origin.

FAMILY : CALAMOPITYACEAE

This family is considered to be an unnatural assemblage of some genera that could not be placed elsewhere. All of them resemble *Lyginopteridaceae* in being *monostelic* and in possessing *manoxylic* secondary wood (except four genera that have been transferred to Cordaitales by Lacey, 1953). The foliage and the reproductive structures are not known. The family is named after the stem genus *Calamopitys* which was discovered by Unger in 1856 from the Thuringian strata of Upper Devonian age in the form of petrifactions. He named the type species as *Calamopitys saturnii*. The family name *Calamopityeae* was given by Solms—Laubach, (1896). The family is entirely Palaeozoic, restricted to the Upper Devonian and Lower Carboniferous periods. It includes the stem genera *Calamopitys*, *Stenomyelon* and *Diichinia* and the petioles belonging to the genus *Kalymma*. Later (Read, 1936) four more stem genera were discovered and the number rose to seven genera and sixteen species (*Bilignea*, *Eristophyton*, *Endoxylon* and *Sphenoxylon*). These four genera had pycenoxylic secondary wood and were transferred to the *Cordaitales* (Lacey, 1953). Only genera with *monoxylic* secondary wood are retained in the family (*Calamopitys*, *Stenomyelon*, *Diichnia*).

Stenomyelon (Fig. 2.50A) was originally discovered by a geologist Matheson in the fifties of the nineteenth century from the late Devonian—Lower Carboniferous and named it

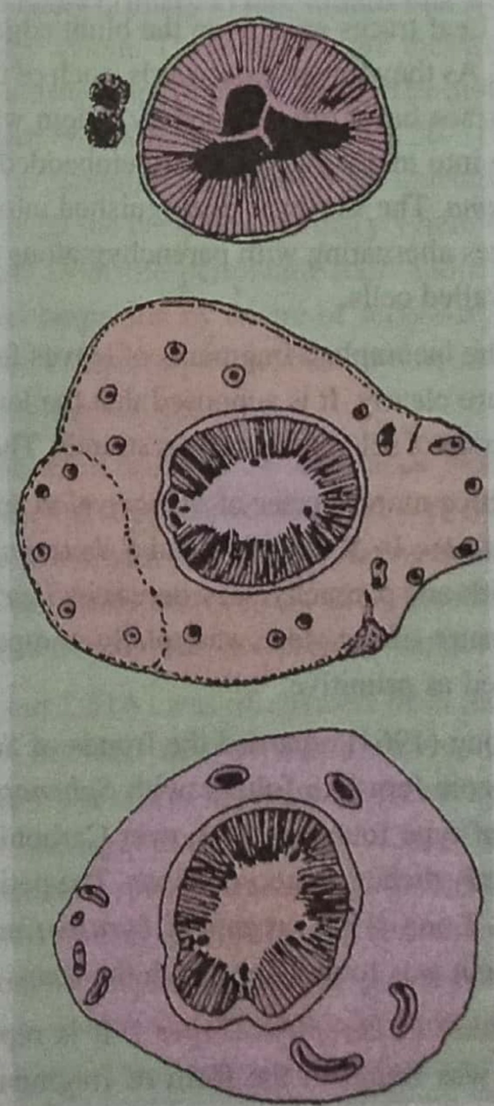

Fig. 2.50. (A—C) : Stem structure in Calamopityaceae. A. T.S. stem of *Stenomyelon tuedianum* with double leaf trace on the left. B.T.S. stem of *Calmopitys americana* C. T.S. Stem of *Dilchnia kentukienesis* (A. After Kidston and Gwynne-Vaughan; B—C. after Read.)

as a "Tweed Mill fossil", after the name of the place where it was discovered . Dr. Kidston later rediscovered it from the same bed and gave a full description of the specimen with the help of Prof. Gwynne—Vaughan. The type species was named as *Stenomyelon tuedianum* Kidston. It was found in the form of petrified pieces of a flattened stem. Fragment of rachis and portions of laminae were also found. A section of the stem (Fig. 2.50A) reveals a *protostele* that is bluntly triangular in outline and is composed of exarch primary xylem. The primary xylem consists of reticulate pitted tracheids. Some parenchymatous cells have been reported to occur along the periphery of the protostele. The primary phloem has not been reported. A band of parenchyma extends from the middle of each of the three sides of the primary xylem towards the centre of the stele. It divides the primary xylem into three groups. These parenchymatous bands are supposed to be **pith.** The tracheids at the outer face of primary xylem are scalariform and narrow. They represent the **protoxylem.** During secondary growth, the secondary xylem first appears along the slightly concave sides of the primary stele. Later it extends all round and completely surrounds the triangular primary stele. Later the secondary xylem assumes a cylindrical form. It is made up of tracheids with multiseriate pits on the radial walls. The secondary xylem is traversed by many medullary rays that are 1—6 cells broad. The secondary xylem is surrounded by a layer or more of thick-walled cells that are regarded as **periderm** layer. Leaf traces arise from the blunt edges of primary xylem. They are more or less cylindrical in shape. As they traverse outwards, each of them bifurcates into two and later into many in the cortex. Each trace has a little secondary xylem which persists for some time. In the petiole the leaf traces divide into many traces that are embedded in the ground tissue. The generic name for the petiole is *Kalymma.* The cortex is distinguished into an outer cortex which is made up of long vertical strands of fibres alternating with parenchymatous cells. The rest of the cortex is supposed to be made up of thin-walled cells.

The incomplete fragments of leaves found in association with the stem pieces do not reveal the structure clearly. It is supposed that the leaves were simple with thick leaf blade and a hypodermis composed of sclerenchymatous strands. There is an evidence of presence of several vascular bundles.

Three more species of *Stenomyelon* are known. These are *S. primaevum*, *S. heterangioides* and *S. muratum*. In *S. muratum* and *S. heterangioides,* the primary xylem was made up of a mixture of tracheids and parenchyma, whereas in *S. primeavum,* there was no parenchyma in the primary xylem. The centre of the stem was totally composed of tracheids of the primary xylem. This species is regarded as primitive.

Long (1964) regarded the fronds of *Stenomyelon* to be like those of *Diplothmenea* which is a Palaeozoic fern-like foliage with *Sphenopteridium* like pinnules. *Sphenopteridium* is also a fern-like leaf type found in the Lower Carboniferous having wedge-shaped or dissected pinnules with uniformly dichotomous venations. The petioles in *Diplothmema* are equally forked below the lowest pinnae. Long (1964) regarded *Lyrasperma scotica* (Fig. 1.21. A) to be the seed of *S. tuedianum* because it was found along with the stems and petioles of this species.

Genus Calanopitys Unger : It is represented by four species. The type species *C. saturnii* Unger was found in the form of fragmentary petrifactions from the Thuringian strata of Upper Devonian age. The largest piece of stem measured about 1.5 cms in diameter and in cross-section revealed the presence of a distinct pith in the centre. The pith is surrounded by the secondary xylem which is made up of tracheids with 4—8 rows of bordered pits and medullary rays that are more than one cell broad and many cells in height. Along the inner border of the secondary xylem and the periphery of pith, these are groups of primary xylem strands (6) that have a distinct internal protoxylem. They are regarded to be leaf traces as found in *Lyginopteris*. These leaf traces traverse through the secondary xylem as single traces and on entering the cortex divide into two (as in *Lyginopteris*). On entering the leaf base, each trace divides into six. The decurrent leaf base is separated from the stem proper by a distinct band of thick-walled cells. The cortex in the stem is wide and consists of an outer cortex made up of sclerenchymatous strands alternating with parenchymatous cells (Sparganum type). The inner cortex is parenchymatous.

Calamopitys annularis (Unger), was discovered from the Upper Devonian deposits of Kentucky. If differs from *C. saturnii* in possessing tracheids mixed with the parenchyma of the pith. The periphery of the pith is occupied by a comparatively well developed primary xylem which exhibits a strong tendency towards the formation of a continuous zone except at places where the protoxylem elements occur. At such places the metaxylem forms a definite strand. The secondary xylem is **manoxylic** and completely surrounds the primary xylem and the mixed pith. The formation of leaf traces is not clear but the strands seem to divide before entering the cortex. The leaf traces in the cortex are concentric.

Calamopitys americana Scott and Jeffrey (Fig. 2.50, B) was also discovered from Upper Devonian deposits from Waverley Shales of Kentucky. It is represented by petrified portions of stems with leaf bases and detached petioles. The centre of the stem is occupied by parenchymatous pith with mixed tracheids. At the periphery of the pith are many primary xylem strands that appear to be contiguous and look like a continuous band of primary xylem. These strands are mesarch. The tracheids are large and are separated from one another by narrow strips of parenchyma. The monoxylic secondary xylem completely surrounds the primary xylem and pith. Its tracheids are 30—60 μ in diameter and have 5—6 alternating rows of small pits. The cambium and phloem are indistinct. The outer cortex is of Sparganum type. The leaf traces arise from the peripheral primary xylem strands. The primary xylem strand divides into two as it departs from the peripheral zone and traverses through the secondary xylem as two separate bundles accompanied by an arc of secondary xylem tracheids. On entering the cortex the, leaf trace bundles are completely surrounded by the secondary xylem. The strands are mesarch and divide further on entering the leaf base.

C. foerstes Read differs from other species in the manner of origin of the leaf traces. In this case the leaf trace originated from two adjacent vascular bundles of the perimedullary primary xylem, as compared to one in all other species. These two become fused with one another during their course towards the cortex through secondary xylem. Each of the fused traces gives out a branch which again fuses to form a single leaf trace in the cortex. This leaf trace has two protoxylem groups.

Genus *Diichnia kentuckiensis* Read (Fig. 2.50 C and 2.51A) was discovered from the Upper Devonian of the New Albany Shale. The section of the petrified stem reveals a wide cortex with outer cortex traversed by a network of hypodermal strands. The rest of the cortex is parenchymatous and is delimited from the vascular region by a periderm-like layer of thick-walled cells. The centre of the stem is occupied by a five-angled pith of mixed parenchyma and tracheids (Fig. 2.50 C). The angles are occupied by five strands of mesarch primary xylem that are separated from the secondary xylem by a narrow band of xylem parenchyma. The secondary xylem is manoxylic and completely surrounds the pith and the primary xylem. The leaf trace is double and originates as a pair of strands from the adjacent primary vascular bundles at the pith angles. These traces do not fuse and traverse separately through the secondary xylem and enter the cortex where they slightly increase in size. They divide once or more times and finally enter the leaf base and the petiole. The unilacunar node with a double trace is considered to be a primitive feature (Bailey, 1956) and has been described from a number of living and extinct genera that are not related otherwise. They are known in the living members like *Ginkgo* (Gunkle and Wetmore, 1946) and *Ephedra* (Marsden and Steaves, 1955). It has also been described in some angiosperms (Bailey, 1956).

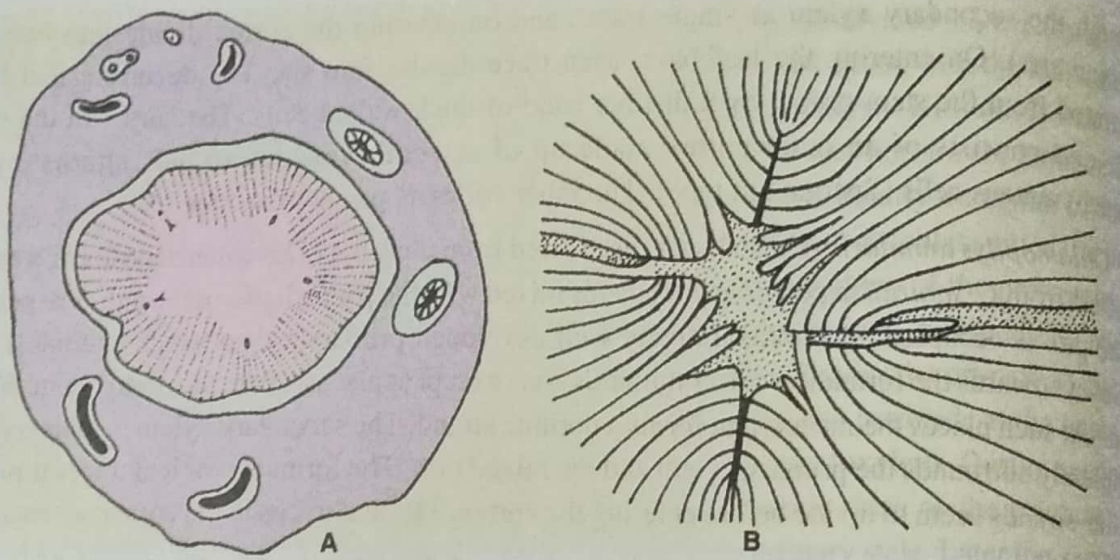

Fig. 2.51. Calamopityaceae. A T.S. stem of *Dilchnia kentuckinensis*. Note the five angled pith and small primary xylem strands in the angles. Two strands on the left have divided. (After Read) B. *Sphenoxylon enpuncate* T.S. stem showing irregular pith, four inwardly projecting secondary wood wedges each having a departing trace. Primary xylem is solid black (After Thomas)

Genus Kalymma (Fig. 2.52). It was originally discovered by Unger from Thuringia of Upper Devonian age. He regarded it to be a stem and described two species which he named as *K. grandis* Unger and K.*striatum* Unger. Later Solms—Laubach regarded it as a petiole of *Calamopitys* and his findings were confirmed by Scott and Jeffrey who found a leaf base with *Kalymma* structure in connection with a piece of *Calamopitys* (believed to be *C. americana*). Seward also confirmed the earlier findings and regarded it as a petiole. It was also collected from Kentucky and Genessee shales of Upper Devonian age. It was also collected from Waverley shales believed to be Lower Carboniferous. Now *Kalymma lirata* is regarded as the petiole of *Calamopitys americana* and *K. resinosa* is believed to belong to *Diichnia kentuckiensis*. The section of the petiole shows a layer of epidermis followed by hypodermal layer of thick walled sclerenchymatous cells. The rest of the tissue is called ground tissue in which is embedded a ring of vascular bundles. In some cases, the bundles may be arranged in a horse- shoe manner. The vascular bundles may be radially elongated or circular in outline. The ground tissue consists of homogenous parenchyma. The xylem in the bundle is entirely primary in nature with a clear distinction into metaxylem and protoxylem. The protoxylem may occupy the centre (in circular bundles) or it may be found at the ends. Phloem elements are not well preserved.

The affinities and the phylogenetic portion of the Calamopityaceae are not yet clear because we are not certain about their foliage and reproductive organs. Long (1964) has no doubt speculated that the fronds of some members are like those of *Diplothemma* and the pinnules like *Spehnopteridium* but it is not certain. He also believed that the seeds called *Lyrasperma scotica* also belong to *Stenomyelon tuedianum* because they were usually associated with stems and petioles of this species. In case these findings are further substantiated by their occurrence in organic connections, then certainly the Calamopityaceae have close relationship with the Lyginopteridaceae. The Calamopityaceae resemble the other Pteridospermales in possessing "Sparganum" type of hypodermis, monostelic primary vasculature and manoxylic secondary wood. The structure of the petiole and the mesarch leaf traces in some species and the association of secondary xylem with the leaf trace bundles are also characters that bring them closer to the Lyginopteridaceae and Pteridosperms in general.

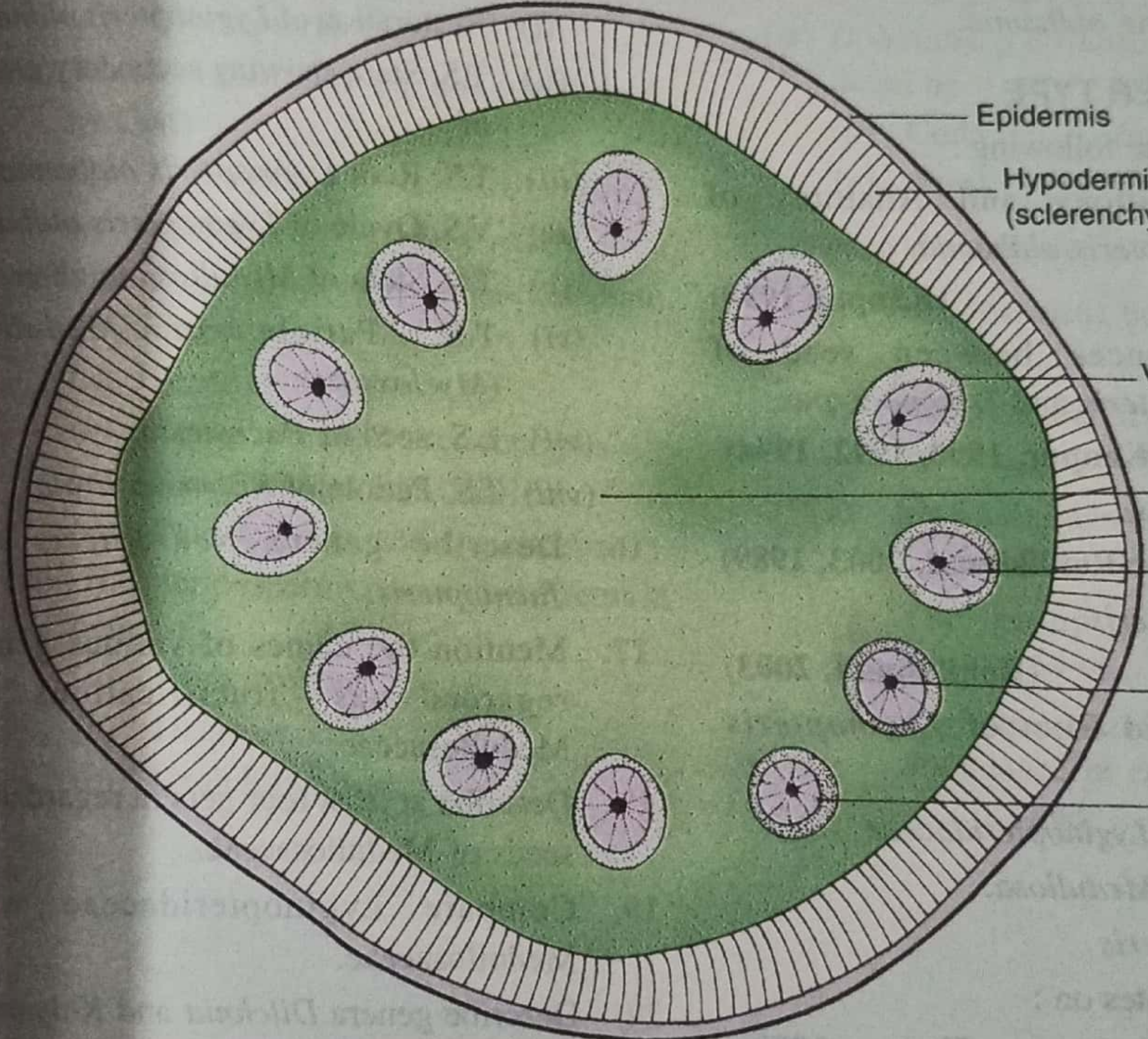

Fig. 2.52. T.S. petiole of *Kalymma lirata* showing internal structure. (1. Epidermis; 2. Hypodermis of sclerenchyma cells; 3. Vascular bundles; 4. Ground tissue; 5. Secondary xylem; 6. Primary xylem; 7. Phloem

QUESTIONS