Distribution of Cordaitales

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- Cordaitales, an extinct group of Palaeozoic tall trees of gymnosperms, formed “the world’s first great forests”. The name was given to honour an Australian botanist, A.J. Corda. Majority of the Cordaitales were tall, large-leaved trees attaining a height of more than 30 metres or so.
- The group started declining during Permian and became completely extinct by the end of this period. As per records the Cordaitales occurred side by side with Pteridospermales .
- Cordaitales fossils have been reported from North and South America, Europe, China, Ruccia, India, Australia and Africa indicating their world-wide occurrence during Devonian and Permian.
- Cordaitales in India are represented in the form of impressions or compressions of leaves, seeds and petrified woods. Representatives of the only family Cordaitaceae have been reported from India.
- No member of Poroxylaceae has been reported. In India, Cordaitaceae are represented in lower Gondwana formations. Cordaicarpus, Dodoxylon, Noeggerathiopsis and Samaropsis are the Cordaitalean genera reported from India.

Distinguishing Features of Cordaitales

- 1. This group of fossil plants had tall trees with slender trunks and a crown of several well-developed branches.
- 2. Plants were present from Devonian to Permian periods of Palaeozoic era (Fig. 1.1)
- 3. The leaves were simple, spirally arranged and strap-shaped, grass-like or paddel-like.
- 4. The leaves attained a length up to 1 metre or even more, and had parallel venation.
- 5. A scanty primary wood was present.
- 6. In mature stems, the secondary wood was mostly pycnoxylic.
- 7. Compound unisexual cones were present.
- 8. Each compound cone had a main axis with bracts subtending secondary fertile shoots possessing fertile and sterile appendages.
- 9. Mega-strobili had sterile appendages below and ovule-bearing fertile appendages above.
- 10. One to four ovules were present on each female fertile appendage.
- 11. Micro-strobili had sterile appendages below and pollen-sac containing fertile appendages above.
- 12. Four to six terminal pollen sacs were present on each male fertile appendage.
- 13. Sperms have not been reported, but presence of pollen chambers suggests that motile sperms might have been formed.

Classification of Cordaitales

Scott (1923) divided Cordaitales into following three families:

1. Cordaiteae, e.g. Cordaites, Mesoxylon, etc.
2. Poroxyleae, e.g. Poroxylon.
3. Pityeae, e.g. Pitys, Callixylon, Dadoxylon.

- Chamberlain (1935) named the three families as Poroxylaceae, Pityaceae and Cordaitaceae.

Sporne (1965) classified Cordaitales into following two families:

1. Cordaitaceae, e.g., Cordaites (leaves), Mesoxylon (stems), Amyelon (roots), Cordaianthus (cones), Cordiocarpus (seeds).
2. Poroxylaceae, e.g. Poroxylon (stems), Rhabdospermum (seeds).

Chamberlain's classification has been followed in the text.

- **A brief discussion of Cordaitaceae and Poroxylaceae is under mentioned:**

1. Cordaitaceae:

Cordaitaceae

- **External Morphology:**
- Cordaitaceae grew luxunently and formed large forests of tall trees during Upper Carboniferous period. Plants attained a height of more than 30 metres. They had terminal and spirally arranged well-spread branches bearing tufts of leaves (Fig. 9.1).
- The leaves were large, leathery, grass--like or paddle-shaped, and attained a length of about 1 metre and a breadth of about 15 cm (Fig. 9.2). They were, however, smaller than that of Cycads. Some members also had small needle-like leaves. The leaves had a dichotomous venation.

- The leaves of several members of Cordaitaceae were highly variable in shape and were put under a form-genus Cordaites. The same name is now given to the stem as well as to the entire plant.
- Some other stem-genera of Cordaitaceae include Mesoxylon, Metacordaites, Parapitys, Caenoxylon, Mesopitys, Cordaicladus and Artisia. Amyelon is a root-genus while Cordaianthus is a name give to the cones or inflorescence. Seeds have been described under the form-genera Cardiocarpus, Mitrospermum and Kamaraspermum.
- Cridland (1964) studied and reconstructed a cordaitean plant. According to him the plants attained a height of nearly 5 metre with stilt roots similar to mangrove plants. These studies suggest the habitat of Cordaites in the swamps along the seashores.

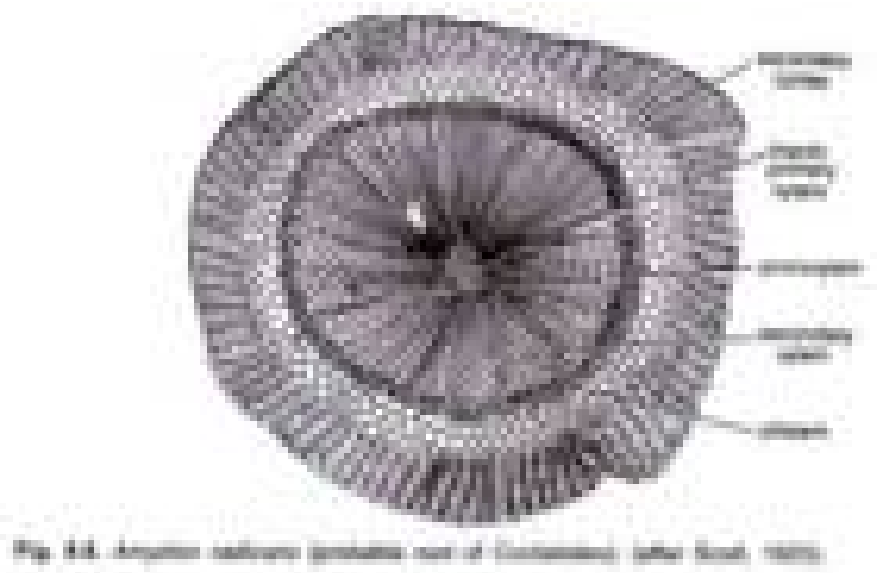
Anatomy of Cordaitaceae

1. Stem:

- The stem (Fig. 9.3) resembled closely with Conifers. Both Cordaites and Mesoxylon possessed a large central pith and cortex. The wood was scanty in some species while in others it developed a large vascular cylinder, and in still other cases distinct growth rings were present. The primary wood was endarch but in Mesoxylon it was mesarch. The secondary wood consisted of pitted tracheids having multiseriate pittings.
- The tracheids were long and slender. Bordered pits were present, and they were confined mainly on the radial walls. In older tracheids, however, the pits were also present on the tangential walls. Medullary rays were one or two cells wide. The bordered tracheids were hexagonal in outline (Fig. 9.4) and the large pith was characteristically discoid (Fig. 9.5).
- Mesoxylon differed from Cordaites in the structure of the leaf trace. A network of sclerenchyma, present in the outer cortex of Mesoxylon, was absent in Cordaites. Since, technically speaking, the genus Cordaites refers to the leaves of Cordaitaceae, an alternative name Cordaioxylon was proposed by Arnold (1967).

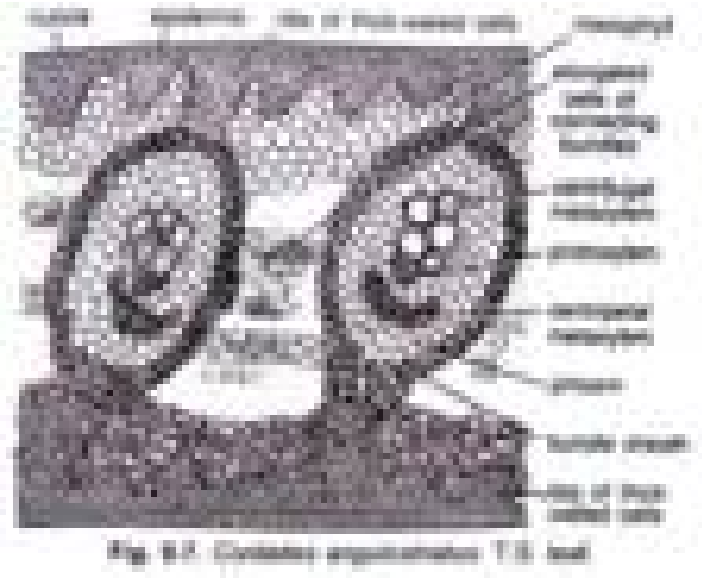
Root

- The roots of Cordaitales are known as **Amyelon** (Fig. 9.6) and resembled very much with the modern Conifers. Cridland (1964) studied the root system of Amyelon and found it to be shallow and highly branched forming stilt roots supporting the stem. They were diarch or triarch in structure. Ectotrophic mycorrhizal fungi were present on the roots.
- The protoxylem had spiral tracheids while the metaxylem was scalariform in structure. Tracheids had multiseriate bordered pits. The cortex was quite large and divisible into outer and inner cortex. The secondary cortex and cambium were also quite distinct.



Leaf

- The Cordaitalean leaf is described under the name Cordaites. Several xerophytic internal characters were present in the leaf. The epidermal and hypodermal cells were thick-walled, and the hypodermal cells on both sides were grouped into ribs. Several mesarch vascular bundles were present.
- Each vascular bundle was surrounded by a thick-walled strong bundle sheath. The transfusion tissue was present in the form of some elongated cells in between two vascular bundles (Fig. 9.7). The mesophyll was clearly differentiated into palisade and spongy parenchyma in species such as Cordaites lingulatus (Fig. 9.8).



- **Spore-producing Organs:**
- The strobili were usually monoecious but some Cordaitales were also dioecious. They were, however, never bisporangiate. The fructifications were borne on slender branches of about 10 cm length. These branches developed on the stem among the leaves. The slender stalk had many stiff but tapering bracts.
- A short bud-like strobilus was present within the axil of each bract. The bracts were probably spirally arranged. Each strobilus attained a length of about 1 cm. Both male and female reproductive organs are known as Cordaianthus, but according to Fry (1955) Cordaianthus is the new name of the reproductive organs or cones of Cordaitaceae.

Male Strobilus

It consisted of a thick central axis possessing many spirally arranged bracts and some microsporophyll's. At the tip of each microsporophyll were present 1-4 microsporangia (Fig. 9.9). These sporangia probably dehisced longitudinally. Three well-studied forms of male strobilus include Cordaianthus concinnus, C. penjonii (Fig. 9.9) and C. saportanus.

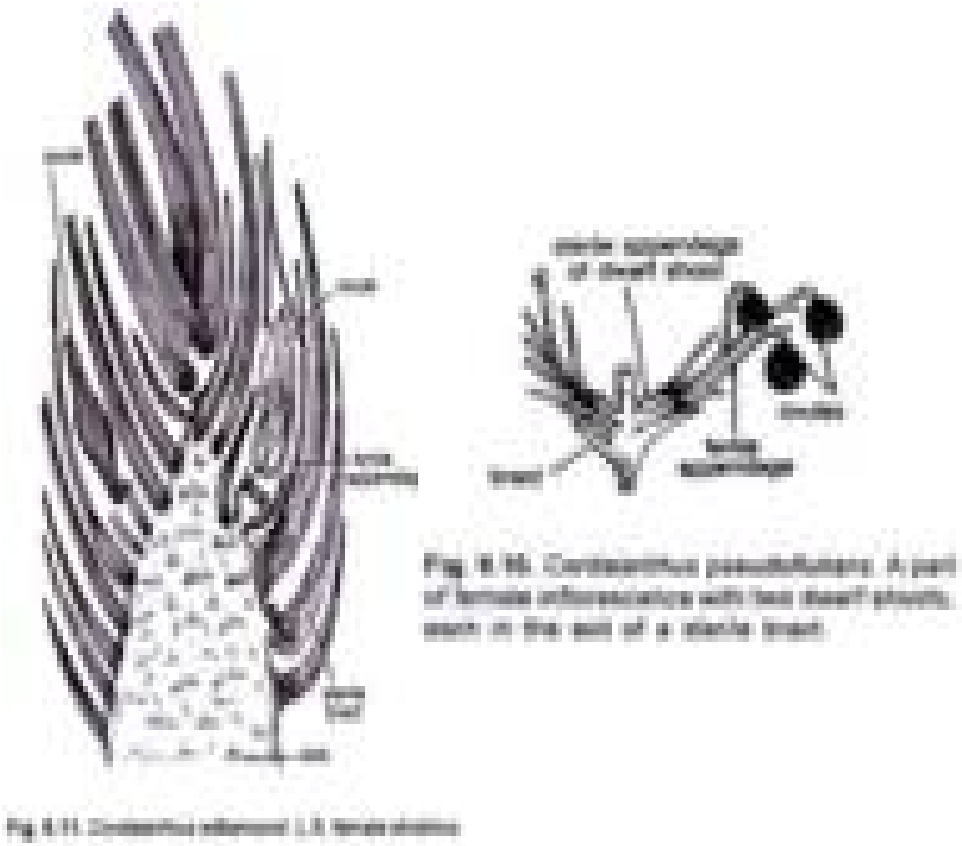
Male Strobilus

The microsporangium wall was probably only one-celled thick and enclosed many microspores. Taylor and Taylor (1987) studied the structure of pollen grains of Cordaitales. According to them the grains may be alete or range from monolete to trilete.

They are mono-saccate with saccus attached on both distal and proximal poles. Different interpretations of male reproductive organs of Cordaites have been given by- Renault (1889), Florin (1951) and Taylor (1973).

Female Strobilus

- Similar to male strobilus, the female strobilus also had a stout axis bearing a large number of spirally arranged bracts. The bracts were more in number than that of male strobilus. Cordaianthus pseudofluitans possessed a few elongated and dichotomously branched fertile megasporophylls (Fig. 9.10). Two or more ovules were present at the apex of each megasporophyll.
- In Cordaianthus williamsonii, a single ovule was present on each fertile appendage (Fig. 9.11). The ovule was bitegmic and the integuments were free in the lower part but fused above. The nucellus of the ovule was free from the integument throughout. A prominent beak with a large pollen chamber was also present.
- Cordaianthus zielleri differed from C. pseudofluitans in the size of megasporophylls, number of functioning megasporophylls, dichotomies and total number of ovules in each strobilus.



Seed

- It is believed that Cordaianthus type of strobili possessed seeds known as Cardio carpus (=Cordaicarpus=Samaropsis). Mitrospermum and Kamarospermum are the other two seed-genera of Cordaitaceae. Seeds were heart-shaped, bilaterally symmetrical and crassinucellate.
- Central nucellus was surrounded by a two-layered envelope, of which the outer layer was probably expanded in the form of a wing. In Cardiocarpus spinatus the seeds were large and surrounded by five distinct layers, including two layers each of sarcotesta and sclerotesta and a layer of endotesta.

Affinities of Cordaitales

- Although Cordaitalean members exhibit several resemblances with and differences from the Pteridospermales, Cycadales, Ginkgoales, Coniferales and Ephedrales, yet they show several unique features which establish them as an independent group.
- **Some of these unique characten sties include their:**
- (i) Arborescent habit,
- (ii) Scanty primary wood,
- (iii) Pycnoxylic secondary wood,
- (iv) Multi-senate pittings on the tracheid-walls,
- (v) Absence of resin canals,
- (vi) Simple but very long (up to 1 metre) leaves with parallel venation,
- (vii) Compound unisexual cones,
- (viii) Fertile female appendages with one to four ovules, and
- (ix) Bilateral seeds.

- **Relation with Pteridospermales (=Cycadofilicales):**
- **Major similarities between Cordaitales and Ptendospermales include the presence of:**
- (i) A large pith in their stems,
- (ii) Multiseriate pittings on the walls of their tracheids,
- (iii) Centripetally developed xylem in their primary wood,
- (iv) Double leaf traces,
- (v) Almost similar general structure and vascularization of their ovules, and
- (vi) General absence of embryos in their seeds.
- **However, the differences appear more marked than resemblances when Cordaitales are compared with**

- **Pteridosperms:**
- (i) A seed-bearing inflorescence, as reported in Cordaitales, is practically unknown in Ptendospermales,
- (ii) There is very little in common between the Cordaitalean leaf and pteridospermic frond,
- (iii) Cordaitales generally possessed pycnoxylic wood while the secondary wood in Ptendospermales was manoxylic.
- **Relation with Cycadales:**
- **Resemblances between Cordaitales and Cycadales include the presence of:**
- (1) The xerophytic nature of their plants,
- (ii) Large pith in their stems,
- (iii) Centripetal wood in their stems,
- (iv) Large amount of sclerenchyma in their leaves,
- (v) Motile nature of their spermatozoids,
- (vi) Comparatively simple and fairly large seeds,
- (vii) Almost similar vasculature of their ovules, and
- (viii) Three distinct layers in the single integument surrounding the ovule.

- **Cordaitales differ from Cycadales in possessing:**
- (i) Simple leaves,
- (ii) Parallel venation,
- (iii) Straight leaf trace,
- (iv) Pycnoxylic wood, and
- (v) Compound nature of their strobili.
- In Cycadales, however, the leaves are pinnately compound, venation is not parallel, leaf trace is not straight, the wood is manoxylic, and the strobili are not compound.
- **Relation with Ginkgoales:**
- **Some common characters found in both Cordaitales and Ginkgoales include the presence of:**
- (i) Double leaf-trace,
- (ii) Motile sperms in Ginkgoales and the probable motility of the Cordaitalean sperms,
- (iii) Anatomy of leaves, and
- (iv) Endospermic beak in their ovules.
- Origin of leaf traces is, however, different in members of both the groups. In Ginkgoales, the double leaf traces originate from two separate protoxylem groups while in Cordaitales they originate from the same group of the protoxylem.

- **Relation with Coniferales:**
- (i) Arborescent habit of both Cordaitales and Coniferales indicates a close affinity between the two groups,
- (ii) Cordaitalean leaves resemble very closely with those of Agathis and Podocarpus of Coniferales. Some of the other points of resemblances between these two groups include their
- (iii) Simple leaves,
- (iv) Parallel venation,
- (v) Sclerenchymatous hypodermis in the leaves,
- (vi) Pycnoxylic wood,
- (vii) Bilaterally symmetrical ovules, and
- (viii) Similarity between the compound strobili of Cordaitales and cones of several members of Pinaceae (e.g. Abies). Connecting links between Cordaitales and Pinaceae may be traced in some fossil coniferous genera such as Lebachia arid Ernestiodendron of Lebachiaceae and Pseudovoltzia of Voltziaceae.
- **However, some remarkable features of cordaitalean wood include the:**
- (i) Absence of resin canals, and
- (ii) Presence of multiseriate bordered pits on the walls of the tracheids. These characteristics suggest that Cordaitales have been more nearer to the Araucariaceae than to the Pinaceae. Some workers of the phylogeny of this group have suggested that araucarians are the derivatives of Cordaitales.

- **Relation with Ephedrales:**
- **The points of similarity between Cordaitales and Ephedrales (e.g. Ephedra) include the presence of:**
- (i) Parallel-veined leaves,
- (ii) Two leaf traces,
- (iii) Haplocheilic stomatal apparatus,
- (iv) Dense pycnoxylic wood,
- (v) Long and slender tracheids with tapering ends,
- (vi) Flattened microsporophyll's in Cordaianthus and some species of Ephedra,
- (vii) Terminal sporangia,
- (viii) Sporangia provided with main vascular bundle,
- (ix) One to six microsporangia in each microsporophyll,
- (x) Reducing number of ovules from many to two to one, and
- (xi) Quite reduced and shortened megasporophylls.
- On the basis of the above similarities, Cordaitales appear to be more closely related to Ephedrales than to other gymnospermous groups.