THE AFFINITIES OF THE PENTOXYLEAE

A. R. RAO*
Professor of Botany (Retd), Lucknow University, Lucknow-226 007, India

ABSTRACT

The medley of characters found in the different components of the Pentoxyleae are discussed. It is pointed out that at the present state of our knowledge of the morphology and anatomy of this group, it is not possible to refer it exclusively to any known group of plants. It is also pointed out that in view of the mixture of characters it shows, it can be only regarded as an isolated synthetic group, showing some features in common with Pteridospermales, Cycadales, Bennettitales, Ginkgoales and Coniferales.

Key-words — Pentoxyleae, Pteridospermales, Cycadales, Bennettitales, Ginkgoales, Coniferales (India).

IN 1948, Prof. Birbal Sahni instituted a synthetic group the Pentoxyleae for the reception of three petrified organ genera with unique and unusual anatomical features combining those of the Pteridosperms, Cycadales, Bennettitales and Conifers. All these were from Nipania in the Rajmahal hills, Bihar.

Stems — Pentoxylon sahnii Srivastava and Nipanioxylon guptai Srivastava.

Leaves — Nipaniophyllum raoi (some of which were known till then as Taeniopteris spatulata McClelland).

Female cones — Carnoconites compactum Srivastava and Carnoconites laxum Srivastava.

Male cone — Sahnia nipaniensis was added to this list by Vishnu-Mittre (1953).

It may be pointed out that organic connection between these organs has not yet been convincingly demonstrated. But still, the disposition of these fossils in the rock matrix, with reference to one another, and the presence of corresponding morphological and anatomical features in them suggest that P. sahnii probably bore the leaves Nipaniophyllum raoi and female cones Carnoconites compactum and male cones Sahnia nipaniensis. It is also likely that the little investigated Nipanioxylon guptai also bore leaves like Nipaniophyllum raoi and perhaps female cones, Carnoconites laxum; no male cones are known. A full description of these genera is given by Sahni (1948). Vishnu-Mittre (1953) and Rao (1974) have also described their morphological and anatomical characters briefly. So no attempt has been made to describe the structural features of these genera again.

In this brief note the medley of characters found in the Pentoxyleae, which make comparison with other higher groups of the plant kingdom possible, have been discussed.

*Present address: Guru Charna, No. 2, XI Main Road, 3rd Block East, Jayanagar, Bangalore-560011.
The stem *Pentoxylon sahnii* was dimorphic like those of the Coniferales or the Ginkgoales. The thick long shoots were covered by just a few leaf scars while the slender short shoots were densely covered with scale leaf and foliage leaf scars as in some cycads and conifers. The internal anatomy shows that the secondary wood had tracheids with uniseriate or biseriate pitting, contiguous and often hexagonal, as in the Araucariaceae of the Coniferae. The primary vascular bundles were in the form of 5 to 6 tangentially extended bands and protoxylem was possibly mesarch, as in some Pteridosperms. In later developmental stages these bands developed secondary xylem on both sides but more on the inner side than on the outer side. This resulted in 3-6, but generally 5, vascular steles in the long shoot, each with exaggerated secondary wood on the inner side — presenting a polystelic condition similar to those of the Medullosae. In fact Sahni drew attention to this similar feature between *Pentoxylon* and *Medullosa*, and Srivastava in a way compared it with *Rhexoxylon* which is supposed to have Medullosaean affinities. Delevoryas (1955) pointed out that centrepetally developed wood is also found in Medullosae. Stewart and Delevoryas (1956) stated that the “stem anatomy of members of the Pentoxyleae described from the Mesozoic of India by Sahni, have much in common with the Medullosaean stem structure and perhaps some affinity may exist”. Seward had suggested as far back as 1917 that leaves like those of *Taeniopteris* were probably borne on Medullosaean stems. It may perhaps be significant that the leaves designated *Nipaniophyllum raoi*, originally known as *Taeniopteris spatulata* McClelland (Rao, 1943) show a mixture of Cycadean and Bennettitalean features. The stomata present a syndetocheilic appearance — although this may be marked by secondary division of the subsidiary cells. The internal anatomy of the leaf showed cycadean features, in its diploxylic vascular bundles, the winged petiole and the slightly sunken stomata. But the bundles themselves are arranged in an arc in the petiole and not in a typical Cycadean pattern. Prof. Sahni has aptly said “in their vascular anatomy as well as their epidermal structures the leaves represent a generalized cycadophyte type with no exclusive affinity with either the Bennettitales or the true cycads”.

A rather confusing feature is that *N. raoi* leaves have not been found yet in actual organic connection with *P. sahnii* although leaves like them cut in transverse sections are found surrounding the short shoots, and sometimes the long shoot also of *P. sahnii*. Some exactly similar types of leaves have haplocheilic type of stomata. From transverse sections only it is difficult to say which one of these types of leaves were the ones borne on *P. sahnii*. It is not unlikely that these leaves had perhaps similar anatomical features while their epidermal features were dissimilar. This is mentioned here to bring home the fact that categorical assignment of affinities cannot be made sometimes, in the absence of complete morphological data.

The male flowers *Sahinia nipaniensis* are neither completely Bennettitalean nor completely Cycadean but show characters of both groups. For example, the general pattern of the flower is Bennettitalean. But they do not show the circinate veneration of the erect part of the flower nor their pinnate branching, so characteristic of the Bennettitales. The filiform branched microsporophylls were originally regarded as
united into a disc at the base, but recent finds of the flower show that the sporophylls were free from each other and were arranged in a spiral phyllotaxis. The unicellular pyriform sporangia measuring 120 x 70 µm contain boat-shaped, monocolpate pollen grains. In these two features these are comparable with the living Cycadales.

The structural features of *Nipanioxylon guptai* and *Carnoconites laxum* are imperfectly known and are therefore not discussed here.

It will thus be seen that the different genera of the Pentoxyleae cannot be assigned exclusively to any known Gymnosperm Group. At the same time they are not totally unlike any group of gymnosperms. The most obvious and intriguing feature is that they present a combination of characters belonging to the Pteridosperms, Coniferae, Ginkgoales, Cycadales and Bennettitales. One may be tempted to infer that this is a unique group showing characters of different gymnospermous groups. Therefore Prof. Sahni rightly regarded them as "belonging to some unknown new and synthetic group of gymnosperms" occupying an isolated position. Investigations carried on this group within the last thirty years have not in any way further clarified our knowledge of the exact affinities of this group. Further work on the detailed morphological and anatomical features of the different members of the groups may in course of time throw light on its position and relationships.

Several questions arise from a study of the Pentoxyleae-imperfect though the study of this group is at present. Did this group arise from any geologically earlier group of plants, say like the Pteridosperms with which it seems to share so many characters? Did it then in course of evolution incorporate in itself the characters of the other gymnosperm groups referred to above? Did this group give rise to any other groups of plants in course of time? Meeuse (1961) suggested "a more or less direct descent of the Pandanaceae and some related monocotyledons from the Pentoxyleae". He has based his conclusions on the basis of similarities found in this group and the Pandanaceae.

These similarities centre round general morphology, leaf morphology and anatomy, stem structure, construction of the male flower and its pollen morphology. The structure of the female flower, inflorescence, the ovule and seed coat morphology also according to Meeuse offer a number of comparisons. This aspect of its affinity also needs a critical study.

It is perhaps futile to further discuss the affinities of this important and fascinating group of gymnosperms until we know more morphological and anatomical details about its constituent members. These facts can only be obtained in a extensive and intensive investigation of the group as suggested by Rao (1976) and then properly assessed.

In conclusion it must be admitted that in the light of our present knowledge, the Pentoxyleae cannot but be regarded as representing an isolated synthetic group of gymnosperms sharing characters with the Pteridosperms, Cycadales, Bennettitales, Ginkgoales and Coniferales.

### REFERENCES


