Anatomy of the leaf and root of *Cycas sp*

Anatomy of the leaf

The leaf of *Cycas* as mentioned above is large and compound. The leaf has stout and woody *rachis* and tough thick and leathry lesflets. A brief description of the anatomy of rachis (petiole) and leaflet is given below :

(A) *Rachis (Peiole)* Fig. 9.8, 9.9, 9.10. T.S of petiole shows the following:

(i) Epidermis is the outermost layer, single lagered covered by a thick cuticle.

(ii) Hypodermis. Just below the epidermis lies the hypodermis which is two-three layers in thickness on the adaxial side and many layered on the abaxial side. Usually the cells of hypodermis are chlorenchymatous.

(iii) Ground tissue is paren-chymatous and follows the hypodermis.

(iv) Vascular bundles arranged in inverted omega shaped (Ω) manner is the characteristic feature. Vascular bundles vary in their structure at the base, centre and apex. Each vascular bundle, ensheathed within a single large sclerencymatous sheath is open and collateral. A single layered endodermis and one or many larged pericycle surround the vascular bundle.

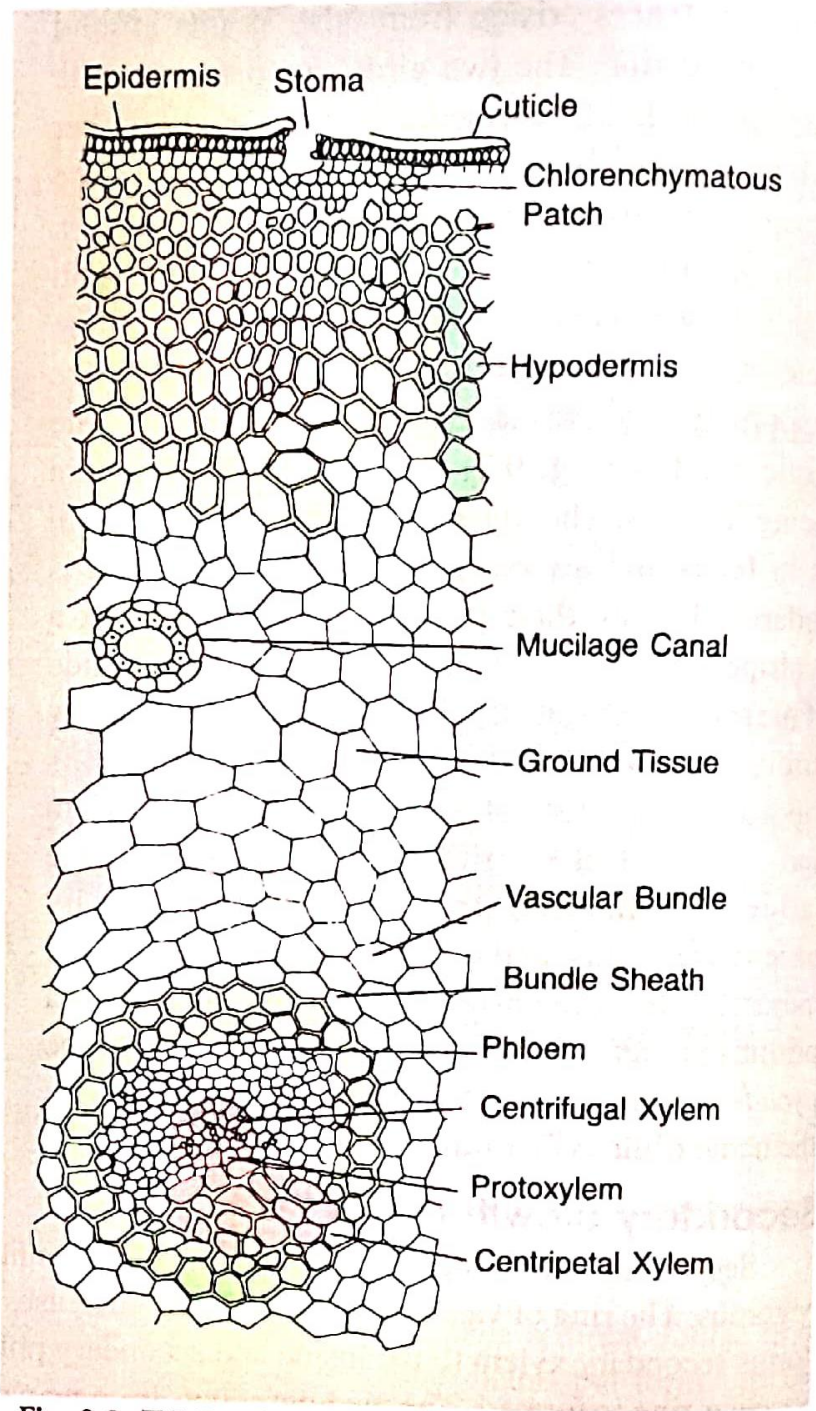


Fig. 9.9. T.S Petiole of *Cycas revoluta* showing one vascular and a portion of other tissues in detail.

At the base the vascular bundle is endarch *i.e.* protoxylem remains towards the centre, the xylem develops centrifugally, the phloem lies towards the abaxial side. The cambium is present on the upper surface of the metaxylem. During the course of upward movement of the bundles, the metaxylem appear opposite the protoxylem and constitute the centrally formed metaxylem. In this way metaxylem is present on both the sides of protoxylem and the bundles are mesarch. As a result the cambium occupies a position on the inner side. In further upward course, the centripetally developed metaxylem increases in quantity, the centrifugual metaxylem decreases in quantity and only two patches of metaxylem remain, each consisting of only a few tracheids. The phloem during this change remains on the abaxial side in this way from the base to the apex of rachis, the xylem elements change from endarch to exarch in the vascular bundles.

(B). *Leaflet* (Fig. 9.11, 9.12) A vertical section of the leaflets in the region of midrib shows the following tissues:

1. Cuticle. The upper surface of the leaf is covered with a thick cuticle. It serves to check excessive transpiration.

2. Epidermis. It forms the outermost cellular layer on both the surfaces of the leaflet. It is protective in function and consists of a single layer of thick-walled parenchymatous cells. The upper epidermis is continuous but the lower is punctured here and there with pits or stomata. The stomata which are confined only to the lower epidermis, are sunken and lodged at the bottom of these pits with overraching rims. (Fig. 9.11.)

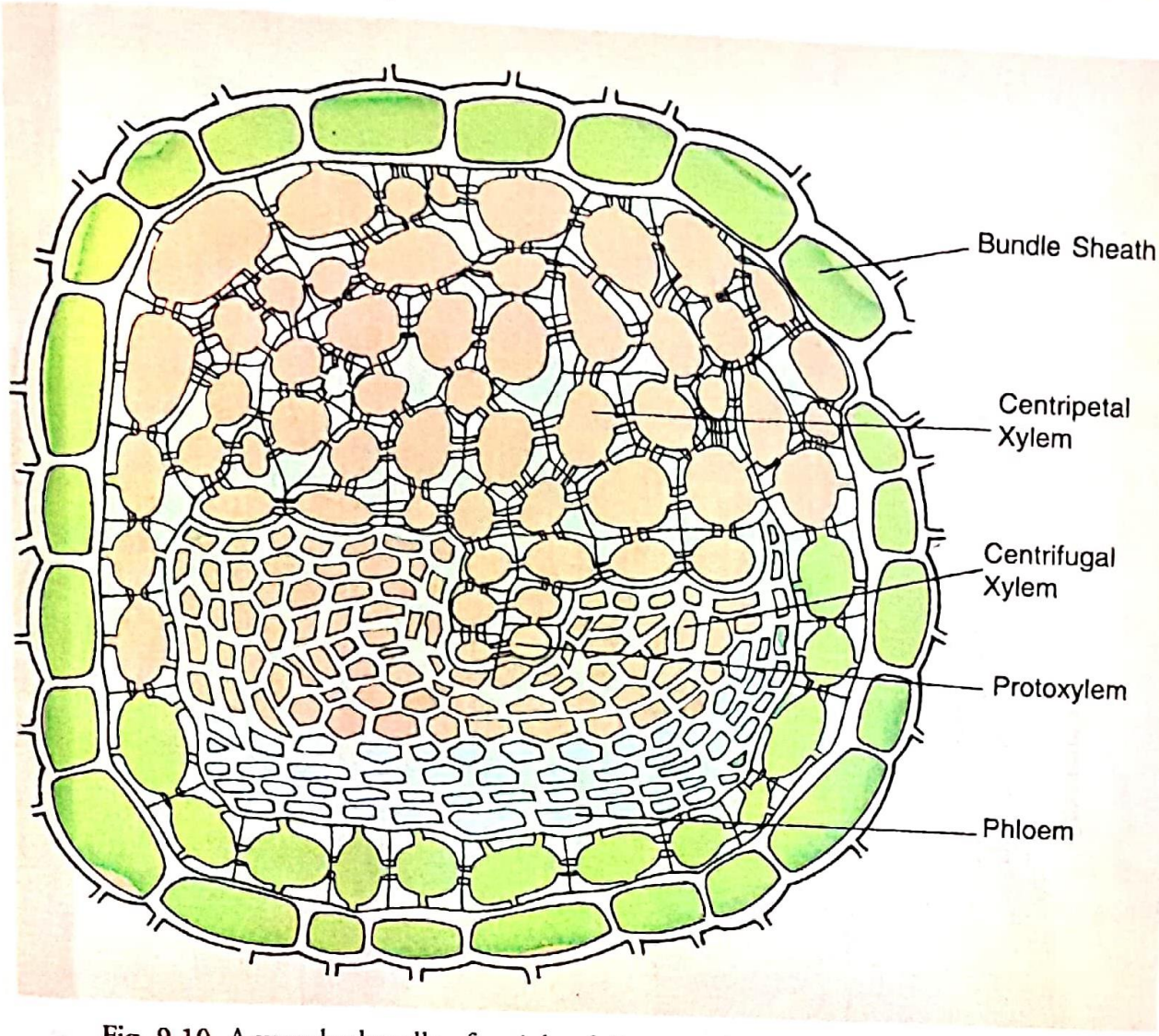


Fig. 9.10. A vascular bundle of petiole of *Cycas revoluta* showing detailed structure.

3. Hypodermis. It forms a single layer of thickened cells on both sides immediately below the epidermis. The cells of the upper hypodermis are highly thickened. It checks excessive transpiration and serves as a heat screen preventing over heating.

4. Mesophyll Tissue. It lies on both sides, between the upper and lower epidermis. It is differentiated into a well developed **palisade layer** on its upper side immediately below the upper hypodermis. It functions as the main photosynthetic tissue. Its elongated coloumnar cells contain abundant chloroplasts. The lower part of the mesophyll which lies within the lower hypodermis consists of loosely arranged parenchymatous cells with scanty inter cellular spaces between them. The cells contain chloroplasts. It is called the **spongy mesophyll.** It functions, as aerating and supplementary assimilatory tissue.

5. **Transfusion tissue.** On either side of the midrib between the palisade and spongy layers is a zone, 3 cells thick, of elongated colourless cells which run parallel to the leaf surface from the midrib to the margin. It constitutes the **accessory transfusion tissue.** The development of this tissue in the leaflet of *Cycas* serves to compensate for the unbranched condition of the midrib as it probably serves as a lateral conducting channel for water.

6. **Vascular Bundle.** It consists of xylem facing the upper surface and phloem facing the lower surface. The latter consists of sieve tubes and phloem parenchyma. It is in the form of an arc. The xylem consists of a mass of tracheids which are centripetal. There is a small patch of centrifugal metaxylem separated from the protoxylem by parenchymatous cells. The protoxylem thus occupies the centre of the bundle. The bundle is, therefore, mesarch in character.

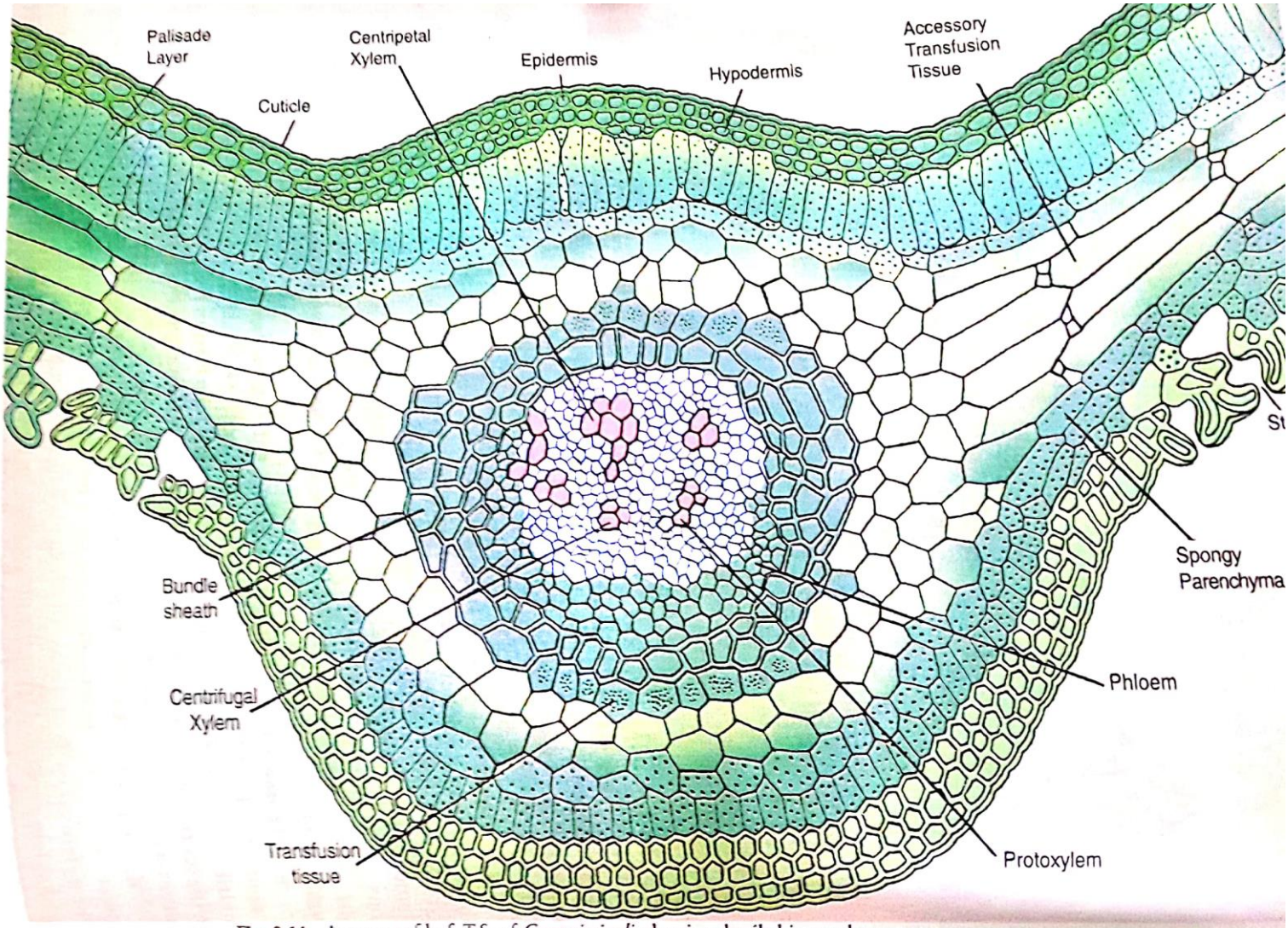


Fig. 9.11. Anatomy of leaf, T.S. of *Cycas circinalis* showing detailed internal structure.

7. **Primary transfusion Tissue.** It occurs on the sides of the xylem mass and consists of tracheidal cells with bordered pits on the walls. It is connected on either side with the accessory transfusion tissue.

Xerophytic Adaptation of the Cycas leaf

The tough and leathery texture and other structures such as strongly cutinized thick-walled epidermis, highly thickened hypodermis on both sides of the leaflet, sunken stomata restricted only to the lower surface, unbranched midrib and occurrence of primary and secondary transfusion tissues, all point to the fact that *Cycas* leaf is a strongly xerophytic object.

Anatomy of the root

1. Primary root (Fig. 9.13). It is identical to that of dicotyledonous root. There is the single layered **epiblema** or **exodermis** surrounding a large thin-walled parenchymatous **cortex.** The cortex is delimited by single layered **endodermis** consisting of four-sided slightly longitudinally elongated cells. Next is the single layered pericycle. It forms the outer layer of the stele which is **tetrarch,** but **diarch** in the youngest parts. There is pith in the centre. The xylem bundles are exarch with protoxylem towards the outside and metaxylem towards the centre. The phloem bundles are equal in number and alternate with the protoxylem elements. The metaxylem elements may fuse or meet in the centre. In this case there is no pith.

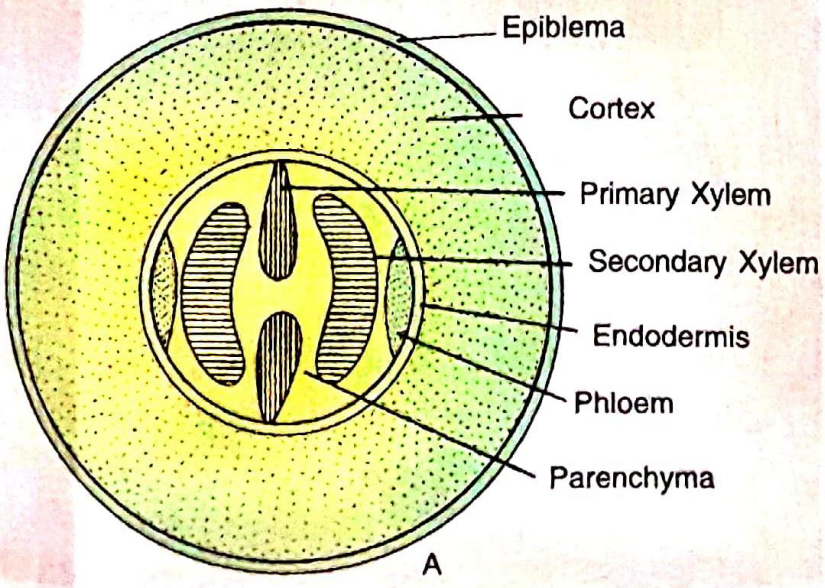
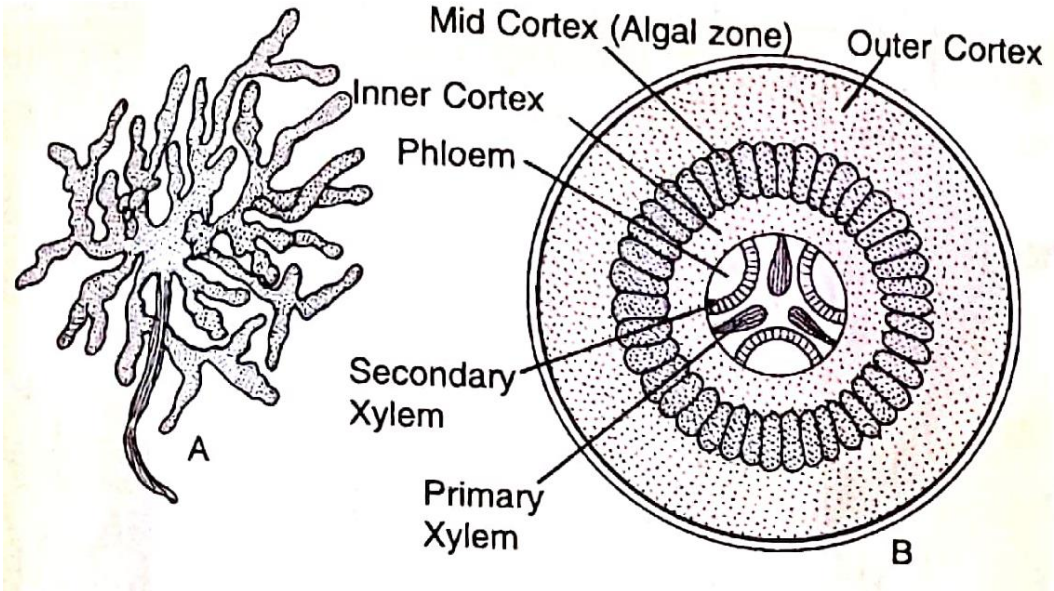


Fig. 9.13. (A) T.S normal root of *Cycas.* (diagrammatic).

Secondary growth (Fig. 9.12) takes place in the older portions. It takes place early and is more or less irregular. Several concentric rings of vascular bundles as well as the periderm develop, in old roots. The tip is protected by a root cap developed from the **periblemma.** There being no true **calyptrogen.**

2. Coralloid Roots (Fig. 9.15). The structure is similar to that of the primary root. In addition, there is a conspicuous broad blue green zone in the middle cortex. This is the **algal zone.** It lies midway between the vascular bundle and the epiblemma. The cortical cells in this region get disorganised and are inhabited by blue green algae or cynobacteria such as *Nostoc* and *Anabaena cycadacearum* and *Calothrix*



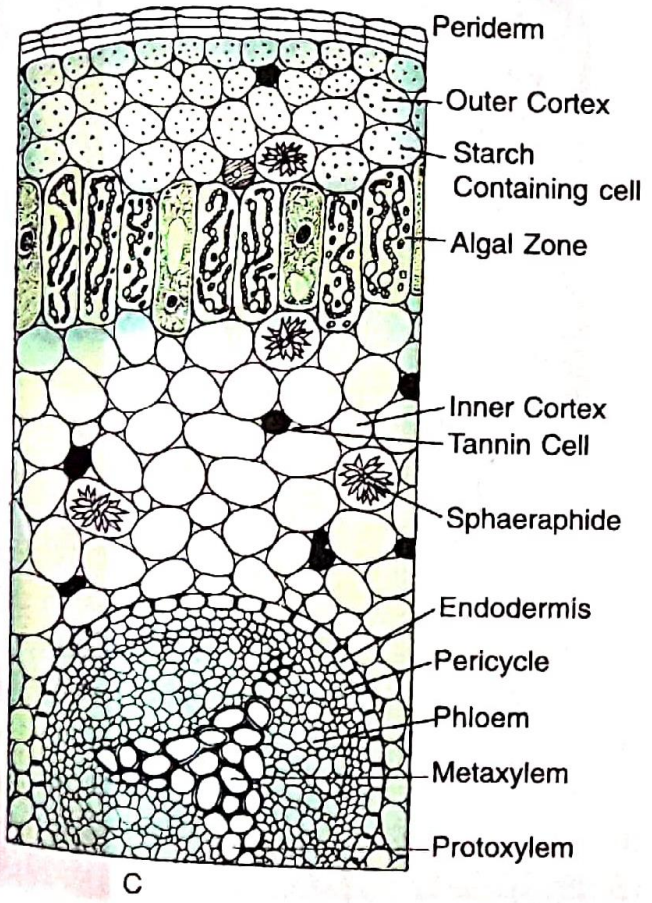


Fig. 9.15. (A-C). Coralloid roots of *Cycas*. A. As seen externally, B.T.S diagrammatic, C, A portion of B in detail.

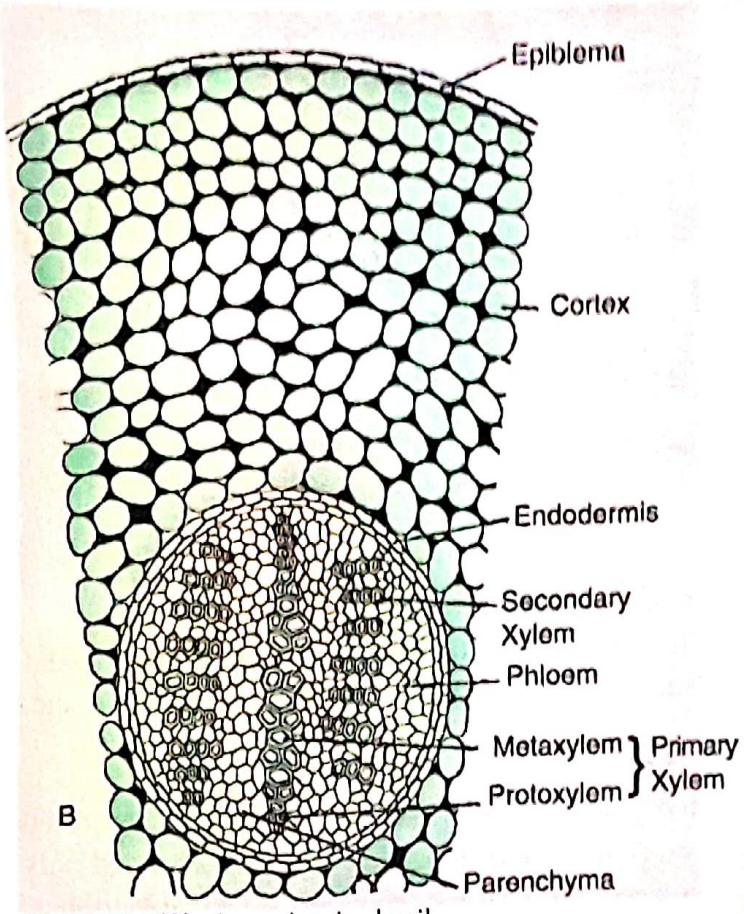


Fig. 9.13 (B), A portion in detail.

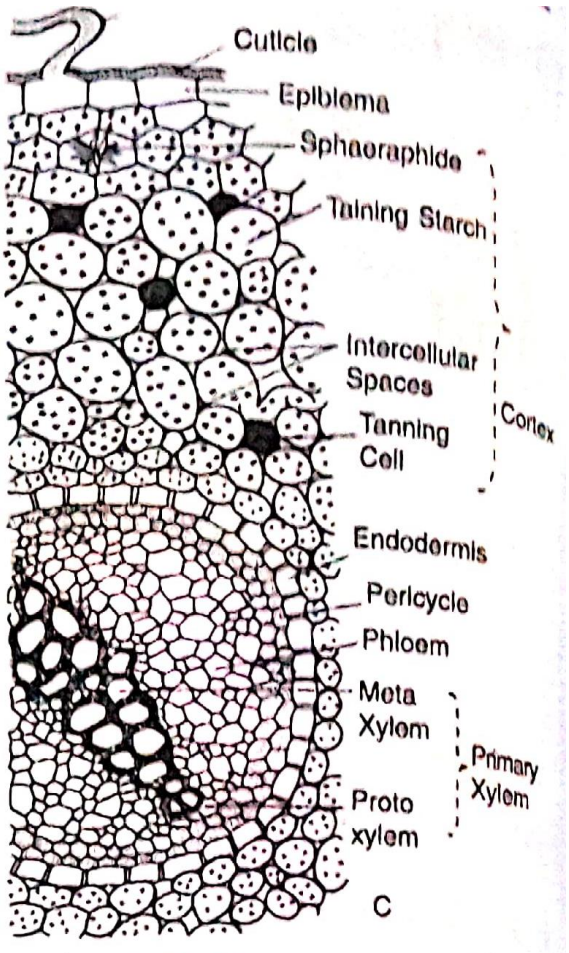


Fig. 9.13. (C) T.S. Primary root of *Cycas revoluta*. It is diarch.

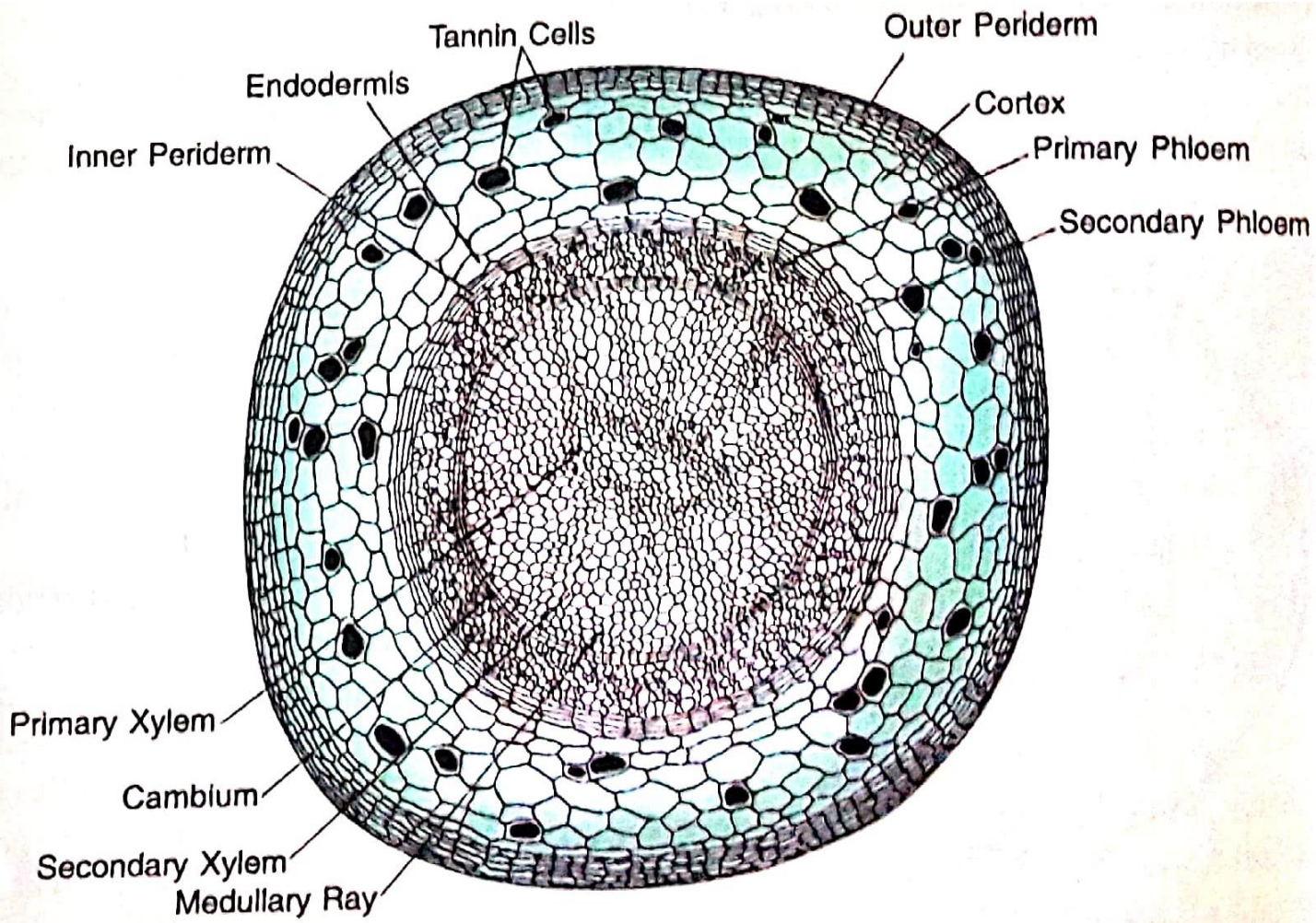


Fig. 9.14. T.S. root of *C. revoluta* showing secondary growth.