CYCAS

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CYCAS

Systematic Position

Gymnospermae

- Division: CYCADOPHYTA
- Class: CYCADOPSIDA
- Order: CYCADALES
- Family: CYCADACEAE
- Genus: CYCAS

(Greek word Kycas = Cocopalm)

Triassic Scenery

Dry Areas

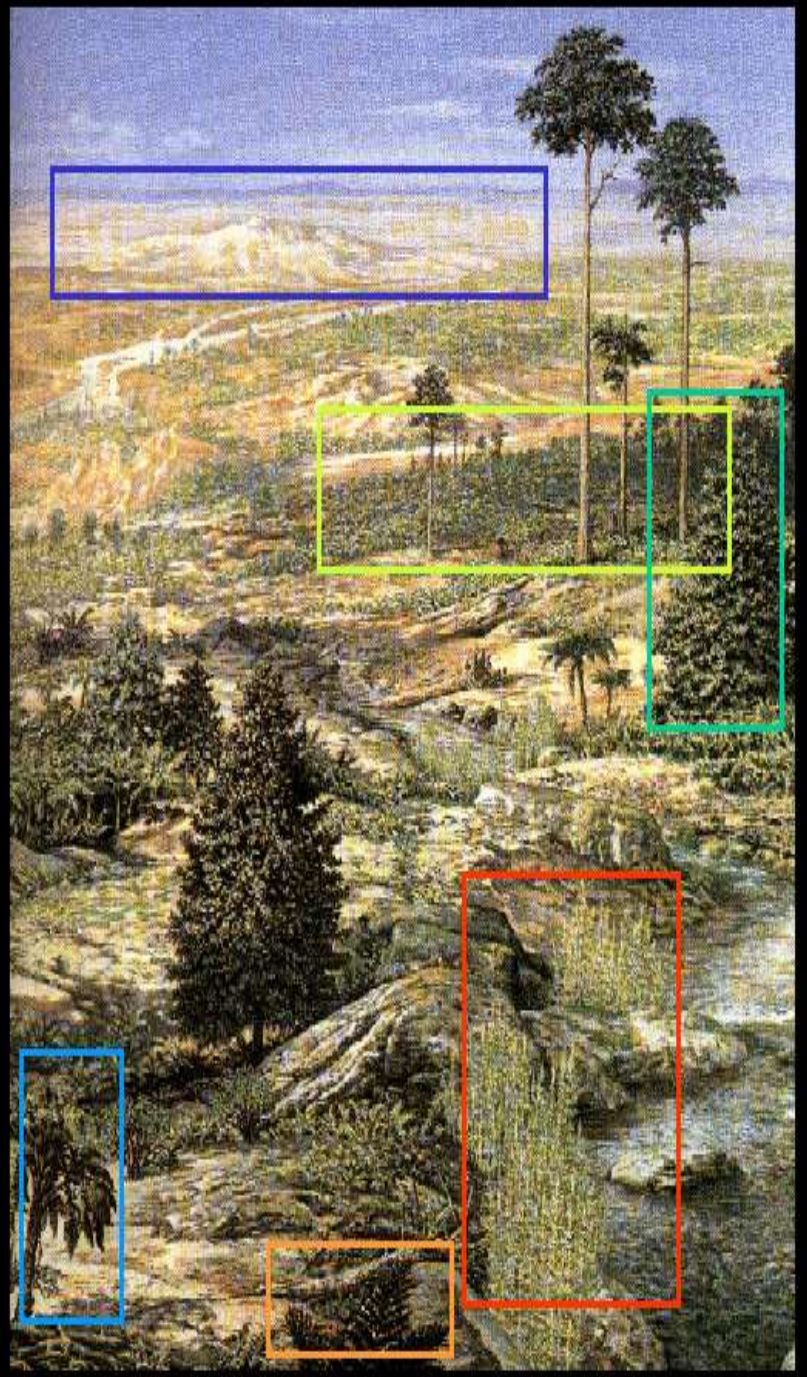
Conifer, Gingko and Fern Forest

Conifer

Horsetails

Ferns

Tree Ferns



Geographical distribution in time and space

- The cycads first appeared in the upper Triassic period and survived until the present day.
- The best preserved remains of the form genera
  1. Paleocycas whose female soprangiophores were described from upper Triassic rocks of Sweden and the leaves were described by the name – Bjuvia simplex
  2. Leptocycas
  3. Lyssoxylon show close affinity with the present day cycads
- They originated in the upper Triassic and existed over a period of at least 250 million years and then gradually declined in number, being represented today only by 11 living genera.

Triassic Period

251 MYA - 199 MYA

Climate: Hot and dry, Seasonal hot summers/cold winters, no evidence of glaciations

Flora: Full recovery of woody trees

Fauna: First dinosaurs, first flying vertebrates, first mammals, new corals/reefs

Continental Masses:

Pangaea rifting

Period ended with mass extinction severe in oceans

Triassic The three distinct rock layers

Pangaea (SUPER CONTINENT)

The name is derived from Ancient Greek

pan (**"all, entire, whole")**

Gaia (**"Mother Earth, land")**

- **Distribution & Occurrence**
- Includes 20 Species
- Occurs wild or cultivated in tropical and sub-tropical regions
  - South of Eastern Hemisphere
  - e.g. S. Japan, India, China,
  - N. Australia, E. Coasts of Africa,
  - Myanmar, Bangladesh, Mauritius,
  - Nepal, etc.
- 6 species Indian – 4 wild & 2 cultivated
  - C circinalis,
  - C. rumphii
  - C. pectinata
  - C. beddomei
  - C. revoluta & C. siamensis

PRESENT DAY DISTRIBUTION OF THE DIFFERENT GENERA OF CYCADALES IS LISTED BELOW

1. **Cycas(20 sps)** : India, Ceylon , java , phillipines, new guinea,fijii island ,Australia ,islands of madogaskar , mauritious , zanziber & cape comorin , south Vietnam , chna , japan, and areas bordering the gulf of Tonkin
2. **Zamia (30-40 sps)** : florida ,west indies ,mexico , northern part of south America and west coast of chile
3. **Macrozamia (14 sps)** : endemic to Australia , particularly in the eastern , central and south western regions
4. **Ceratozamia (4 sps)** : endemic to mexico , particularly in the southern mexico and Guatemala
5. **Lepidozamia (2 sps)** : endemic to Australia
6. **Dioon (3-5 sps)** : endemic to mexico and Honduras ; also found in central America
7. **Encephalortos (30 sps)** : In meridional africa ; endemic to congo
8. **Microcycas (1 sps)** :restricted to cuba
9. **Stangeria (1 sps)** : restricted to Zululand in south Africa
10. **Bowenia (2 sps)** : endemic to Australia , particularly to the region of north eastern queens land

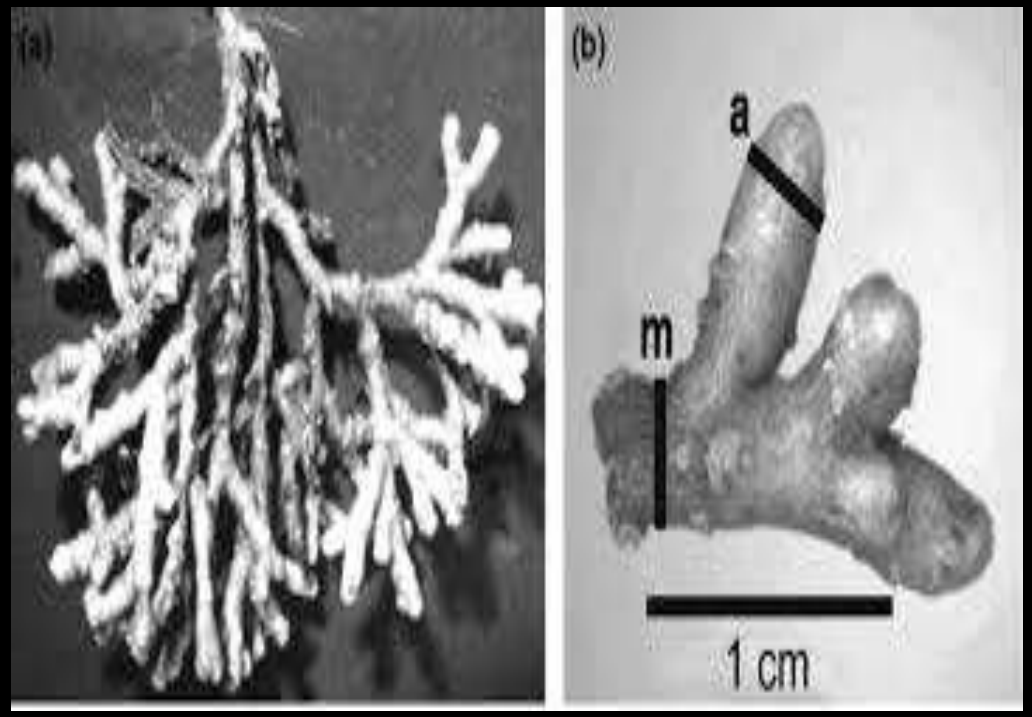
Sporophytic Plant Body

- Plants are low and palm-like, height 4-8 feet
- Tallest species, C. media – upto 20 feet high
- Stem unbranched, columnar and covered with persistent leaf bases
- leaves dimorphic
- Female reproductive structures – the megasporophylls are not aggregated in cones
- Ovules (2 or more) borne on the lower margins in ascending order

- **External Morphology**
- Stem – Cycas plant shows tuberous stem when young, becoming columnar and unbranched later
- Leaf – Shoot apex is protected by a rosette of brown scale leaves
- Plant grows very slowly adding a new crown of leaves every 1 or 2 years, alternating with crown of scale leaves

- **External Morphology**
- The pinnately compound megaphyllous leaves have 80-100 pairs of leaflets arranged on the rachis
- Circinnate axis of young leaves is a fern like character
- Leaf base is rhomboidal in shape and attaches the leaf transversely to the stem
- The leaflets are thick , leathery in texture, ovate or lanceolatein shape & photosynthetic in function.

- **Root** is of two types-normal and coralloid.
- Normal tap-roots grow from the radicle deep inside the soil giving out lateral branches
- Some of the lateral roots grow apogeotropically towards the surface of soil and branch dichotomously
- These roots are short, thick and swollen at the tips.
- Cluster of coralloid roots



- The much branched mass appears like a coral on the soil surface hence called coralloid roots
- Do not bear root caps
- The cluster has lenticel like apertures
- Become infested by N2 fixed blue-green algae (cyanobacteria); bacteria & diatoms e.g. Nostoc, Anabaena
- Symbiotic relationship thus established

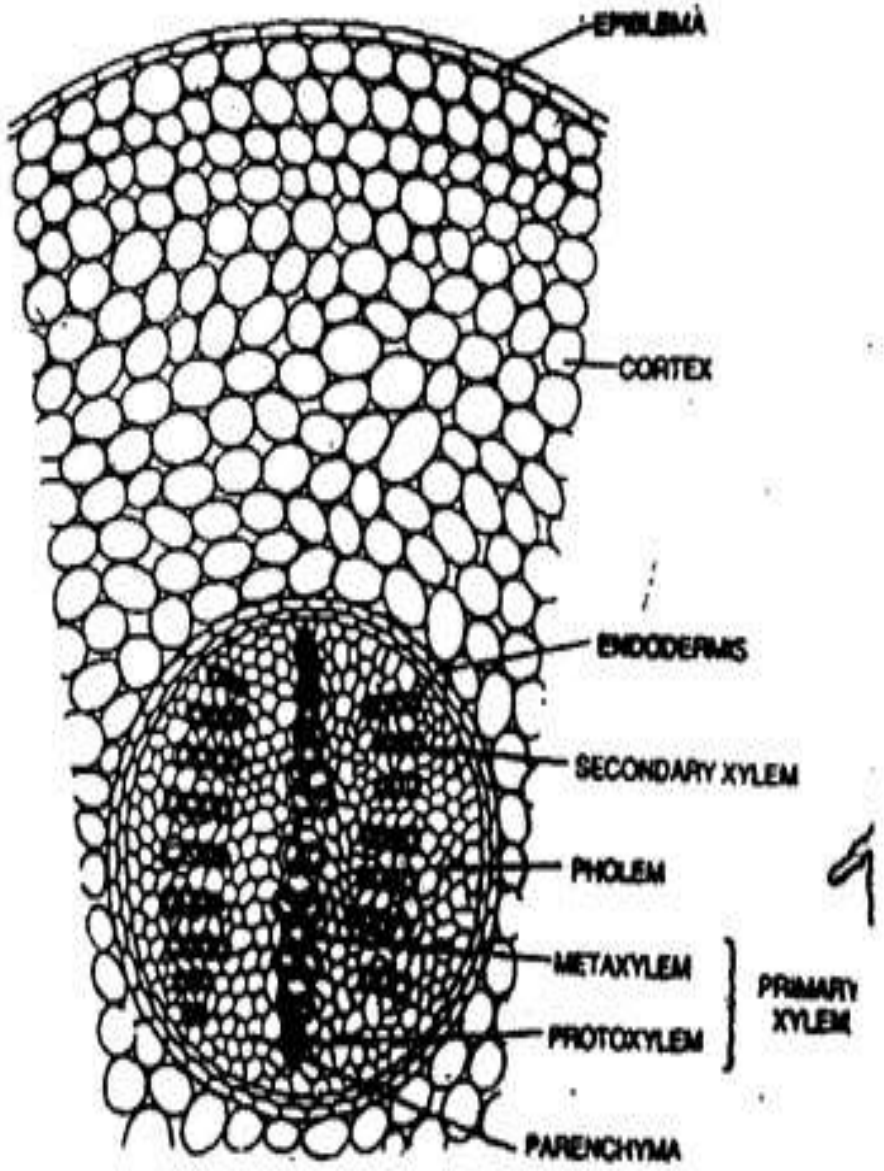


Fig: internal structure of root

Anatomy

Root

- Young root shows typical structure like that of a dicotyledonous root
- Outermost layer, epiblema, encloses the parenchymatous cortex interspersed with tannin cells and mucilage canals
- Endodermis with casparian thickenings
- Pericycle is multilayered with thin cells having starch grains
- Vascular tissue within is typically radial
- Roots usually diarch to tetraarch, rarely polyarch
- Vessels absent in vascular tissue
- Pith reduced or absent

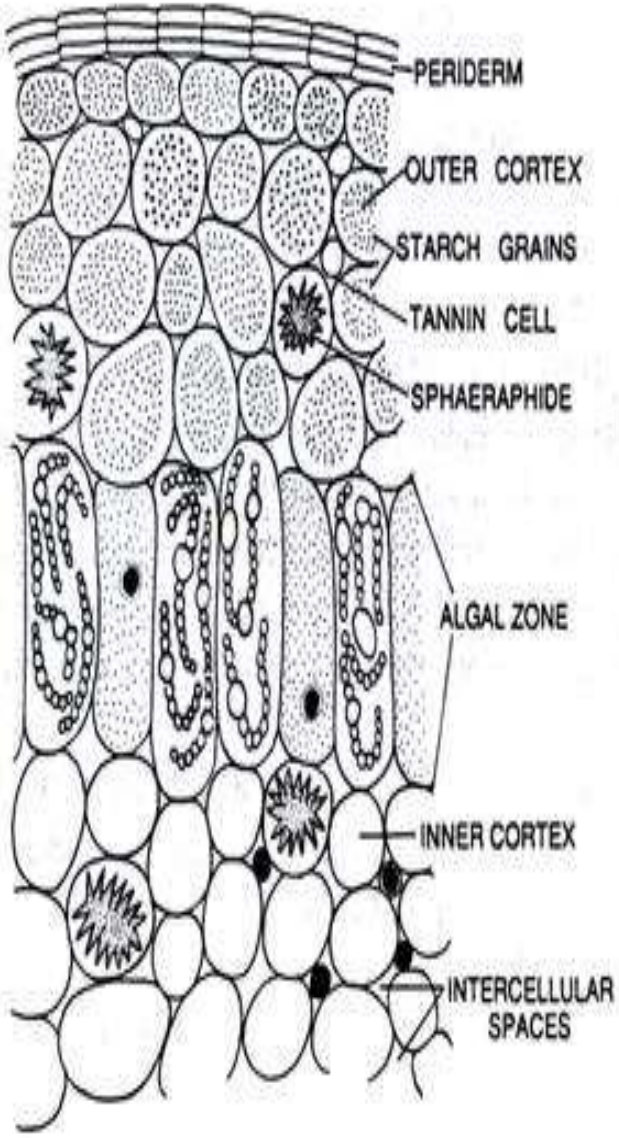


Fig. 3.13. *Cycas revoluta*. Transverse section of a part of coralloid root showing cortical region and algal zone.

Anatomy – Root

Coralloid Roots

Three zones:

1. Outer cortex
2. Middle cortex
3. Inner cortex

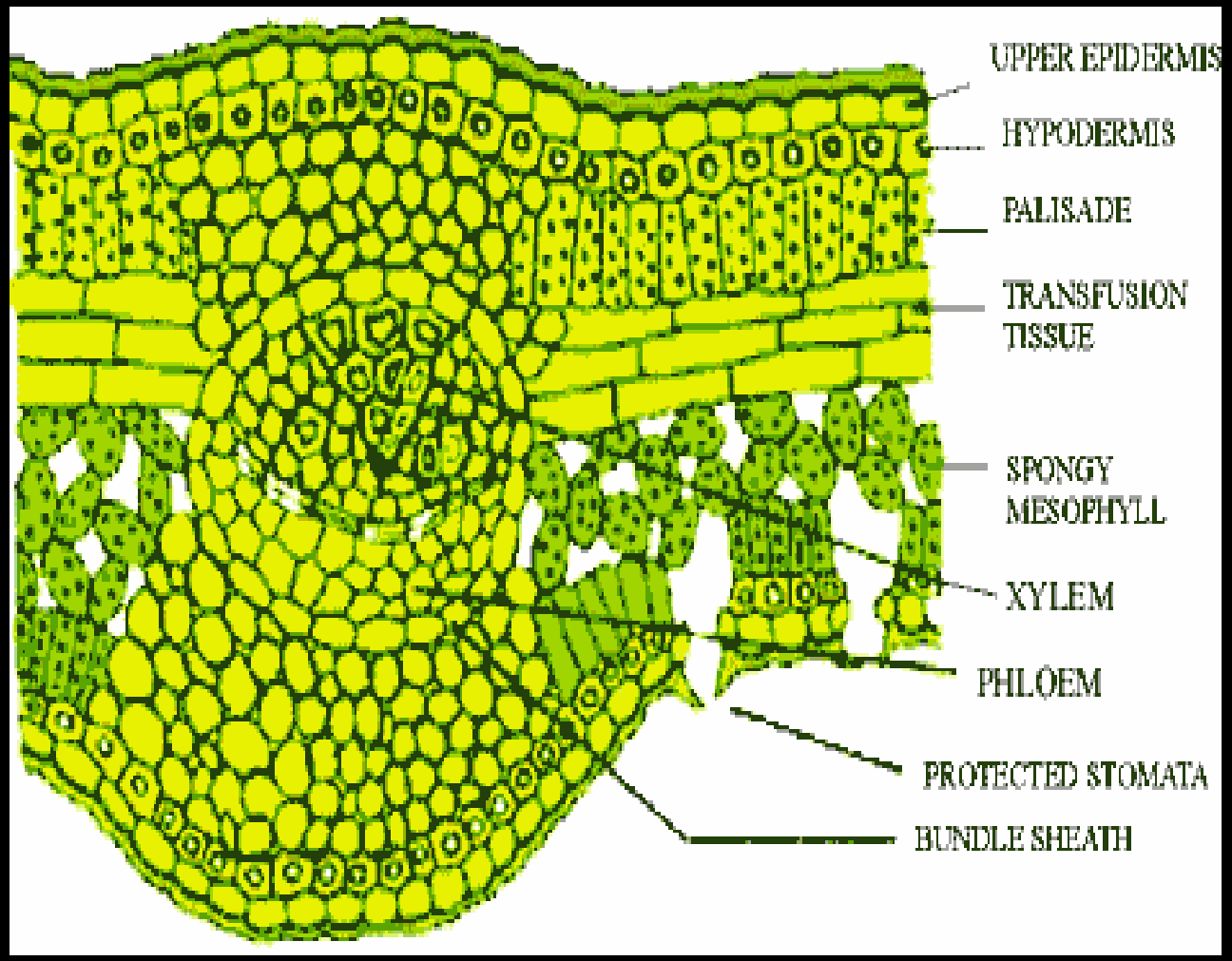
The outer layers formed by cork cambium.

- Has additional algal zone in the middle cortex
- Cells of algal zone palisade like and form the middle cortex
- Stele diarch, triarch or tetrarch surrounded by pericycle.
- Schneider (1894)suggested that symbiotic association.

Anatomy – Rachis

- Rachis of Cycas
- Woody and thick
- Hypodermis sclerenchymatous
- Characteristic feature is omega shaped (Ω) outline of the numerous vascular bundles
- Each bundle has sclerenchymatous bundle sheath and is open, collateral.
- Single layered endodermis
- One or multilayered pericycle surrounded by vascular bundle
- Xylem develops centrifugally
- Phloem lies towards the abaxial side
- Cambium is found in the upper surface of the xylem

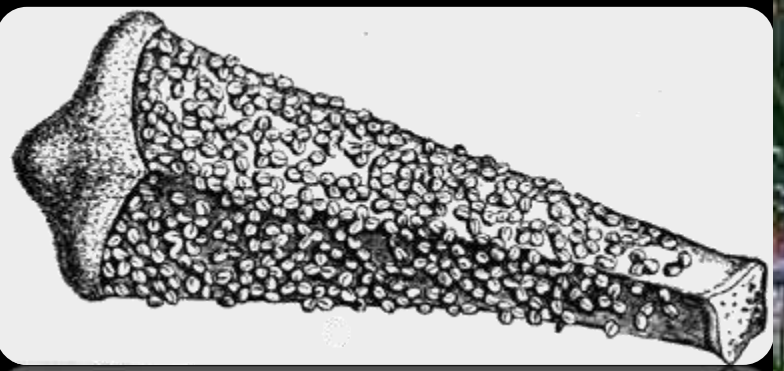
Anatomy – Leaflet



- Cycas Leaflet
- Leaflet is thickly cutinized and leathery
- Possesses all xerophytic characters
- Sunken stomata and thickened hypodermis present
- Well developed palisade layer in mesophyll
- Between the palisade and lower mesophyll layers, there are transversely running long colourless cells in 3-4 layers extending from mid-rib to near leaf margin
- These constitute the transfusion tissue
- Mid-rib bundle consists of a broad triangular centripetal xylem and two small patches of centrifugal xylem – thus dipoxylic
- Phloem abaxially placed

Reproduction – Vegetative

- 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



MALE CONE

- Strictly dioecious plant
- **Male** plants are rare
- 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
- Cone shortly stalked & large (up to 50cm length or more)

FEMALE CONE

- 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 cms. long
- Lower petiolar part bears the naked ovules on the margins

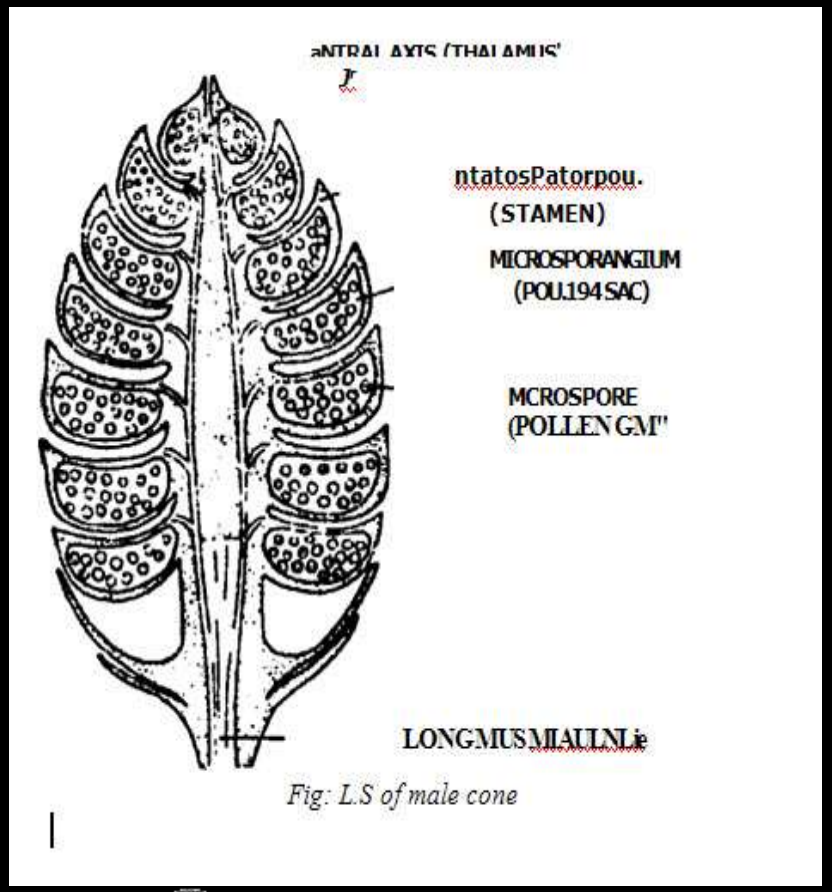
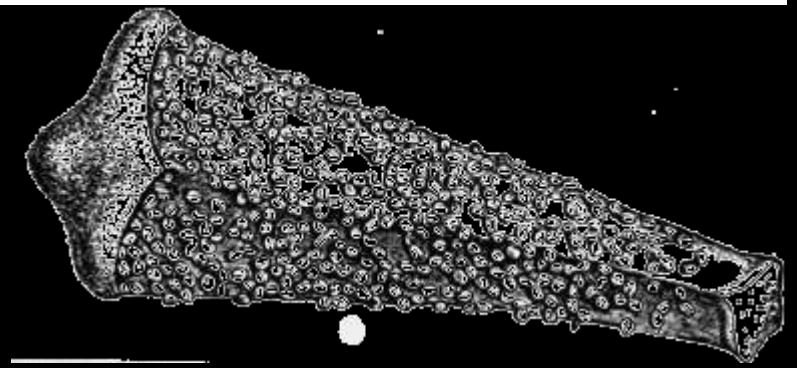


Fig: L.S of male cone



L.S OF MALE CONE

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

Pollination

- The pollen grains are carried by wind (Anemophily) and caught by pollination drop secreted by ovule. **Pollination is direct**.
- The pollination drop is dehydrated and the pollen grains are sucked into the pollen chamber.
- Pollen grains take rest for some time in the pollen chamber.

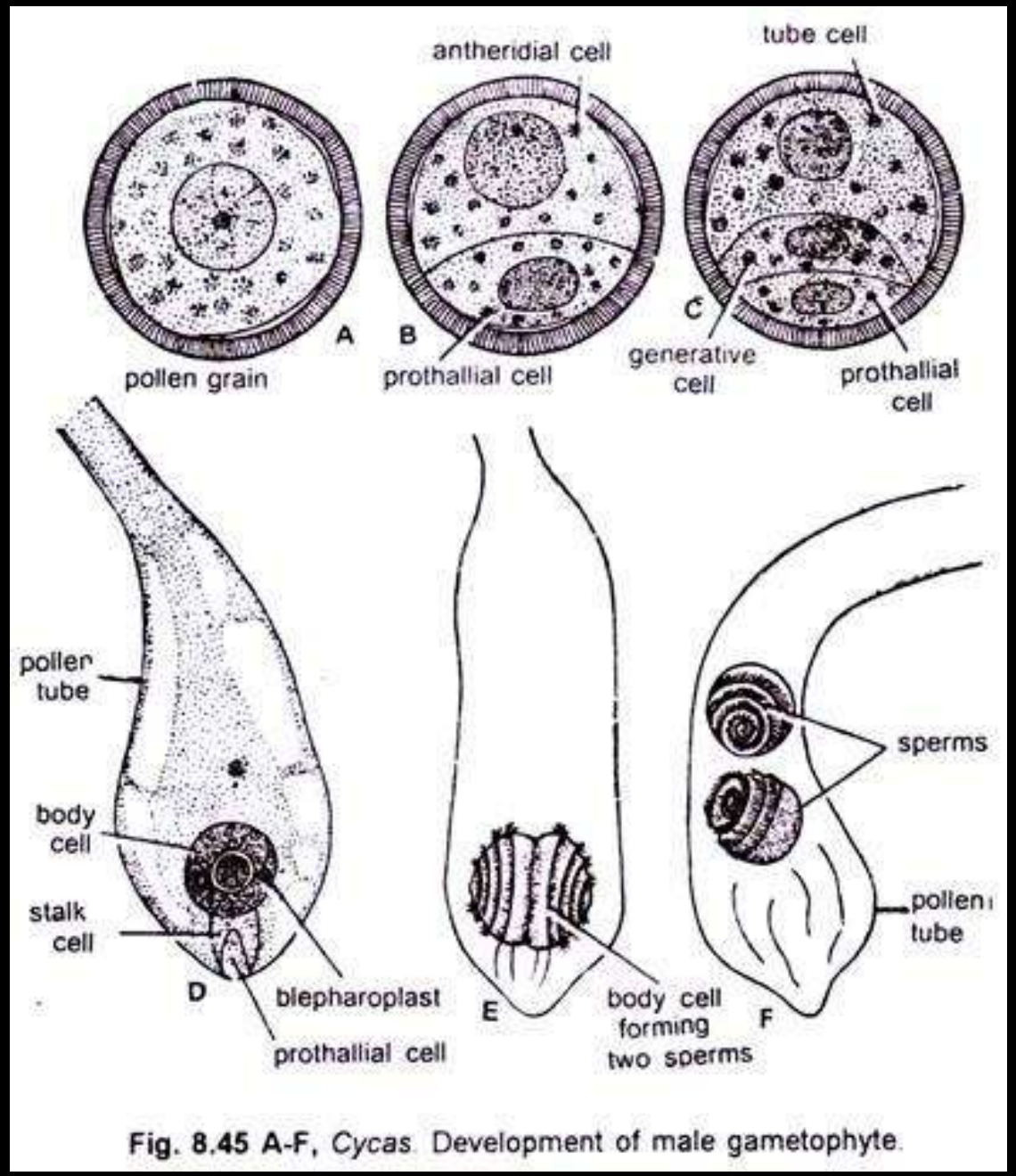
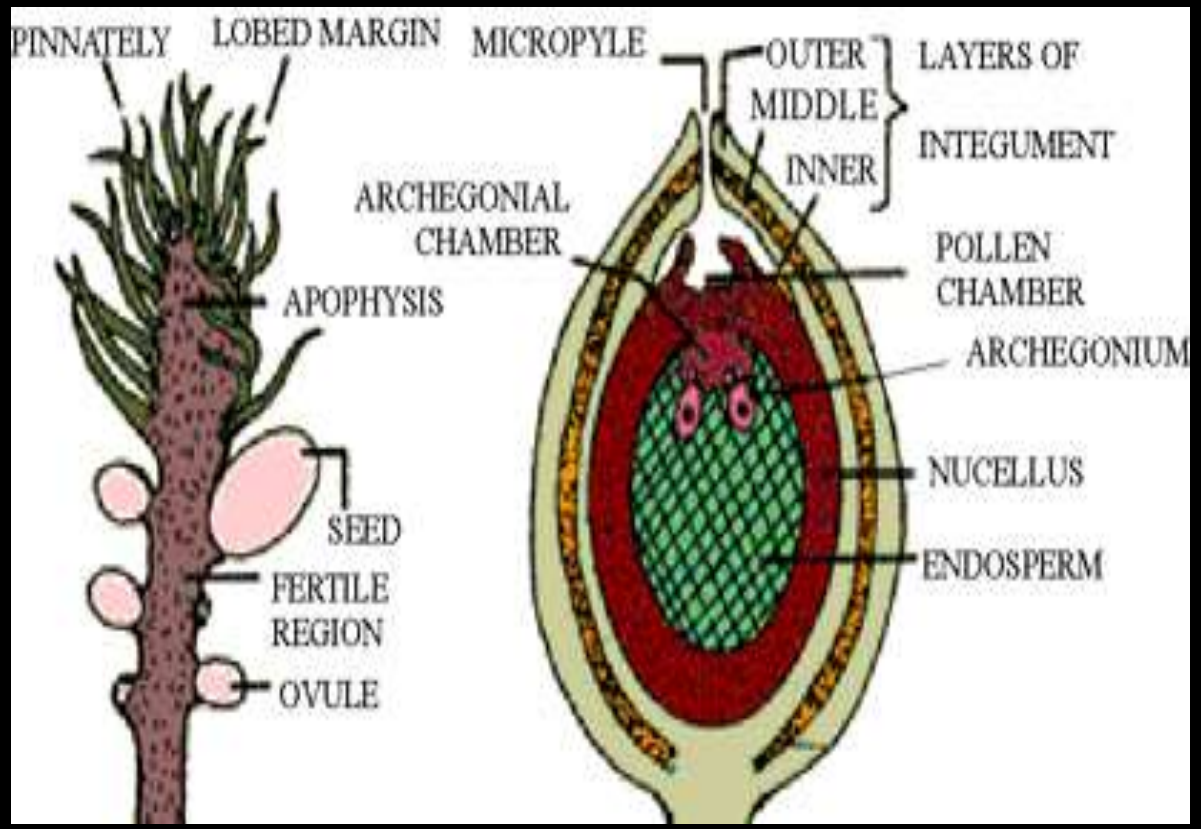


Fig. 8.45 A-F, *Cycas*. Development of male gametophyte.

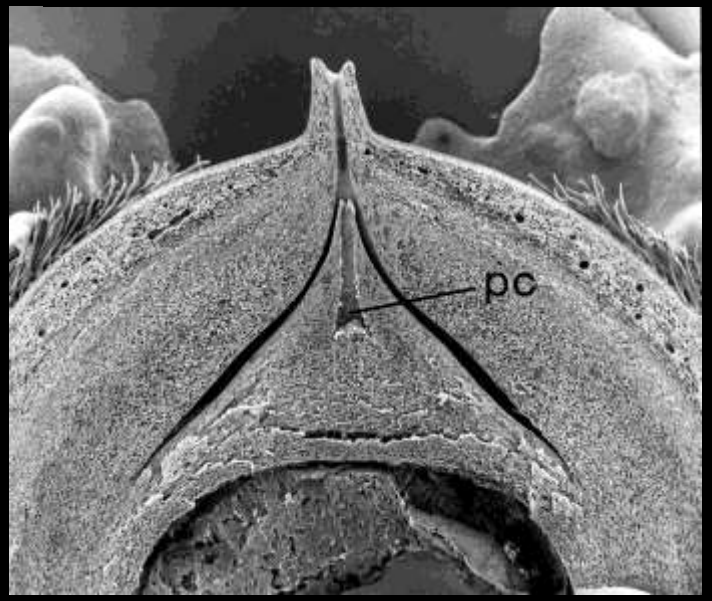
Pollination Development of male gametophyte after pollination

- 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, multiciliatedantherozoids. 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

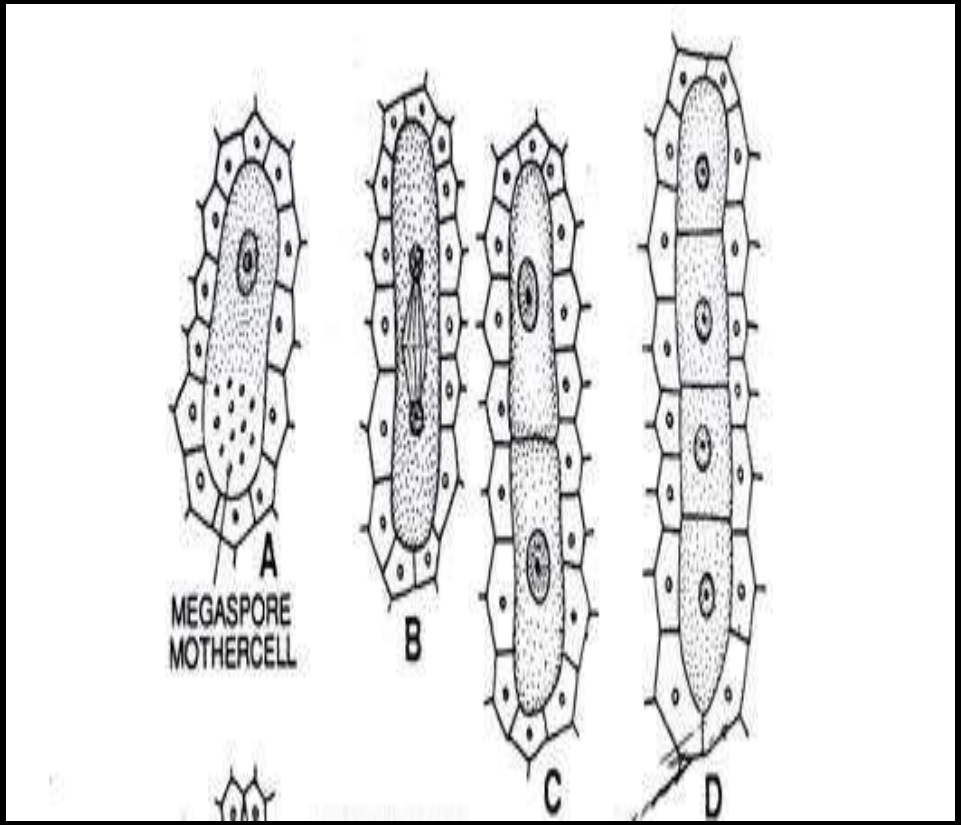


Ovule Structure

- Largest ovule (6cms.x4cms.) 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.

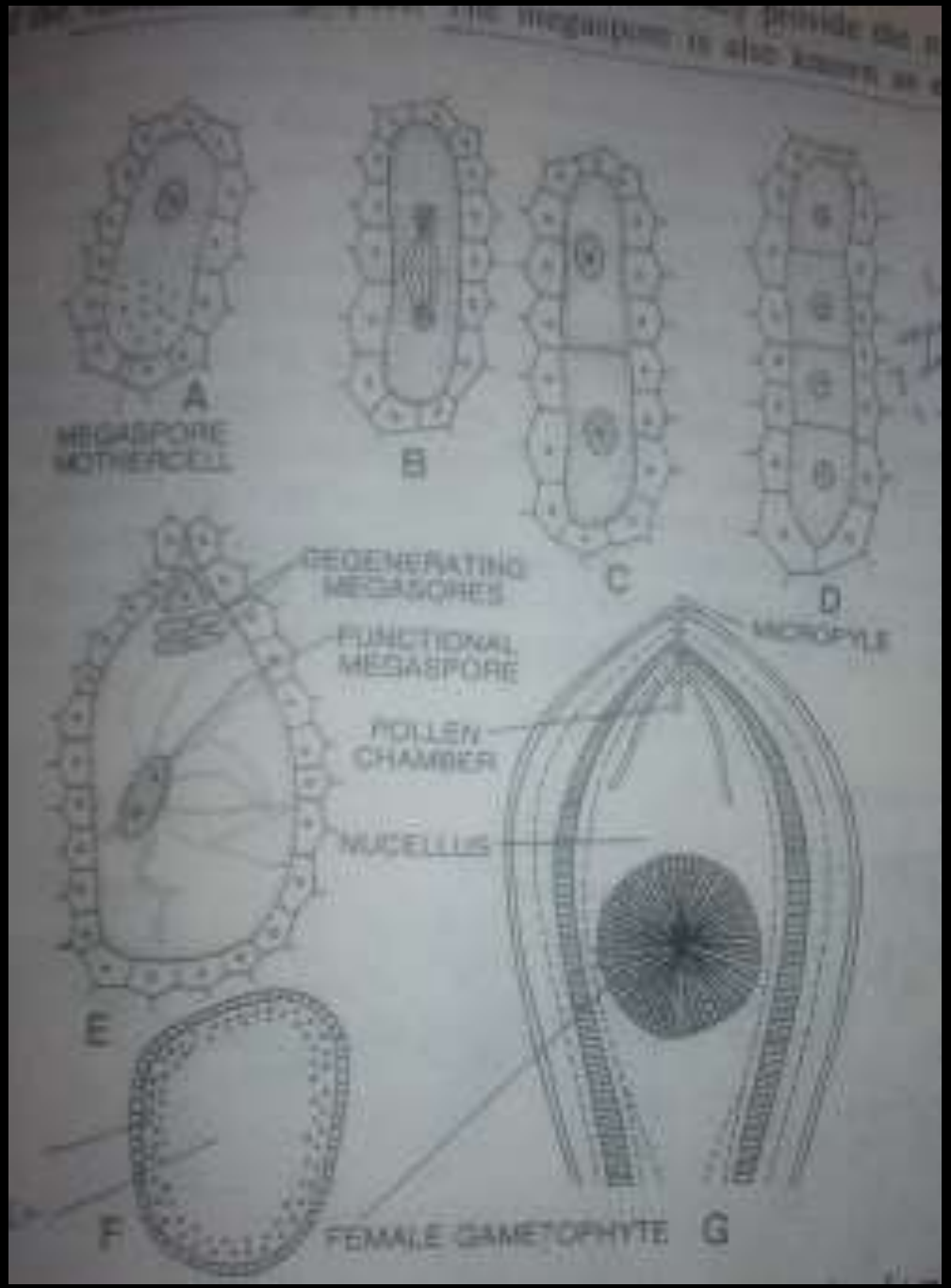


- Nucellus is extended into the **micropyle** as a beak known as **nucellar beak**
- Cells of the nucellar beak degenerate and **form pollen chamber**
- The substance formed due to degeneration is secreted out through micropyle as a **drop** known as pollination or **nectar drop**
- Nectar drop helps in **trapping** the pollen grains carried through the **agency of wind**



MEGASPORES (formation)

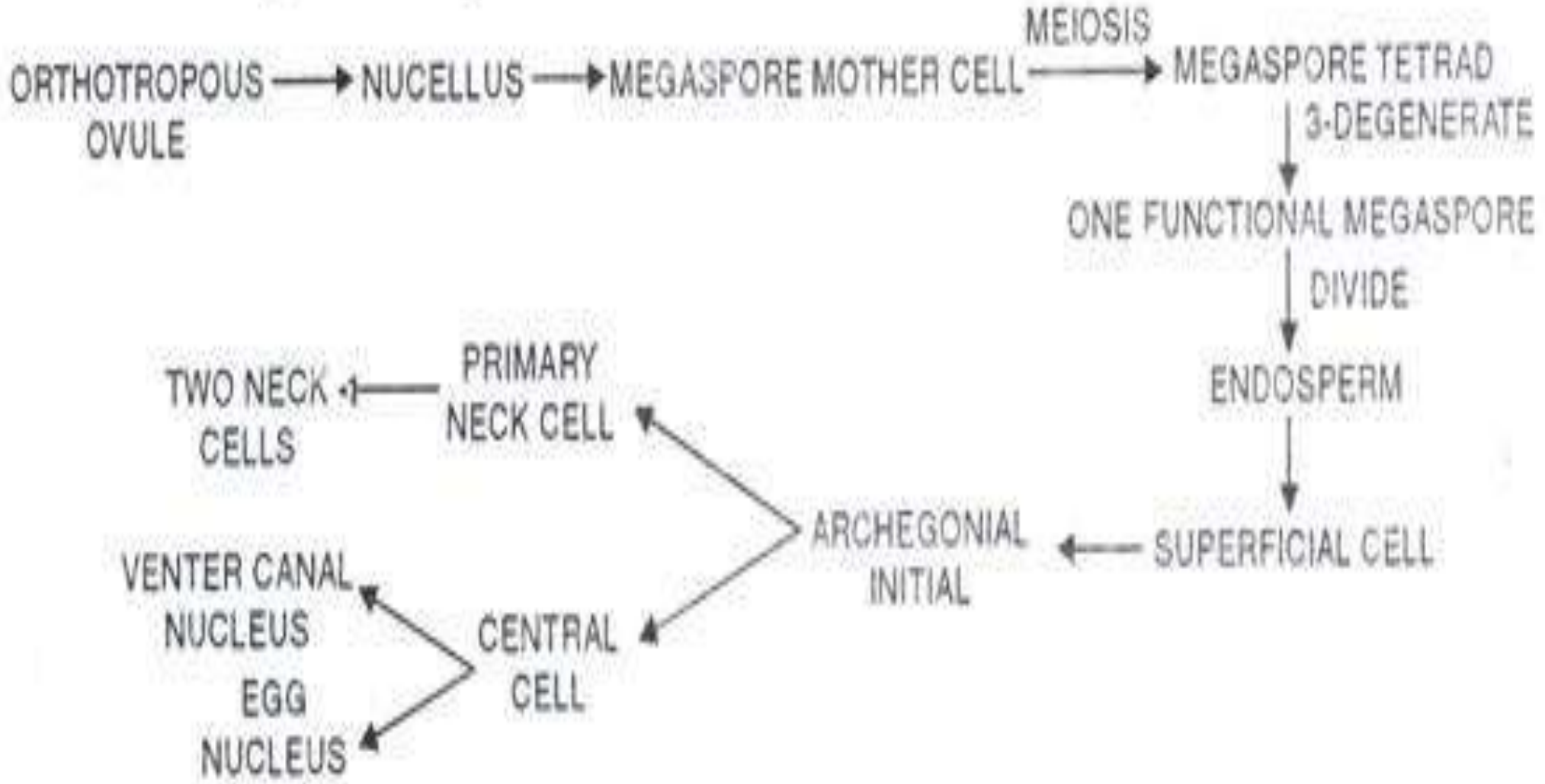
- One of the cells of nucellus behaves as archesporial cell by showing enlargement.
- It may directly behave as megaspore mother cell or divides to form a parietal cell and megaspore mother cell
- Megaspore mother cell divides meiotically and forms 4 haploid megaspores in a linear tetrad
- The upper 3 micropylar megaspores degenerate and only the lower one is functional.
- The upper 3 megaspores are nutritional in function.
- The megaspore is also known as embryo sac.

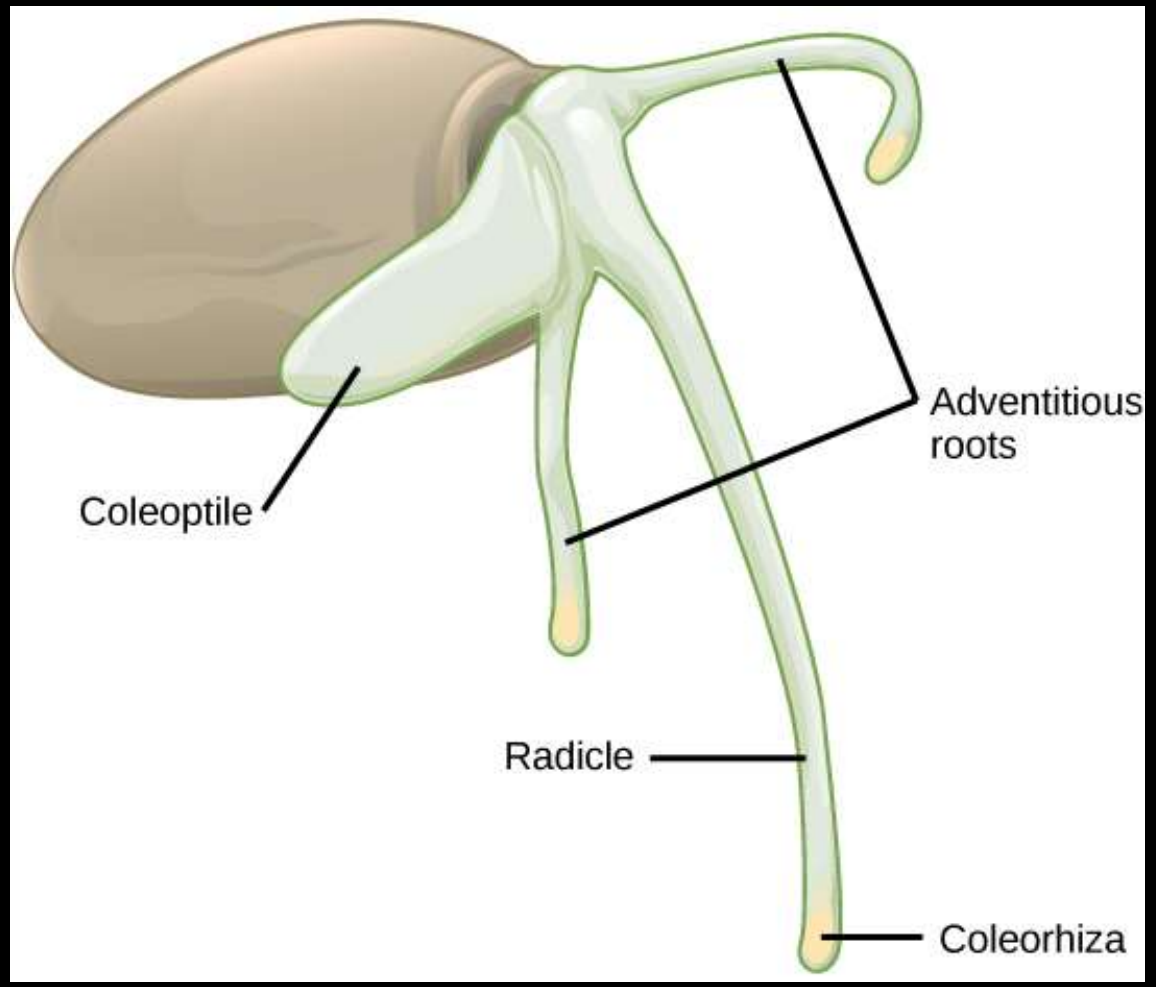


Development of female gametophyte

- Megaspore is the first cell of female gametophyte.
- Its nucleus undergoes many free nuclear divisions.
- Cell walls are formed in centripetal manner around the nuclei to form multicellular female gametophyte or female prothallus
- It utilises the nucellus for its development and
- nutritive in function for the development of embryo.
- Hence this haploid structure is also referred as endosperm
- Free nuclear division takes place until a 1000 free nuclei are formed within the megaspore.
- The space formed by the degeneration of nucellus cells between pollen chamber and female gametophyte is known as archegonial chamber.
- While megaspores increases in size, its germination starts.
- Surrounding nucellar tissue forms a layer
- Which is nutritive in function
- The archegonia begins to develop on the germinated megaspore.

Summary of development of Female Gametophyte





- **Seed**
- 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..
- Nucellusis 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.

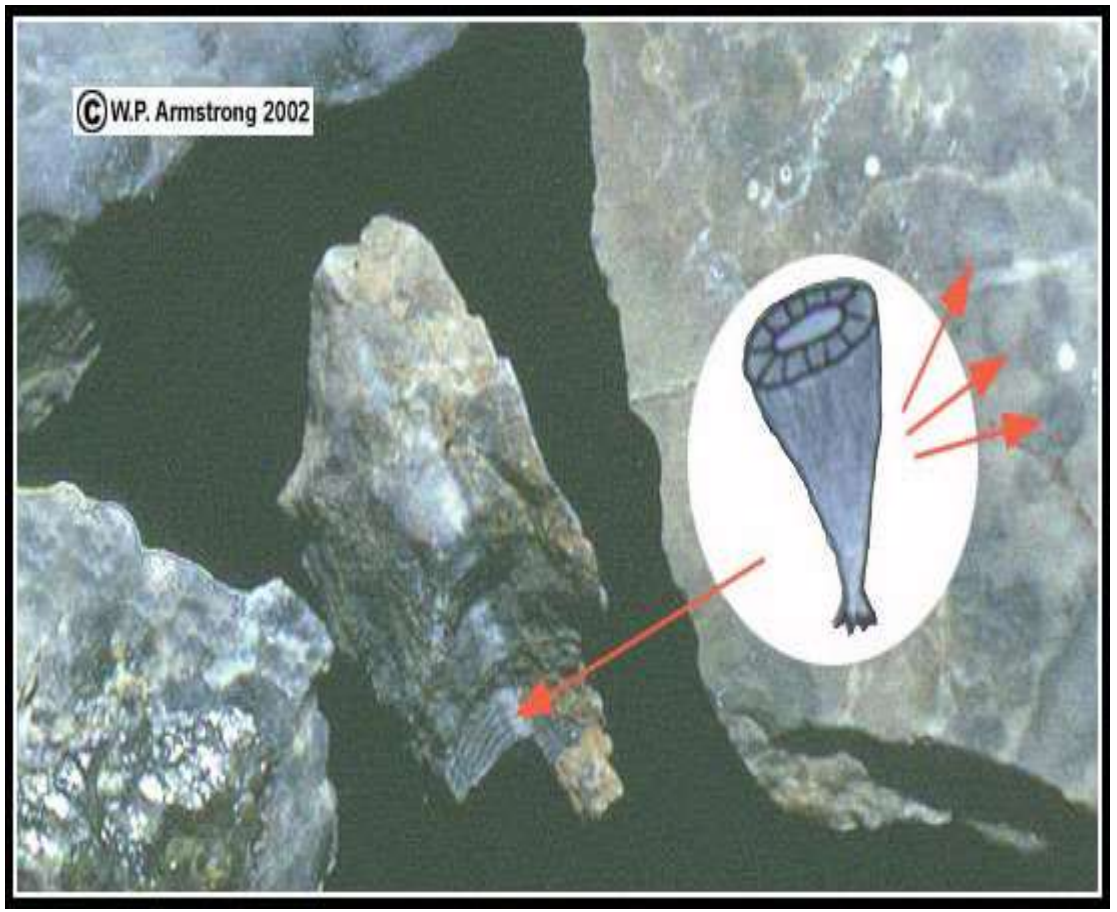
FOSSIL CYCADS

- The cycadales 1st appeared in upper Triassic period.
- Distributed world wide and reached their maximum distribution in the Jurassic and cretaceous periods of Mesozoic era.
- Then declined in numbers , being represented today by 11 living genera. How ever, discovery of the megasporophyll of phasmatocycas kansna from the lower Permian indicate the existence of cycads in palaeozoic era.
- some representative forms of fossil cycads are listed below

Fossil cycads

Phasmatocycas:

mamay (1976)- lower pernian – mega sporophyll having bilaterally arranged basal ovules



Archeocycas :

mamay (1976)- lower pernian – mega sporophyll having undivided distal blade and 4-6 pairs of basal ovules

Palaeocycas :

- Florin (1933) – upper Triassic –
- Reconstruction of the form genus considered of unbranched trunk reaching a height of about 3 meters.
- The leaves were described by the name bijuvia simplex having about 1 meter long and 20 cm broad simple leaves .
- The seed bearing organ was dscribed by the name palaeocycas integer having 30 cm long and 5 cm broad axis with cylindrical stalk bearing 4 seeds

Baenia :

- Harris (1961)
- Jurassic of Yorkshire
- Reconstruction now includes certain leaves by the the name nilssonia pseuductenis and nilssonia compacta.

Pseudoctenis :

- Harris – Jurrassic –
- A form of leaves that was much more like that of modern cycads
- Unipinnate with parallel venation
- Stomata haplocheilic-wavy epidermal cells

PRIMITIVE CHARACTERS

- Stem is tuberous and partly or wholly subterranean – leaf bases are caduceus
- Leaf rachis and the young leaflets show circinate vernation and the unrolling of successive leaflets proceeds from the base upward
- Leaves are large and bipinnate . leaflets are dorsiventral
- The cortex and pith are large and parenchymatous the pith is vascular bundles
- Presence of mesarch vascular bundle in the middle of rachis (cycas)

- Metaxylem trachieds possess scleriform thickening and simple pits in their radial walls
- Small scales or ramenta are present at the base of each microsporangium
- Male and female cones are large and heavy
- The micro and megasporophylls are foliaceous
- Large number of microsporangia are borne in definite soral clusters
- The microsporangia have well marked line of dehiscence
- The male gametes are large , ciliated , motile
- Fertilization is zoodiogamous (swim)

ADVANCED FEATURES

- Stem is columnar trunk – like and arborescent (tree like)
- Leaf bases are persistant
- The leaves are pinnate (cycas) . the leaflets are sessile with entire margin
- The primary vascular cylinder of stemis eustelic
- Presence of both endarch and exarch xylem in the midrib bundle of the pinnae as in the vascular strands in the leaf rachis
- Vascular bundles are arrange in the shape of inverted omega (?) in the petiole

- Presence of thick cuticle and hypodermis
- Stomata are present only on lower epidermis of the leaflets
- Secondary xylem tracheids posses multiseriate bordered pits on their radial walls
- Integumentary vascular traces are collateral
- Structure of archegonia is highly advanced type . there is complete absence of neck canal cells in the archegonia . the neck is short , only 4 celled
- Pollen grains germinate to produce pollen tube which carries the ciliated gametes to the vicinity of the archegonia

PHYLOGENY

- The group cycadales arose in palaeozoic era
- The time when pterido phytes , ptreridosperms and cordaitales were abundant .
- The possible ancestors of the present day cycadales
- Therefore , must be among these groups of plants .
- Among the 3 groups , pteridosperms resemble more closely with the cycadales and due to this fact it is quite possible that cycadales must have evolved from the extinct pteridosperms – devevoryas 1956 – scott – 1909 – and 1923 ; beck – 1976 ; tylor – 1969 , mamay – 1969 ,

The Resemblances Of Cycadales With Pteridosperms Are

- Pinnate foliage leaves
- Circinate vernation
- Main trunk covered with the armour of leaf bases
- Large pith and broad cortex
- Presence of centripetal xylem in the foliar strands Presence of two vascular strands in the ovules
- The foliar megasporophylls of cycas arranged spirally on the trunk Motile and multiciliated spermatozoids

- Manoxylic secondary wood Presence of mucilage canals in the pith and cortex.
- Resemblances of cycadales with pteridophytes are not much significant.
- similarly , there is no proper link to correlate the origin of cycadales from cordaitales.
- however the resemblances with the bennettatales clearly indicates that the 2 groups have their separate phylogeny and have not sought their origin from each other it is therefore ,
- concluded that cycadales must have originated from some palaeozoic pteridospermous group of plants

Economic and health benefits of Cycads

- Some cycads are poisonous as a result there are not many medical benefits
- These are also very close to extinction If prepared correctly they can be eaten
- The nuts contain a nerve toxin Consumption of the starch derived from cycads is a factor in the development of Lytico-Bodig disease,
- a disease symptoms similar to Parkinson's and ALS.
- But they look kind a pretty!!

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