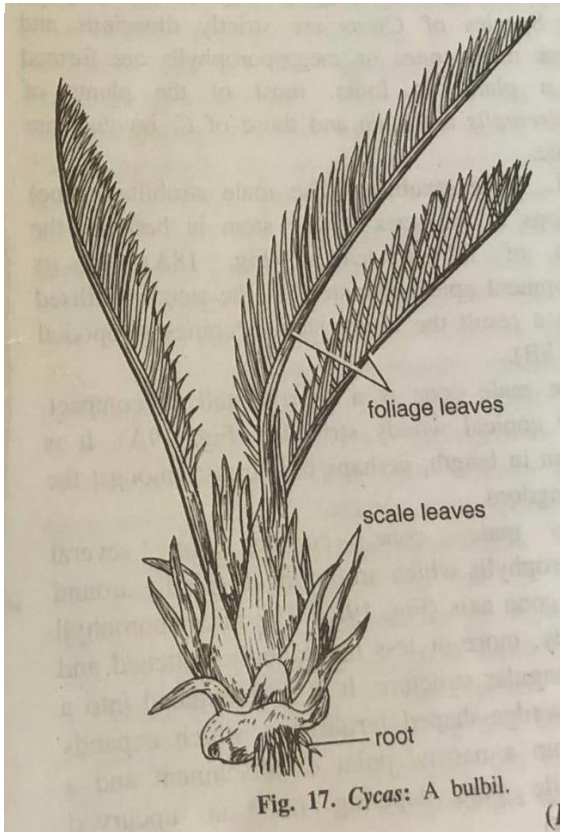


Fig. 17. *Cycas*: A bulbil.

Naturally from Suckers

Cycas male cone

Sexual reproduction :

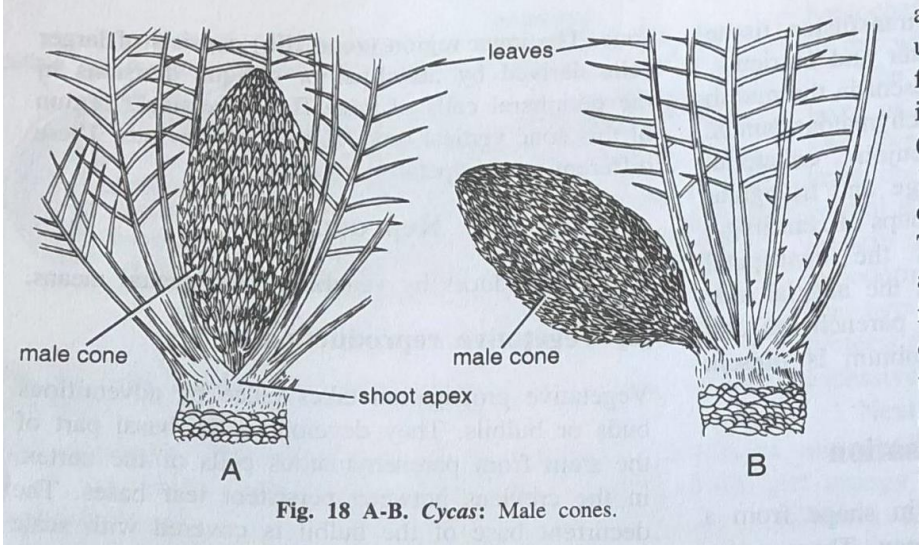


Fig. 18 A-B. *Cycas*: Male cones.

- Heterothallic (dioecious)
- Microspore give rise to male gametophyte (pollen grain)
- Megaspore give rise to female gametophyte (egg)

Male strobilus (cone)

- At apex, singly
- Shortly stalked, compact, oval, conical, woody 40-80 cm length (largest among plant kingdom)

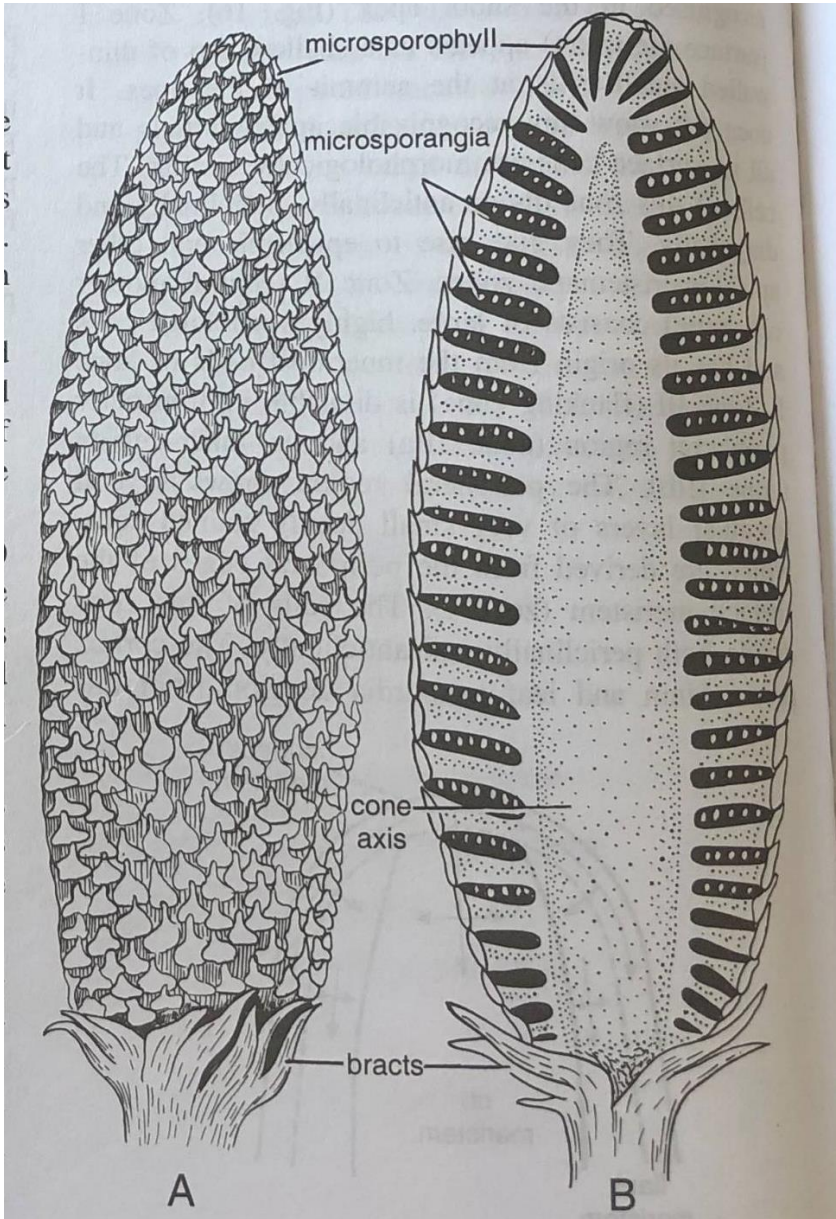
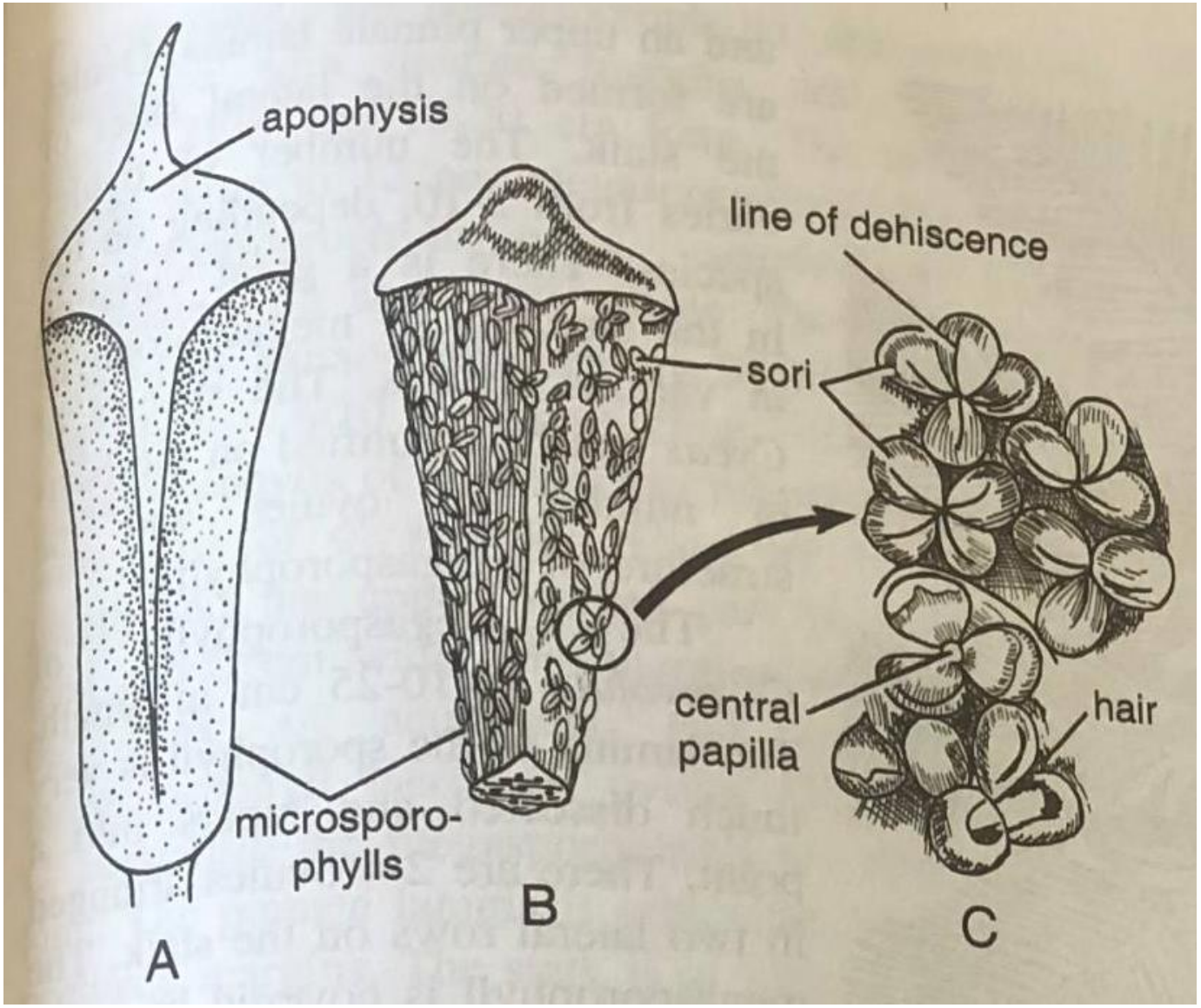
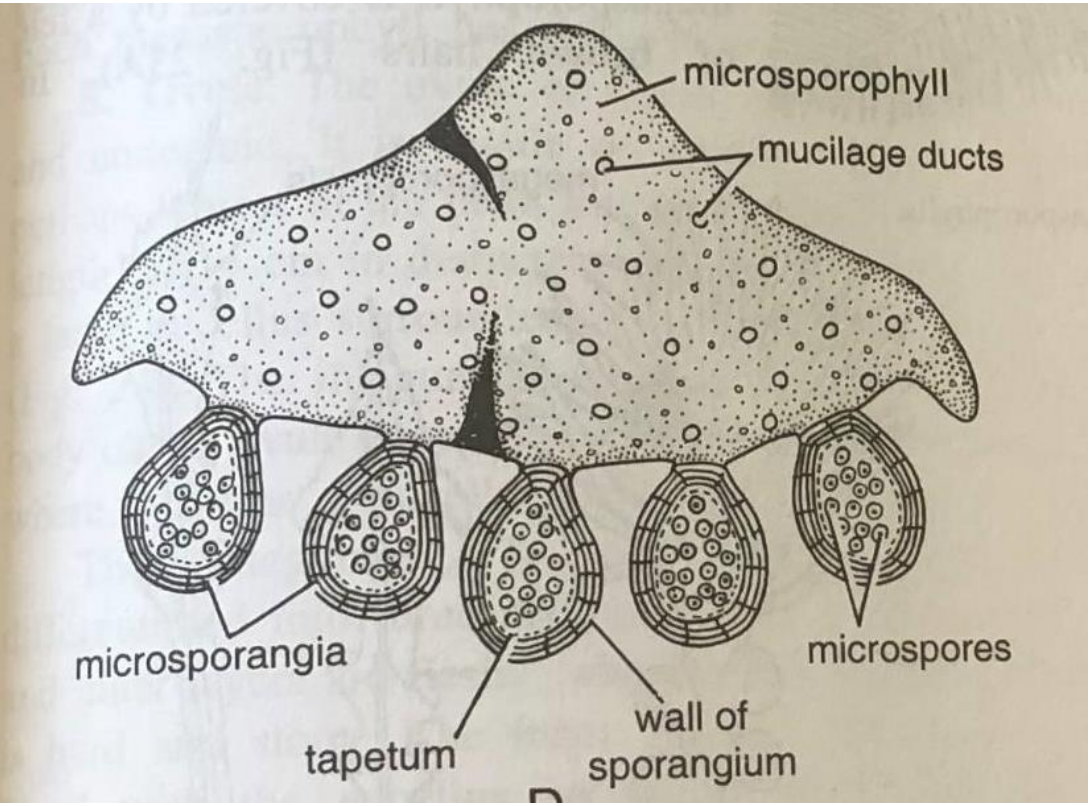


Fig. 19 A-B. ***Cycas*****:** Male cone; **A.** Entire, **B.** Longitudinal section.

Microsporophylls



V.S Microsporophyll



Microsporangia:
Shortly stalked/ sessile
Wall: 3 regions- Exothecium (thick walled, cutinized cells)
Endothecium ()(thin walled)
Tapetum (nutritive)
Large number of microspores in sporangium.
Microspores: Pollen grain are globular, uninucleate, haploid.
Exine uniformly thick

Cycas megasporophyll-

- not in cones
- Occur in close spirals, acropetal succession
- New megasporophylls every year (like foliage leaves)
- Modified leaves

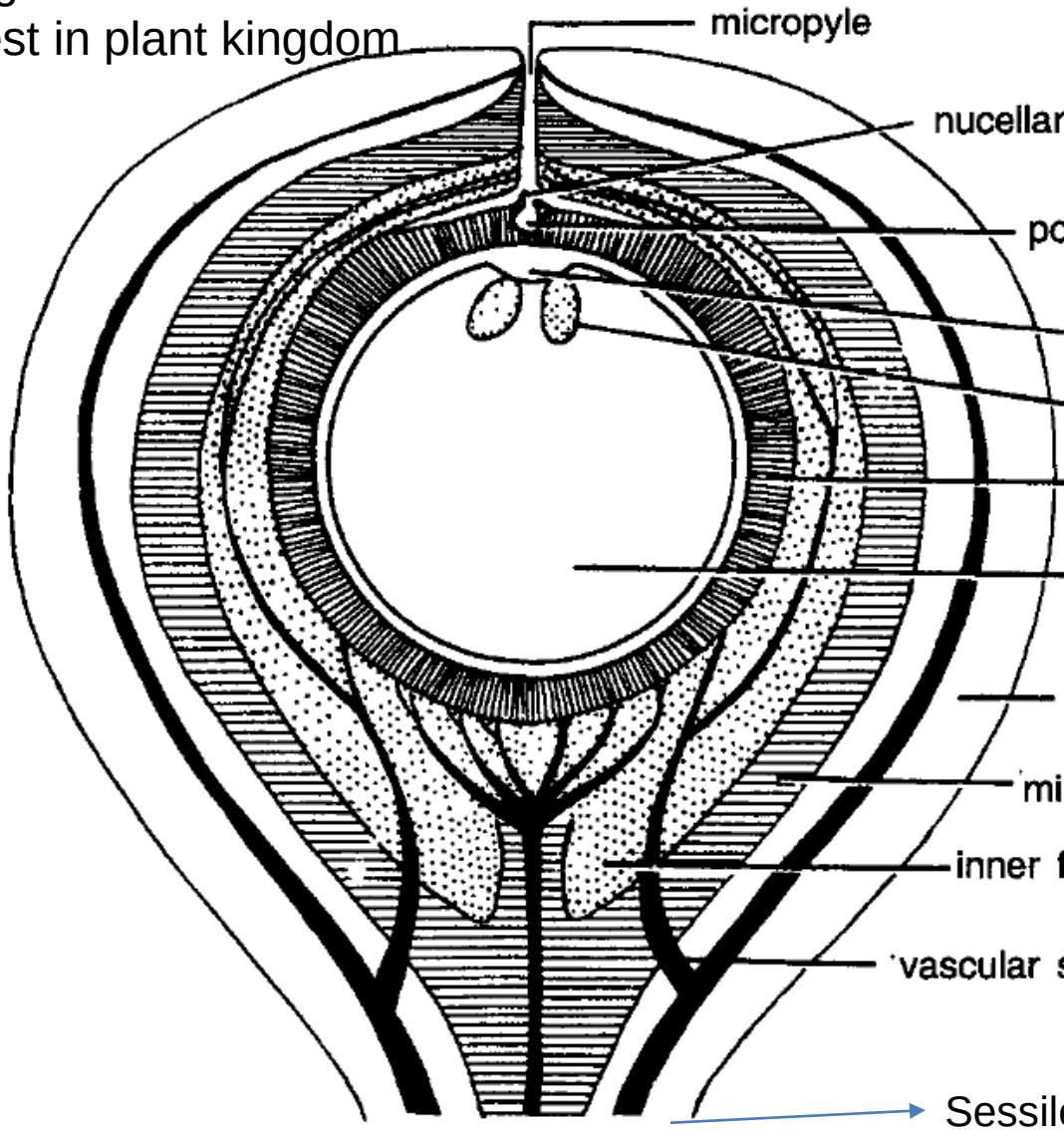

Cycas revo
Cycadacea
©G. D. Carr


Cycas circinalis
Cycadaceae
© G. D. Carr

- Orthotropous
- Unitegmis
- Largest in plant kingdom

L.S OVULE

Nucellus + integument



(By breaking of nucellar beak tissue)

(2-8 in no.)

Large, surrounded by integument

(**Sarcotesta**)

(**Sclerotesta**)

(**Short lived**
Fused with nucellus
Short lived (papery layer in mature ovule))

Integument

Sessile/ Short stalk

Young: **Green,** covered by multicellular hair

Mature: **Red**/**Orange ,** hair disappear

GAMETOPHYTES

Heterosporous- Microspores Megaspores

Last phase of sporophytic gen
1st stage of gametophytic generation
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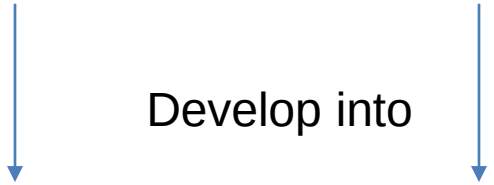


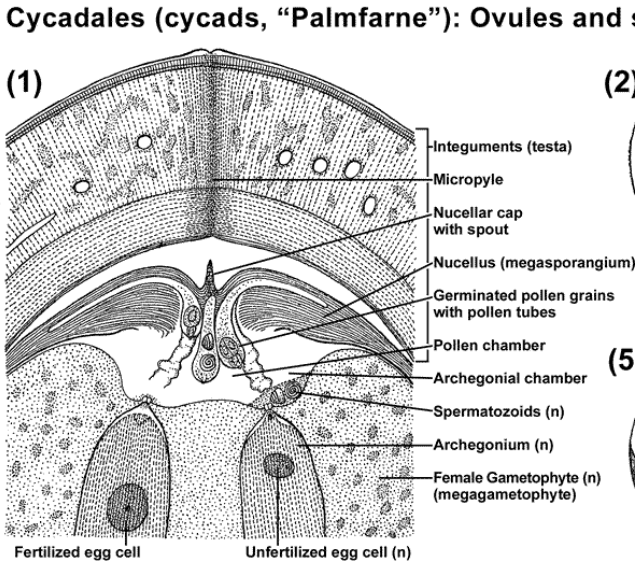
Male gametophyte Female Gametophyte

Male Gametophyte (Sperm)

- Pollen grain develops partially inside sporangium and partially in pollen chamber after pollination
- PG shed at 3 celled stage in air after microspirangium dehise (v light weight)

Pollination

- Nucellar beak during this time: disorganise to form **viscous fluid**
- fluid ooze out of micropyle (**pollination drop**)
- microspores **entangle** in pollination drop
- Pollination drop **dries**
- microspores **sucked** in micropylar canal
- micropylar canal gets **plugged**



- After pollination, Ovule increases in size (unpollinated oveles dry and wither away)

Thick at 2 poles

PG released at 4 celled stage

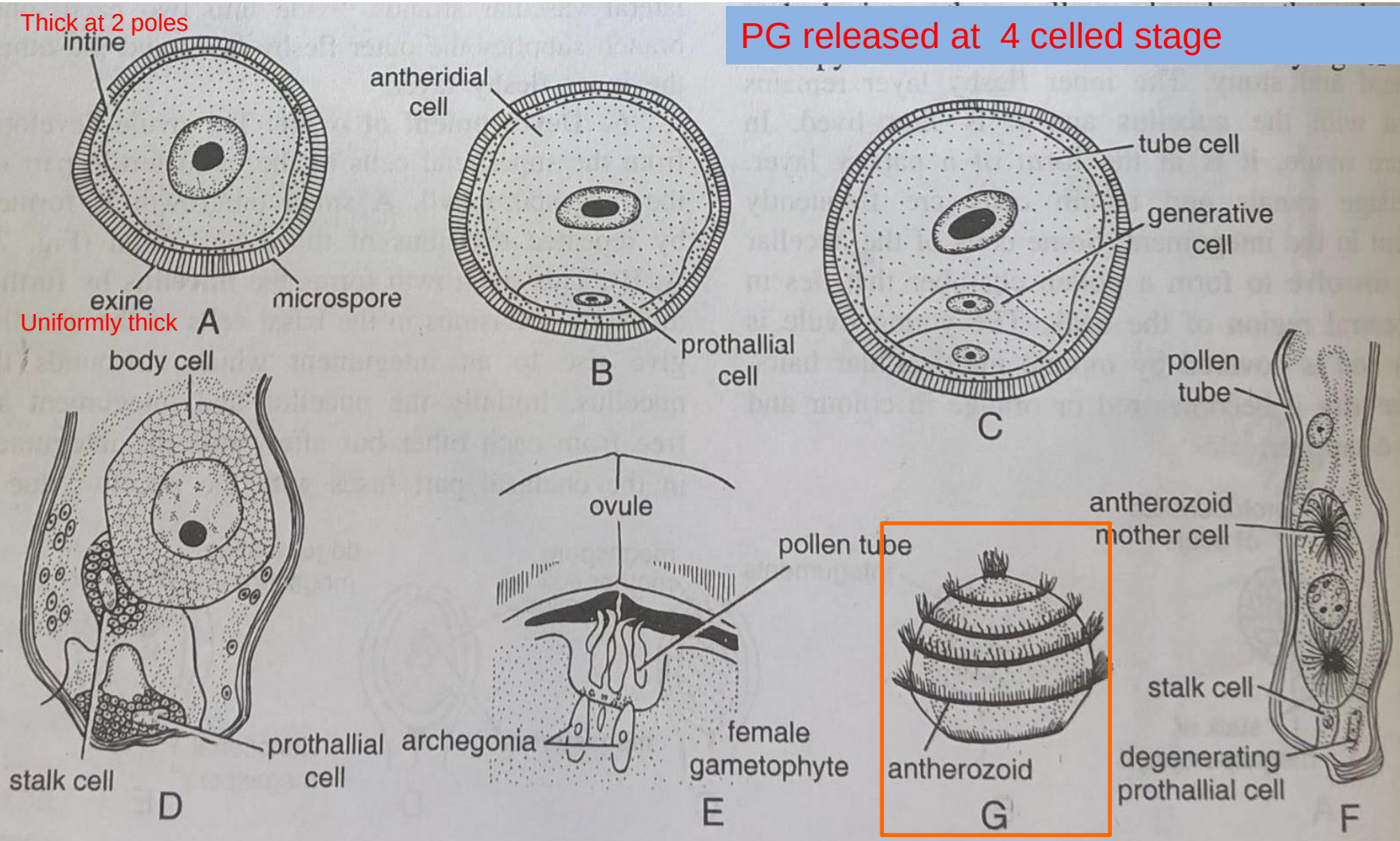


Fig. 26 A-G. *Cycas*: Development of male gametophyte; A-C. Stages before pollination, **D-F.** Stages after pollination, **G.** An antherozoid.

Male Gametes: Naked, top shaped, 180-210 um, many cilia, largest in plant kingdom.

FEMALE GAMETOPHYTE

- Develops from functional megaspore in ovule.
- Per ovule=2-8 archegonia
- Nucellar tissue above archegonial initial disintegrates to form archegonial chamber
- Mature Archegonium:
  - 2-4 neck cells
  - 1 egg
  - Archegonial jacket around venter

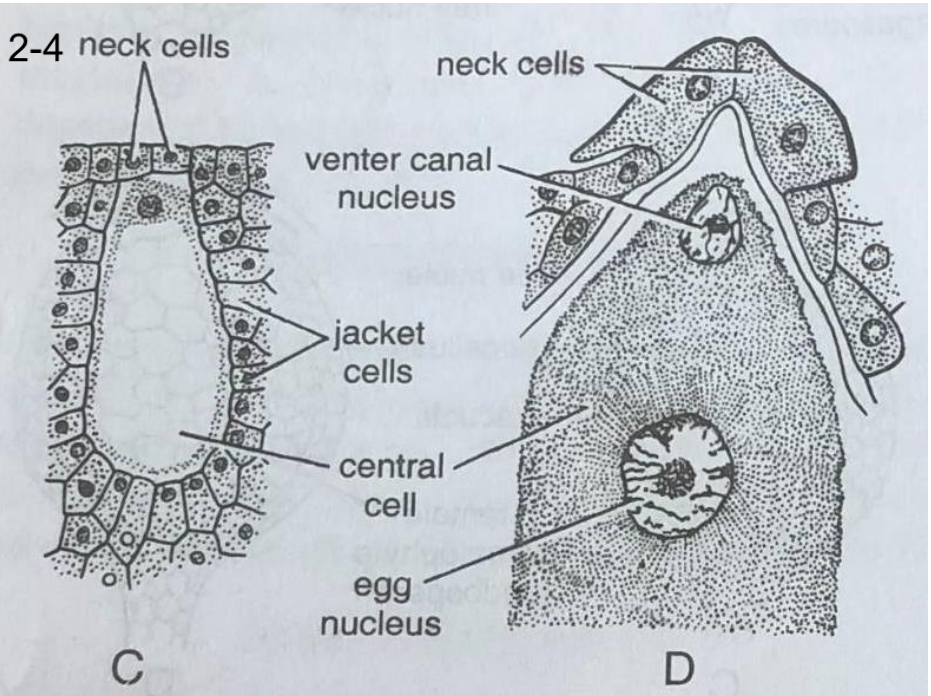
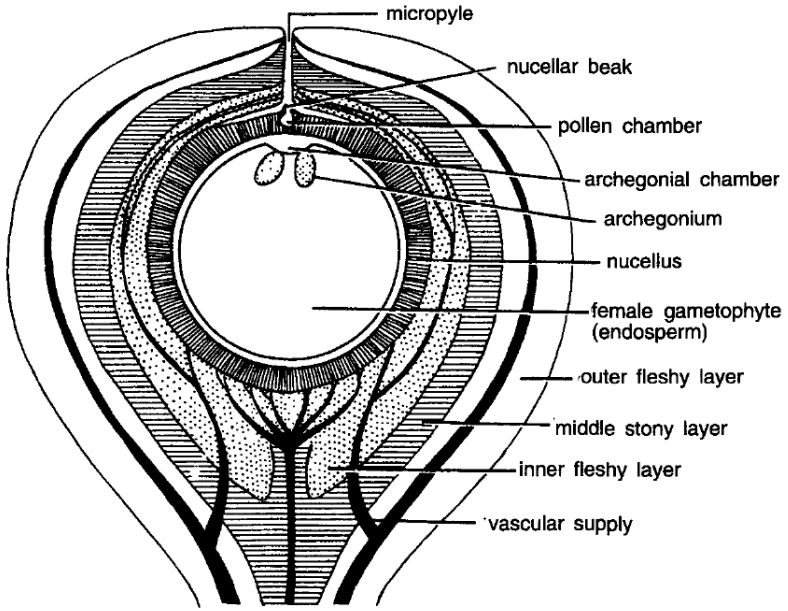
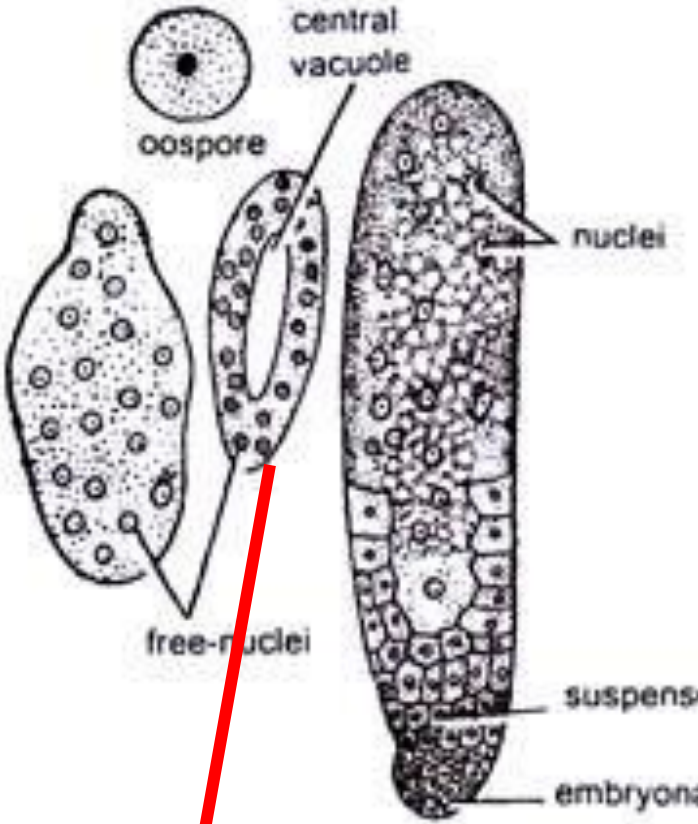


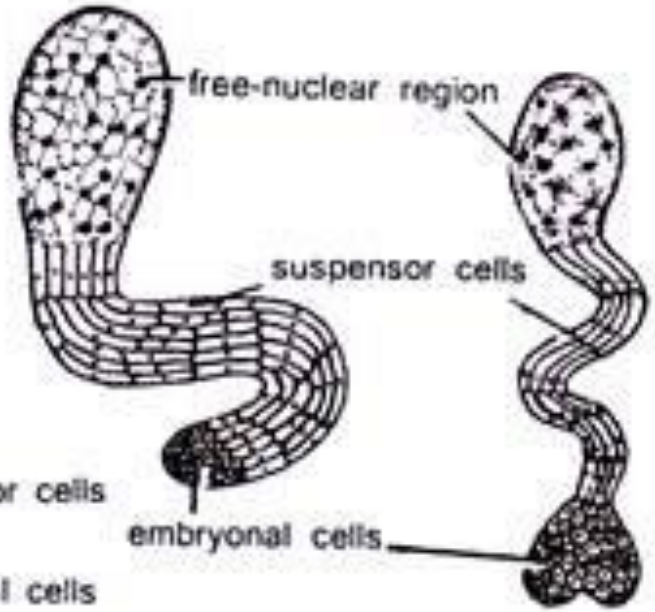
Fig. 28 A-D. ***Cycas*****:** Stages in the development of archegonium.



FERTILIZATION

- Pollen tube breaks nucellar tissue and reaches archegonia.
- Pollen tube bursts (due to high osmotic pressure) and releases contents (male gametes / sperms).
- When neck cells come in contact with neck cells of archegonium, gametes are sucked in violently
- Normally, 1 male gamete enters archegonium (if both enter, one degenerates. Phenomenon of entrance of more than one male gamete in archegonium is called **polyspermy**).
- Male gamete + egg → zygote.





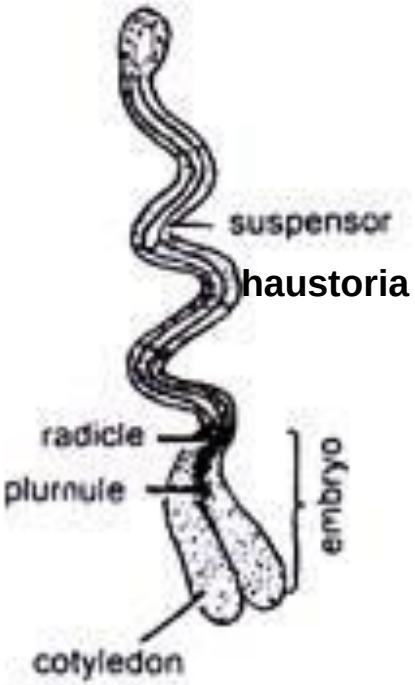
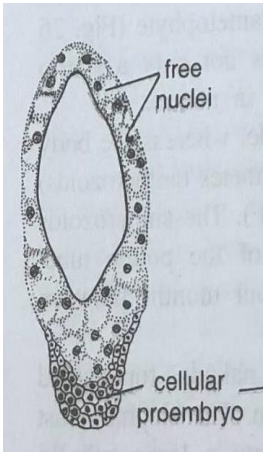


Fig. 8.51. *Cycas*. Development of oospore Fig. 8.52. *Cycas*. Showing formation of proembryo.



EMBRYOGENY

OVULES

SEEDS

SEED

Red/ orange/dark brown

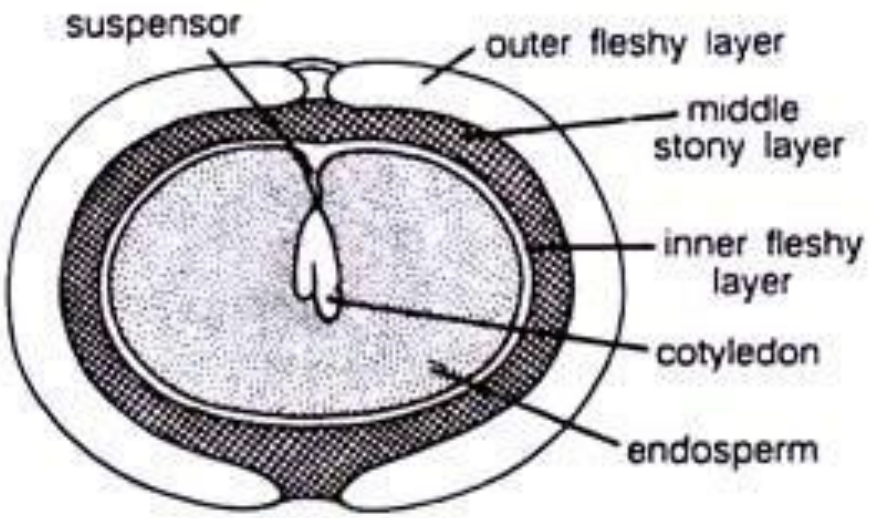


Fig. 8.53 *Cycas*. L.S. seed.

- Seed =3 generations:
- **Seed coat**= integument of ovule=1st sporophytic stage
- **Endosperm**= gametophytic stage
- **Embryo**=new sporophytic stage.

SEED GERMINATION

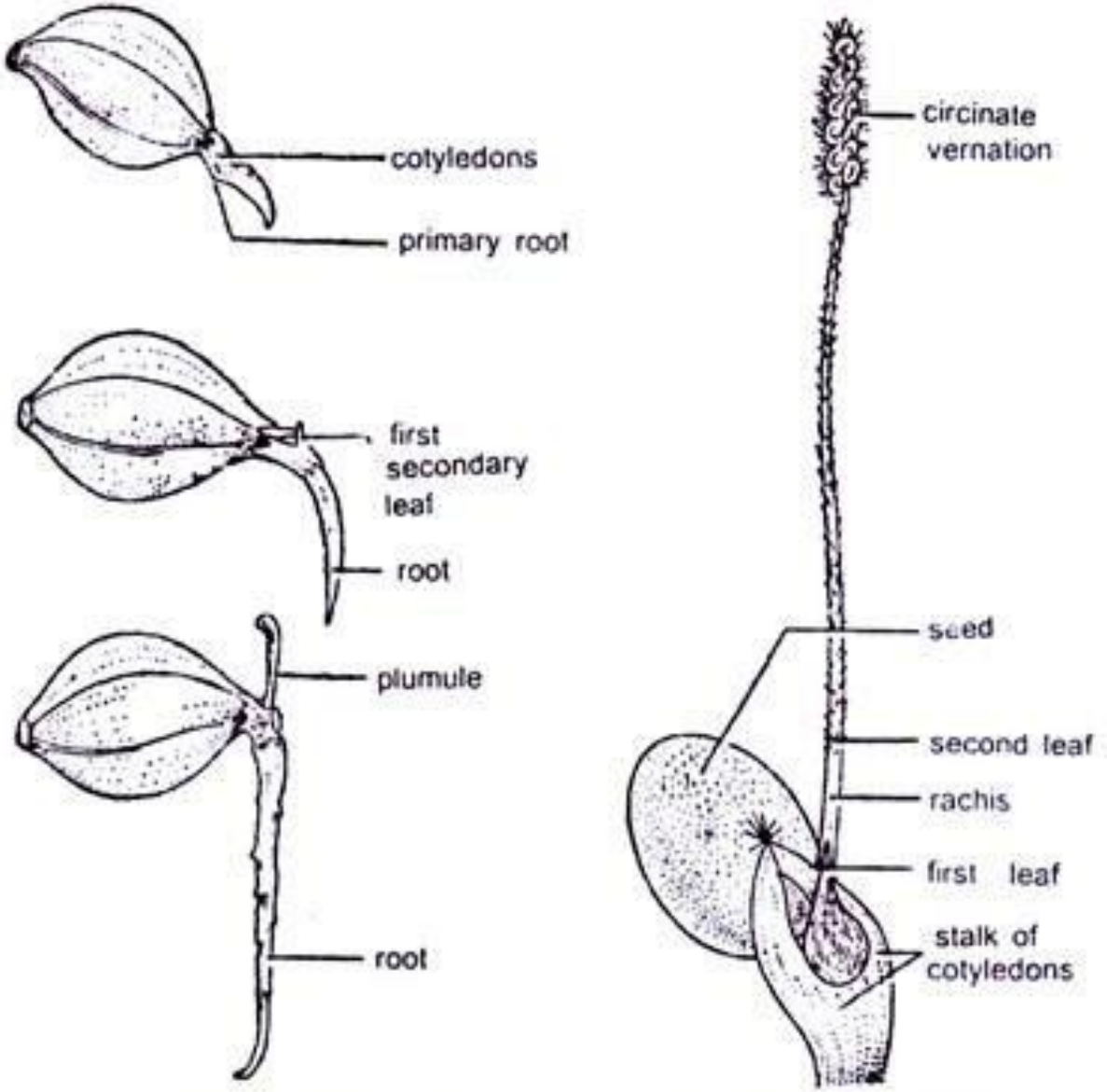


Fig. 8.54. *Cycas*. Various stages of seed germination.

like the banana leaf ... The seed-bearing organs or megasporophylls

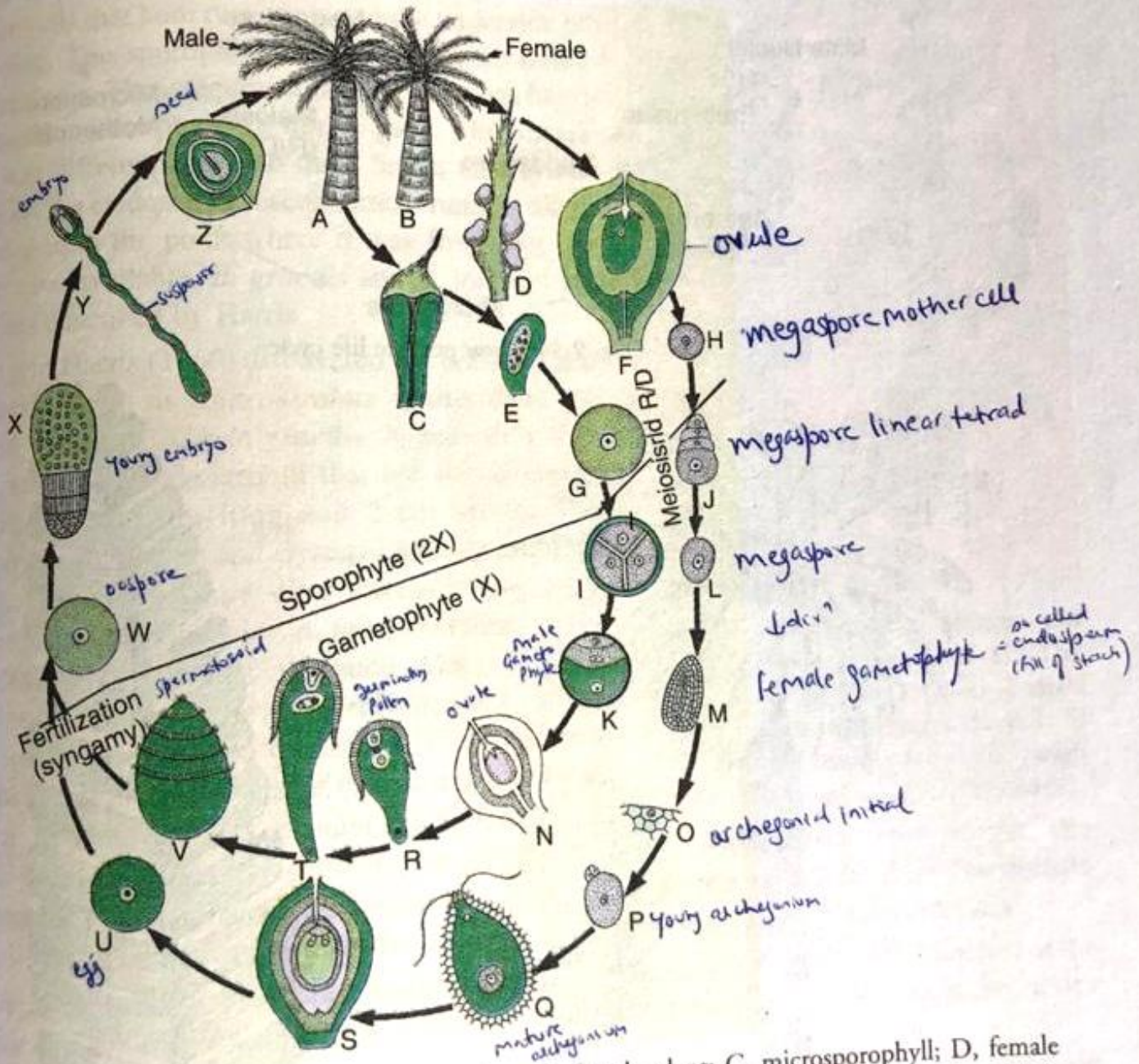


Fig. 9.33. *Cycas* sp. Diagrammatic life-cycle; A, male plant; B, female plant; C, microsporophyll; D, female ... microspore mother cell; H, megasopore mother cell; I, ... M, female

➤➤ *Fill in the blanks*

1. The upper sterile portion of the microsporophyll of *Cycas* is called.....
2. The leaf traces in the stem of *Cycas* are of two types, viz., ... and.....
3. The coralloid roots of *Cycas* are.....in nature.
4. The archegonium of *Cycas* lacks.....
5. In plant kingdom the largest ovules occur in.....
6. In *Cycas* the proembryo is differentiated into three regions, the middle one of which is known as.....
7. Dispersal of microspores in *Cycas* takes place at.....celled stage.
8. Each male gametophyte of *Cycas* has.....male gametes.

➤➤ *True and false statements*

1. In gymnosperms, sperms are always flagellated.
2. In *Cycas* the pollen tube serves only as a sperm carrier.
3. The coralloid roots of *Cycas* are useful for aeration and nitrification.

4. The pollen tube in *Cycas* is of haustorial nature.
5. *Cycas rumphii* occurs wild in Andaman and Nicobar islands.
6. Leaves of *Cycas* show circinate vernation.
7. The ovules of *Cycas* are anatropous and unitegmic.
8. In *Cycas* the endosperm develops before fertilization.
9. In *Cycas* the bulbils are differentiated on the main stem in between the leaf bases.
10. In *Cycas* each year foliage leaves are produced only in one whorl where as scale leaves may be produced in two or more whorls.

➤➤ *Multiple choice questions*

Answer key

➤➤***Fill in the blanks***

1. apophysis, 2. direct traces and girdle traces, 3. apogeotropic, 4. neck canal cell, 5. *Cycas*, 6. suspensor region, 7. three, 8. two.

➤➤***True and false statements***

1. False, 2. False, 3. True, 4. True, 5. True, 6. True, 7. False, 8. True, 9. True, 10. False.

END