REVISION OF THE GENUS *GONDWANOXYLON* SAKSENA WITH CRITICAL REMARKS ON THE FOSSIL WOODS OF *AILANTHOXYLON* PRAKASH

U. PRAKASH, J. K. VERMA* & R. DAYAL
Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

The two fossil dicotyledonous woods, *Gondwanoxylon kathotiai* (Saksena, 1963) and *G. ghiarii* (Saksena, l.c.), have been re-investigated here from their type slides. On re-description they have been found to resemble the genus *Ailanthus* of the family Simaroubaceae, and therefore referred to the genus *Ailanthoxylon* Prakash (1959). The species, *Gondwanoxylon kathotiense*[1], is found to be identical to the already described *Ailanthoxylon indicum* Prakash whereas *G. ghiarense*[1], an entirely new species of *Ailanthoxylon*, is re-described under the revised name *Ailanthoxylon ghiarense* (Saksena) comb. nov. In the later part is given a critical review of the hitherto described species of the genus *Ailanthoxylon*. Because of no essential differences the species *A. scantiporosum* Ramanujam (1960), *A. mahurzariense*[1] Shallom (1961) and *A. pondicherriense* Navale (1964) have been united here under the name *Ailanthoxylon indicum* Prakash (1959), which has priority over the rest.

INTRODUCTION

FOR a precise botanical interpretation of fossil woods, sound knowledge of the anatomy and the structural variability of modern woods is very essential. It not only minimises the mistakes in the identification but also prevents us in making " superfluous species " of fossil woods which might have been actually derived from the same species growing in different environmental conditions or even from different parts of a single tree. Recently, in an attempt to find out the taxonomic position of the fossil woods, *Gondwanoxylon kathotiense* and *G. ghiarense*, described by Saksena (1963) from South Rewa, Central India, re-investigation of the type material was undertaken. This study has revealed that both these woods belong to the family Simaroubaceae and show close affinity with the genus *Ailanthus*. A detailed account concerning this is being given in the first part of this paper. The later part deals with a critical review of the hitherto described species of the genus *Ailanthoxylon* Prakash. From a detailed comparative study of the living species of *Ailanthus* as well as the fossil species, no essential differences have been found between the species *Ailanthoxylon indicum* Prakash (1959), *A. scantiporosum* Ramanujam (1960), *A. mahurzariense* Shallom (1961) and *A. pondicherriense* Navale (1964); infact there is marked resemblance in all observable characteristics. Therefore, all these species have been united here under the name *Ailanthoxylon indicum*, which has priority over the rest.

Revision of the Genus *Gondwanoxylon* Saksena 1963

Recently Saksena (1963) has described two fossil dicotyledonous woods from South Rewa, Central India, under a newly created genus *Gondwanoxylon*[2], as *Gondwanoxylon kathotiense* and *Gondwanoxylon ghiarense*. The age of these woods has been suggested as Upper Cretaceous. He compared them extensively with several families of the modern dicotyledons, but reached no conclusion as to their affinities and placed them provisionally under the family Celastraceae. From text-figures and photographs, however, Saksena's fossil woods looked very much like *Ailanthoxylon* Prakash (1959). Reexamination of the type slides of both these woods has confirmed this doubt.

1. The specific epithets *kathotiai* and *ghiarii* used by Saksena, and *mahurzarii* by Shallom after the localities from where the fossil woods were collected, have been properly modified to *kathotiense*, *ghiarense* and *mahurzariense* respectively to conform to the recommendation in the International Code of Botanical Nomenclature (Lanjouw *et al.*, 1961, p. 73).

2. In the literature we find the name *Gondwanoxylon waltoni* proposed by Maheshwari (MS, in Kräusel, *et al.*, 1962, p. 102) for a gymnospermous wood. Since the name *Gondwanoxylon* has been used by Saksena (1963) for dicotyledonous woods, in a valid publication, the name *Gondwanoxylon* proposed by Maheshwari should be revised when published.

*Assistant Professor of Botany, Government Holkar College, Indore, Madhya Pradesh.

MAP 1 — Past distribution of the genus *Ailanthus* in the Northern (after Tanai & Suzuki, 1963a) and Southern hemispheres.

Unfortunately some of the anatomical details were incorrectly described by Saksena, which in consequence, precluded any chance of tracing their affinities correctly to the genus *Ailanthoxylon* of the family Simaroubaceae.

The two fossil woods, *Gondwanoxylon ghiarense* and *G. kathotiense*, resemble each other in gross features, though differing in important anatomical details and were, for this reason, placed as two separate species of *Gondwanoxylon* by Saksena. He described them both, as possessing typically septate fibres and with no xylem parenchyma whatever, thus looked for affinities amongst families possessing these two important diagnostic characters. Simaroubaceae was one of the families with which he compared his fossil woods but saw no points of resemblance, in fact wide differences, and dismissed it.

A critical examination of the type slides has revealed that what had been considered by Saksena (1963, p. 30) as septate fibres are in fact parenchyma strands while the abundant aliform parenchyma, seen in the transverse section, had been considered merely as ' crack ' or ' colouration ' on the surface of the wood. The two woods, in fact, possess all the diagnostic features of the genus *Ailanthoxylon* Prakash and should, therefore, be appropriately referred to it.

It has been further found that while *G. ghiarense* is an entirely new and hitherto undescribed species of *Ailanthoxylon*; *G. kathotiense* is identical to *A. indicum* Prakash in all details of anatomy. Since, however, both these woods were incorrectly described and also incorrectly assigned to Celastraceae, they are being redescribed below from their type slides[3].

DESCRIPTION

Family — Simaroubaceae

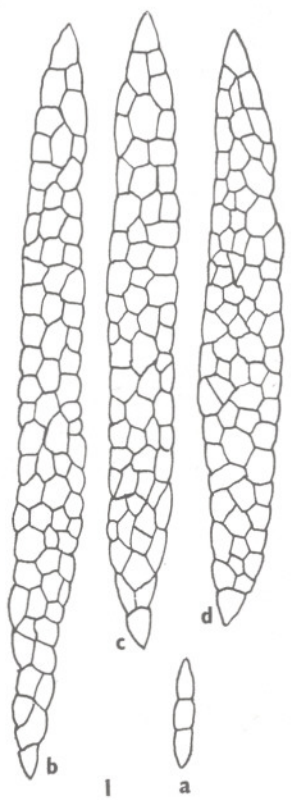
Genus — *Ailanthoxylon* Prakash, 1959
***Ailanthoxylon indicum* Prakash, 1959**

Synonym: 1963, *Gondwanoxylon kathotiense* Saksena

Pl. 1, Figs. 1, 3; Pl. 2, Figs. 5-7; Text-fig. 1

Topography — Wood diffuse-porous (Pl. 1, Fig. 1). *Growth rings* not observed (Pl. 1, Fig. 1). *Vessels* moderately small to medium-sized, mostly solitery, sometimes in pairs, rarely in radial groups of three cells, evenly distributed, contiguous with the rays on one or both the sides, 5 per sq. mm. (Pl. 1, Fig. 1); tyloses present. *Parenchyma* paratracheal, aliform to confluent (Pl. 1, Fig. 1), the bands upto 6 (mostly 3-4) cells, in thickness. Xylem rays very fine to medium, or broad, 1-6 (mostly 3-4) seriate (Pl. 1, Fig. 3, Pl. 2, Fig. 5; Text-fig. 1) and 16-90 μ wide, 5-6 per mm.; ray tissue homogeneous (Pl. 2, Fig. 6); uniseriate rays rare (Text-fig. 1a), 1-5 cells and 44-195 μ high; multiseriate rays fusiform, homocellular consisting only of procumbent cells (Pl. 2, Fig. 5; Text-figs. 1b-d), 6-56 cells and 150-1350 μ high. *Fibres* aligned in radial rows of 2-14 cells between the two consequtive xylem rays.

Elements — Vessels thin-walled, t.d. 95-195 μ r.d. 95-225 μ, round to slightly oval, those in radial groups flattened at places



Gondwanoxylon kathotiense Saksena

Text-fig. 1a-d — Uniseriate and multiserate xylem rays in tangential section. ×125.

3. Type slides of both the woods were obtained from Professor S. D. Saksena on request and are now kept at the Museum of the Birbal Sahni Institute of Palaeobotany, at his suggestion.

of contact (PL. 1, FIG. 1); vessel-members very short to moderately short, 200-300 μ, long with oblique end walls; perforations simple; intervessel pit-pairs not well preserved; vessel-parenchyma pits not well-preserved, bordered, many per cell (PL. 2, FIG. 7); vessel-ray pits not observed. *Parenchyma strands* 2-4 celled (PL. 2, FIG. 5), parenchyma cells thinwalled, t.d. 16-36 μ, vertical height 75-160 μ. *Ray cells* thinwalled; procumbent cells with radial length 36-120 μ, vertical height 20-32 μ. *Fibres* moderately thickwalled, nonseptate (PL. 2, FIG. 5), circular to angular in cross-section, t.d. 15-30 μ, r.d. 15-30 μ; interfibre pits not observed.

Gondwanoxylon kathotiense Saksena (1963) on redescription shows the following important features: vessels moderately small to medium-sized, mostly solitary; parenchyma aliform to confluent; rays 1-6 (mostly 3-4) seriate, with homogeneous ray tissue; fibres nonseptate. In these anatomical features the fossil wood shows a close resemblance to the genus *Ailanthus*. It is, therefore, referred to the genus *Ailanthoxylon* Prakash (1959), with which the identity of the genus *Gondwanoxylon* has been already pointed out in the preceding pages.

Detailed comparison with all the species referred to *Ailanthoxylon* has further shown beyond doubt that the present fossil wood is identical to *A. indicum* Prakash. It would not be necessary to repeat the details here, but no differences were seen between the two species (*see* TABLE 1). *Gondwanoxylon kathotiense* is, therefore, merely just another piece of the earlier described *A. indicum* wood. The name *G. kathotiense* thus no longer remains in existence and it remains only to report the finding of *A. indicum* from a new locality of South Rewa. This in itself is important, in so far as it enlarges the range of distribution of the genus *Ailanthoxylon*.

Holotype — Represented by four slides numbered 248, 249, 357, 497.

Locality — Near village Ghiar (23·50: 81·19) on the right bank of the Son river, South Rewa, Madhya Pradesh.

Horizon and Age — According to Saksena the locality is surrounded by flat-topped hills of the Deccan Traps and Intertrappean beds, which are generally considered of Upper Cretaceous age. From this it appears that the fossil wood is from beds which are most probably Intertrappeans. These beds are now considered to be of Early Eocene age (CROOKSHANK *et al.*, 1937; SAHNI, 1940).

***Ailanthoxylon ghiarense* (Saksena) comb. nov.**

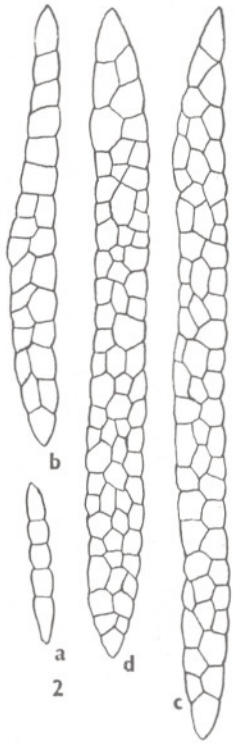
Synonym: 1963, *Gondwanoxylon ghiarii* Saksena

Pl. 3, Figs. 10, 12, Pl. 4; Figs. 14-17; Text-fig. 2

It has been shown in the preceding pages that the genus *Gondwanoxylon* instituted by Saksena for his two fossil woods was infact identical to the genus *Ailanthoxylon* Prakash and that *G. kathotiense* was a mere synonym of *A. indicum*.

A critical examination of the type slides of the other species, *Gondwanoxylon ghiarense*, has revealed that it is a new species of *Ailanthoxylon*. In describing this wood Saksena again made the same mistakes of interpretation of the observed anatomical characters; he mistook the parenchyma strands for septate fibres and the aliform to confluent parenchyma bands he considered merely as ' cracks ' or ' colouration ' of the wood surface. It is, therefore, being redescribed below from its type slides under the revised name *Ailanthoxylon ghiarense* (Saksena) comb. nov.

Topography — Wood diffuse-porous (PL. 3, FIG. 10). *Growth rings* not observed. *Vessels* medium-sized to moderately large, visible to the naked eye as pin points, mostly solitary, sometimes in radial groups of 2 to 3 cells, occasionally in small irregular clusters, contiguous with the rays on one or both the sides, distributed without any pattern (PL. 3, FIG. 10), 4-6 per sq. mm.; tyloses present. *Parenchyma* paratracheal, usually aliform to confluent formed by the union of lateral extensions from the adjacent vessels (PL. 3, FIG. 10); the tangential bands upto 5 (mostly 3-4) cells thick (PL. 4, FIG. 14). *Xylem rays* distinct to the naked eye on the cross-section of the wood, fine to medium, 1-4 (mostly 2-3) seriate (PL. 3, FIG. 12; TEXT-FIG. 2) and 15-60 μ wide, 7-9 per mm.; ray tissue weakly heterogeneous; uniseriate rays rare, consisting of upright cells (TEXT-FIG. 2a), 4-13 cells and 145-1575 μ high; the multiseriate rays homocellular as well as heterocellular, consisting mostly of procumbent cells, sometimes with 1-2 (mostly 1) marginal rows of upright cells (PL. 4, FIG. 17; TEXT-



Ailanthoxylon ghiarense (Saksena) comb. nov.

TEXT-FIG. 2a-d — Uniseriate and multiseriate xylem rays seen in tangential section. ×125.

FIG. 2b-d), 6-118 cells and 165-2025 μ high, sometimes showing dissection. *Fibres* arranged in radial rows of 3-16 between the two consecutive xylem rays (PL. 4, FIG. 14), nicely preserved only at some places.

Elements — Vessels thin-walled, the walls about 3-6 μ thick, t.d. 105-180 μ, r.d. 120-225 μ, round to oval in cross-section, those in radial groups flattened at the places of contact; vessel-members moderately short to medium-sized, 300-400 μ in length, usually truncate; perforations simple; intervessel pit-pairs ill preserved; vessel-parenchyma pits bordered, many per cell (PL. 4, FIG. 16); vessel-ray pits not seen. *Parenchyma strands* 3-5 celled (PL. 4, FIG. 15), cells thinwalled, t.d. 28-32 μ, vertical height 80-104 μ. *Ray cells* thin-walled; procumbent cells upto 64 μ in radial length, vertical height 20-24 μ; upright cells 40 μ in radial length, vertical height 72 μ. *Fibres* moderately thick-walled with large lumina, non-septate (PL. 3, FIG. 12), oval to angular in the cross-section, t.d. 20-28 μ, r.d. 12-32 μ; interfibre pits not observed.

Specimen No. 33074 cf. *Ailanthoxylon ghiarense*

This specimen from Mohgaonkalan, although identical to *Ailanthoxylon ghiarense*, shows a good deal of variation in its wood structure. It is a well-preserved piece of secondary wood measuring 7 cm. in length and 4 cm. across, before cutting and shows certain anatomical details clearly, which in Saksena's type slides are either indistinct or not seen altogether. The colour of the fossil specimen is dirty white to black. Pith is absent but the specimen comes from a region near to it, as indicated by the converging xylem rays towards one end (pith side) seen on the cross surface of the wood (PL. 5, FIG. 21).

The variations are seen in, the two regions of the wood, the region nearer the pith and that away from it. The latter region is identical to *Ailanthoxylon ghiarense* in wood structure.

In the region nearer the pith, the parenchyma is vasicentric, sparse, in 1-3 cells thick sheath with short, narrow and 2 cells thick, lateral extensions often joining the adjacent vessels (PL. 5, FIG. 21), whereas in the outer region, the vasicentric parenchyma is more abundant, aliform to confluent, the extensions being broader, 4-7 cells thick near the vessels, becoming 2-3 cells thick outwards (PL. 5, FIG. 22). The xylem rays also correspondingly differ in the two regions. Those in the region near the pith are taller, mostly biseriate, occasionally uniseriate, and homocellular to heterocellular (PL. 5, FIG. 23), whereas in the outer region they are comparatively less tall, 1-4 (mostly 3-4) seriate with mostly homocellular to sometimes weakly heterocellular rays (PL. 5, FIG. 24). There is also some variation in the size and distribution pattern of the vessels in the two regions of the fossil wood, but this is not very marked.

The intervessel pit-pairs not preserved in Saksena's specimen are clearly seen in the present specimen. They are large, 8 μ in diameter, bordered, alternate with oval to hexagonal borders and lenticular, horizontal apertures (PL. 4, FIG. 19).

DISCUSSION

Comparison with the Living Species — There is a close agreement in all the struc-

tural details of the above two fossil woods with the wood structure of the modern genus *Ailanthus* of the Simaroubaceae. For a detailed comparison thin sections of the five available species of this genus, viz., *A. excelsa* Roxb., *A. grandis*-Prain., *A. malabarica* DC, *A. kurzii* Prain and *A. altissima* Swingle were prepared and studied. Besides, comparison was also made with the descriptions and figures of other species of this genus. These are *Ailanthus cacodendron* Schinz. et Thellung. (KANEHIRA, 1921, pp. 58-59, PLS. 11-12, FIGS. 66-67), *A. glandulosa* Desf. (CHALK & RENDLE, 1929, p. 13, FIG. 11), *A. philippinensis* Merrill (KANEHIRA, 1924, pp. 15-16; METCALFE & CHALK, 1950, p. 324; REYES, 1938, pp. 159-160, PL. 24, FIG. 1), *A. moluccana* DC. var. *javanica* Koord. et Valet., *A. malabarica* DC. var. *mollis* Koord. et Valet, (MOLL & JANSSONIUS, 1908, pp. 77-83, FIG. 87), and *A. blancoi* Merrill (WEBBER, 1936, pp. 579-583, FIG. 7). From a detailed examination of all the above species, it was found that the present fossil wood shows closest resemblance with the wood structure of *Ailanthus grandis*.

The shape, size and distribution of the vessels in the fossil wood is similar to that of this living species, though there is greater frequency of vessel multiples in the living species than in the fossil. In both, the perforations are simple and the intervessel pit-pairs are large, alternate, bordered with oval to hexagonal borders and lenticular, horizontal apertures.

The distributional pattern of the parenchyma is almost identical in both as is the structure of fibres. The xylem rays of the fossil wood and those of *Ailanthus grandis* are nearly similar although there are some differences in the frequency of the heterocellular rays in the two. 1-5 (mostly 3-4) seriate and high xylem rays of *A. grandis* are quite comparable to the similar rays in the fossil wood (PL. 3, FIGS. 12 & 13) except that the rays are mostly heterocellular in the extant wood as opposed to mostly homocellular rays in the Intertrappean fossil, although both are characterized by homocellular to weakly heterocellular rays (PL. 4, FIGS. 17 & 20). Also, the uniseriate rays are comparatively more frequent in the living species than in the fossil wood (PL. 3, FIGS. 12 & 13).

Comparison with the Fossil Species — A number of fossil woods assigned to the Simaroubaceae have been described from India and abroad. Among those referred to the genus *Ailanthoxylon* Prakash, *Ailanthoxylon indicum* Prakash (1959) alone is valid. That all the other species of *Ailanthoxylon*, viz., *A. mahurzariense*, *A. scantiporosum* and *A. pondicherriense* are mere synonyms of *Ailanthoxylon indicum* has been shown in the subsequent pages (*see* also TABLE 1).

The present fossil wood, *Ailanthoxylon ghiarense*, while resembling *Ailanthoxylon indicum* in many of its structural details, differs from it chiefly in the nature and distribution of the xylem rays. In *Ailanthoxylon indicum*, the xylem rays are fusiform, 1-6 (mostly 4-5) seriate, 4-54 cells and 80-1376 μ high, with homogeneous ray tissue, whereas in the present fossil they are 1-4 (mostly 2-3) seriate, 6-118 cells and 165-2025 μ high, with homogeneous to weakly heterogeneous ray tissue, a condition seen also in the modern wood of *Ailanthus grandis* to which species the present fossil shows the closest resemblance (PL. 3, FIGS. 12, 13). The present fossil is, therefore, quite different from *Ailanthoxylon indicum*.

The diagnosis of the genus *Ailanthoxylon* given by Prakash (1959) and revised by Shallom (1961) does not cover all the characters, hence an emended diagnosis is proposed here for the same.

EMENDED GENERIC DIAGNOSIS

Ailanthoxylon

Wood diffuse-porous or ring-porous. *Growth rings* present or absent. *Vessels* small, medium sized to large, usually solitary, often in pairs, rarely in groups of three or more cells; tyloses present or absent; vessel-members short to medium; perforations simple; intervessel pit-pairs large, bordered, alternate, border usually polygonal, aperture lenticular and horizontal; vessel-parenchyma and vessel-ray pits similar to the intervessel pit-pairs. *Parenchyma* paratracheal, usually of aliform to confluent type. *Xylem rays* fine to medium or broad, more or less fusiform; uniseriate rays rare; ray tissue homogeneous or weakly heterogeneous. *Fibres* moderately thick walled, typically non-septate; interfibre pits bordered.

SPECIFIC DIAGNOSIS

***Ailanthoxylon ghiarense* (Saksena) comb. nov.**

Wood diffuse-porous. *Growth rings* not observed. *Vessels* medium-sized to moderately large, t.d. 105 to 180 μ, r.d. 120 to 225 μ, mostly solitary, sometimes in radial groups of 2 or 3 cells, 4-6 per sq. mm.; perforations simple; intervessel pit-pairs large, 8 μ in diameter, bordered, alternate, with oval to hexagonal border and lenticular, horizontal apertures; tyloses present; vessel-parenchyma pits similar to the intervessel pit-pairs. *Parenchyma* usually aliform to confluent; tangential bands up to 5 (mostly 3-4) cells thick; parenchyma strands 3-5 celled. *Xylem rays* 1-4 (mostly 2-3) seriate and 15-60 μ wide, 7-9 per mm.; ray tissue weakly heterogeneous; uniseriate rays rare, homocellular, consisting of upright cells, 4-13 cells and 145-1975 μ high; multiseriate rays homocellular as well as heterocellular, consisting mostly of procumbent cells, sometimes with 1-2 (mostly 1) marginal row of upright cells, 6-118 cells and 165 to 2025 μ high. *Fibres* moderately thickwalled, non-septate.

Holotype — Represented by five slides numbered 361, 363, 488, 489, 490.

Localiti — Near village Ghiar (23·50: 81·19) on the right bank of Son river, South Rewa, Madhya Pradesh.

Horizon and Age — According to Saksena the locality is surrounded by flat-topped hills of the Deccan Traps and Intertrappean beds, which are generally considered of Upper Cretaceous age. From this it appears that the fossil wood is most probably from the Deccan Intertrappean beds. These beds are now considered to be of Early Eocene age (CROOKSHANK *et al.*, 1937; SAHNI, 1940).

CRITICAL REVIEW OF THE FOSSIL WOODS OF *AILANTHOXYLON* PRAKASH

The genus *Ailanthoxylon* was instituted by Prakash in 1959, for fossil woods showing resemblance to that of *Ailanthus*, based on a block of fossil wood from Mohgaonkalan beds of the Deccan Intertrappean series, which he described as *Ailanthoxylon indicum*. Since then, three other species have been referred to this genus from other Indian localities. These are *Ailanthoxylon scantiporosum* Ramanujam (1960) from Mortandra, district South Arcot, Madras, *A. mahurzariense* Shallom (1961, *see* also 1959) from the Deccan Intertrappean beds of Mahuzari, near Nagpur and *A. pondicherriense* Navale (1964) also from Mortandra.

Here it is important to mention that in describing the fossil wood, *A. scantiporosum*, Ramanujam (1960) considered it to be the first fossil record of *Ailanthus* from India and abroad, accordingly he assigned it to a new genus, viz., *Ailanthoxylon*, whereas, in fact Parakash (1959) had already instituted the genus *Ailanthoxylon* for his fossil wood *Ailanthoxylon indicum*. The two homonyms are also synonyms and the latter i.e. *Ailanthoxylon* Ramanujam should be rejected in favour of *Ailanthoxylon* Prakash which obviously has priority.

Critical re-examination of *A. indicum* and *A. pondicherriense* was made from their type slides, whereas *A. mahurzariense* and *A. scantiporosum* were studied from their description and illustrations alone, since their type slides could not be obtained[4].

From a careful and detailed comparative study of the anatomical characters of these species, no essential differences were discovered between the species, *A. indicum*, *A. mahurzariense*, *A. pondicherriense* and *A. scantiporosum*. It appears that while making these new species too much stress was laid on minor characters which could have been accounted for either due to bad preservation or as normal variations of little diangostic value. Therefore, all these species have been united here under the name *Ailanthoxylon indicum*, which has priority over the rest. In the accompanying Table 1 are summarized the ages, localities and the more important anatomical features of all the species of *Ailanthoxylon* mentioned above and their modern equivalent.

The important diagnostic characters of *Ailanthoxylon indicum* as given by Prakash (1959) are: Diffuse-porous nature with indistinct growth rings; large to medium-sized and mostly solitary vessels; intervessel pit-pairs alternate, bordered, hexagonal with lenticular apertures. Wood parenchyma of aliform-confluent type with occasional metatracheal parenchyma; tan-

4. Letters were sent to the Heads of the Department of Botany, College of Science, Nagpur, Maharashtra and Waltair University, Andhra Pradesh, for the loan of type slides of *A. mahurzariense* Shallom and *A. scantiporosum* Ramanujam respectively. No replies, however, were received.

TABLE 1 — COMPARATIVE STATEMENT OF STRACTURAL FEATURES OF FOSSIL SPECIES, REFERABLE TO *AILANTHOXYLON* PRAKASH, WITH THEIR AGE AND LOCALITY

Name of the fossil species	Growth rings	Vessels				Parenchyma	Xylem rays	Fibres	Locality	Horizon & Age	Remarks
		shape, size and distribution of the vessels	Perforations	Pitting	Tyloses						
1. *Ailanthoxylon indicum* Prakash	Indistinct	Round to oval in cross-section, large, often medium sized, mostly isolated, often in groups of 2-3 cells, t.d. 100-240 μ, r.d. 112-265 μ; 3-5 per sq. mm.	Simple	Intervessel pit-pairs bordered, alternate, hexagonal with lenticular orifices; vessel-ray pits and vessel-parenchyma pits not seen	Absent	Aliform-confluent with occasional presence of metatracheal parenchyma; tangential bands 3-5 (up to 7) cells and 40-200 μ, thick	1-6 (mostly 4-5) seriate, uniseriate and biseriate rays rare, 16-144 μ wide, fusiform, 4-54 cells and 80-1376 μ high; homogeneous	Non-libriform, non-septate, arranged in distinct radial rows; pits not very clear	Mohgaonkalan, district Chhinwara, Madhya Pradesh	Deccan Intertrappean Series; Early Eocene	Resembles the modern wood of *Ailanthus malabarica*
2. *A. mahurzariense* Shallom	Faint	Small to medium sized; mostly solitary and in radial rows of 2-3 cells; t.d. 100-150 μ, r.d. 150-200 μ.	Simple	Intervessel pit-pairs bordered, alternate, widely spaced or closely crowded, hexagonal; vessel-parenchyma pits similar to intervessel pits	Present	Aliform-confluent, tangential extensions ending blindly; metatracheal parenchyma as separate scattered cells	1-7 (mostly 2-7) seriate, uniseriate rays rare, 50-150 μ wide, 1-70 cells and 60-1600 μ high; homogeneous	Non-libriform, somewhat radially arranged; non-septate, interfibre pits bordered	Mahurzari, district Nagpur, Maharashtra	Deccan Intertrappean Series; Early Eocene	Identical to *Ailanthoxylon indicum* Prakash
3. *A. scantiporosum* Ramanujam	Lacking	Round in cross section, medium-sized to large, generally solitary, locally in groups of 2 or 3 cells;* t.d. 116-190 μ,* r.d. 158-180 μ; 2-5 per sq. mm.	Simple	Intervessel pit-pairs bordered, alternate, crowded and polygonal with usually wide borders and lenticular orifices; vessel-ray and vessel-parenchyma pits similar to intervessel pits	Absent	Mainly as 1-3 or rarely 4 cells thick vasicentric sheaths round the vessels, with short lateral extensions	1-6 (mostly 3-5) seriate, 9-55 cells long, homogeneous locally becoming heterogeneous by the presence of large sheath like cells at their outer fringes	Non-libriform, non-septate; interfibre pits narrowly bordered	Tiruchhitambalam and Mortandra, district South Arcot, Madras	Cuddalore Series; Middle Tertiary (Mio-Pliocene)	Identical to *Ailanthoxylon indicum* Prakash
4. *A. pondicherriense* Navale	Not visible (Indistinct)	Round to oval, generally medium-sized, solitary, less frequently in radial groups, t.d. 120-180 μ; 4-8 per sq. mm.	Simple	Intervessel pit-pairs bordered, alternate, polygonal; vessel-ray pits not clear	Appear to be present	Vasicentric, aliform to confluent with occasional metatracheal parenchyma in short bands of 2-3 cells thick; confluent parenchyma bands 3-5 cells thick	Usually 3-6 seriate, uniseriate and biseriate rays rare; 5-45 cells high, homogeneous, of procumbent cells only	Non-libriform, 'non-septate, arranged in radial rows; interfibre pits not seen clearly	Usteri, near Pondicherry, district South Arcot, Madras	Cuddalore Series; Middle Tertiary (Mio-Pliocene)	Identical to *Ailanthoxylon indicum* Prakash
5. *Gondwanoxylon kathotias** Saxena	Not observed	Round or oval, moderately small to medium sized, mostly solitary, sometimes in pairs, rarely in radial groups, t.d. 95-195 μ, r.d. 95-225 μ; 5 per sq. mm.	Simple	Intervessel pit-pairs bordered, alternate, not well preserved; vessel-ray pits not observed; vessel-parenchyma pits bordered, many per cell	Present	Paratracheal, aliform to confluent; bands up to 6 (mostly 3-4) cells thick	1-6 (mostly 3-4) seriate, uniseriate rays rare, 16-90 μ wide, fusiform, 1-56 cells and 44-1350 μ high, homogeneous	Non-septate, arranged in radial rows; interfibre pits not observed	Kathotia, South Rewa, Madhya Pradesh	Probably Deccan Intertrappean Series; Early Eocene	Identical to *Ailanthoxylon indicum* Prakash
6. *Ailanthoxylon ghiarense* comb. nov. (Saxena)	Not observed	Round or oval, medium-sized to moderately large, mostly solitary, sometimes in radial groups of 2 to 3 cells, t.d. 105-180 μ, r.d. 120-225 μ; 4-6 sq. mm.	Simple	Intervessel pit-pairs ill preserved; bordered,** alternate, oval to hexagonal; vessel-ray pits and vessel-parenchyma pit similar to intervessel pits	Present	Paratracheal, usually aliform to confluent, the tangential bands 3-4 (up to 5) cells thick	1-4 (mostly 2-3) seriate, uniseriates rare, 15-60 μ wide, 4-138 cells and 145-2025 μ high, homogeneous to weakly heterogeneous	Non-septate, arranged in radial rows; interfibre pits not observed	Ghiar, South Rewa, Madhya Pradesh	Probably Deccan Intertrappean Series; Early Eocene	Resembles the wood of modern *Ailanthus grandis*

*From the redescription by the present authors.

**Intervessel pit-pairs not distinctly seen in this specimen; they are being described from specimen No. 33074.

gential bands narrow to moderately broad (up to 7 cells thick). Xylem rays fusiform, 1-6 (mostly 4-5) seriate, homogeneous, 4 to 45 cells high and 4-6 per mm. Wood fibres non-septate; interfibre pits not very conspicuous.

Prakash was not very definite about the exact nature of the vessel-ray and the interfibre pits, since they were not distinctly seen. According to him the former were ". . . . . not very well seen. However, they are simple, rounded and many per cell" while the latter ". . . . . are not very conspicuous. In some of the fibres they appear to be simple" (PRAKASH, 1959, pp. 16 & 18). In both the living species, *Ailanthus grandis* and *A. malabarica* with which he compared his fossil wood these pits are bordered; so also in the fossil wood, *Ailanthoxylon mahurzariense* Shallom which differs from *Ailanthoxylon indicum* mainly on this point. On examining the type slides of *A. indicum* authors found them so badly preserved that no inference could be drawn as to their nature, and it is more likely that as in the living species of *Ailanthus*, in *A. indicum* too, both these kind of pits were bordered.

In considering the affinities of *A. indicum* Prakash (*loc. cit.*) cautiously referred it to be nearly related to the extant species *Ailanthus malabarica* and *Ailanthus grandis*, not being identical with either. However, on a further detailed examination of both these living species and the fossil, it was found that *A. indicum* showed a closer resemblance to *Ailanthus malabarica* than to *A. grandis* (*see* TABLE 1 & 2). Moreover, *A. grandis*, possessing narrower and taller rays, has been found to resemble very closely another fossil wood, *Gondwanoxylon ghiarense* which has been redescribed in the preceding pages as a new species of *Ailanthoxylon*.

Shallom compared her *Ailanthoxylon mahurzariense* with *Ailanthoxylon indicum* and noticed a near resemblance in all characters except for " simple vessel-ray pitting which is definitely bordered " in her fossil wood (SHALLOM, 1961, p. 67). Further she mentioned that the vessel-parenchyma and interfibre pits which also show bordered nature in the specimen described by her had not been described in *A. indicum*. Other minor differences claimed by her as being specific between *A. indicum* and *A. mahurzariense* are: large to medium-sized vessels (t.d. 100-240 μ, r.d. 112-165 μ), 1-6 seriate and 4-54 cells high xylem rays in the former, whereas in her species, *A. mahurzariense*, the vessels are small to medium-sized (t.d. 100-150 μ, r.d. 150-200 μ) and the rays are 1-7 seriate and 1-70 cells high. It is rather unfortunate to create new species based on such minor anatomical differences as these, specially when the other details are almost identical as are found in *A. indicum* and *A. mahurzariense*. The minor differences in size of the vessels are of little diagnostic value, if any, and it is known that vessel size is a character of very variable nature. The rays are 1-7 seriate and 1-70 cells high in her species and 1-6 seriate and 1-54 cells high in *A. indicum*. The differences between the two are thus not such as to be considered of any value in specific delimitation; such structural variations being a normal feature even in the living woods.

It is thus concluded that *Ailanthoxylon mahurzariense* Shallom is conspecific with the earlier described *Ailanthoxylon indicum* Prakash.

A. mahurzariense was compared by Shallom to the extant species, *A. excelsa* and *A. malabarica* with a nearer approach to the latter. The close similarity, existing between *A. indicum* and *Ailanthus malabarica*, has also been pointed out by the present authors.

On a critical comparison of *Ailanthoxylon scantiporosum* Ramanujam (1960) with *Ailanthoxylon indicum* Prakash (1959) it has been found that the two are identical in all respects, except for the size of vessels which has been given as being 225-310 μ in diameter in *A. scantiporosum*. However, on checking up the figures 29 and 30 given on plate 20 in Ramanujam's paper (1960), which are on the same magnification, the size of the vessels has been calculated 116-190 μ in tangential diameter and 158-180 μ in radial diameter which does not tally with the vessel size range (225-310 μ) given in the text on page 115. These measurements, on the other hand, compare favourably with those of *A. indicum*. Thus *A. scantiporosum* and *A. indicum* seem to be identical in all respects.

Ailanthoxylon scantiporosum Ramanujam has been considered by its author to agree very closely, with the wood structure of the extant species, *Ailanthus excelsa*. On a careful study of the living as well as the fossil species, however, it was found that

the fossil wood described by Ramanujam does not compare with the modern wood of *Ailanthus excelsa* (*see* TABLES 1, 2). The amount and distribution pattern of the parenchyma seen in *A. excelsa* (PL. 2, FIG. 8) is quite different from that described and figured by Ramanujam (1960, p. 116, PL. 20, FIGS. 29-30; TEXT-FIG. 20) in *Ailanthoxylon scantiporosum*. In the living species (PL. 2, FIG. 8) the paratracheal parenchyma is abundant, forming a halo of vasicentric sheath, 1-6 cells in thickness, about the vessels or vessel groups, frequently with tangential extensions of several cells wide which end blindly or extend across the rays to unite with those from other vessels, whereas in *A. scantiporosum* the vasicentric parenchyma sheath is only 1-4 cells thick, with locally short lateral extensions as shown in the text-figure (*in* RAMANUJAM, *loc. cit.*, TEXT-FIG. 20). The xylem rays also differ markedly in the two species: those of *Ailanthus excelsa* are broader being 1-14 (mostly 8) cells wide and upto 30 cells in height, while those of *A. scantiporosum* are 1-6 (mostly 3-5) cells in width and 9-55 cells high. In fact, similarity in these and other characters of the fossil wood are with the modern wood of *Ailanthus malabarica* (TABLES 1 & 2).

Recently Navale (1964) has described a species of *Ailanthoxylon* as *A. pondicherriense* from the Cuddalore series of South India. He distinguished this fossil wood from *Ailanthoxylon indicum* on grounds that the latter possessed " more abundant parenchyma in tangential bands, larger vessels and the rays ranging from uniseriate to multiseriate condition " (NAVALE, *loc. cit.*, p. 70). The discrepancy seems to be due to an incorrect observation or interpretation and infact there are no differences between the two so far as the nature and distribution of the parenchyma and the xylem rays are concerned (*see* TABLE 1). However, the size of the vessels is 120-180 μin Navale's specimen and 100-240 μ in *Ailanthoxylon indicum*. But for this slight difference in vessel size, which may well be considered as a variation, the two species are identical.

Further, Navale considered that *A. pondicherriense* agreed closely with the wood structure of the extant, *Ailanthus grandis*. From a critical study of its anatomical characters, (*see* TABLE 1), however, it is found that it compares well with the wood of *Ailanthus malabarica* instead.

Thus, from this critical review it is conclusively established that *A. indicum*, *A. mahurzariense*, *A. scantiporosum*, *A. pondicheriense* and the species described as *Gondwanoxylon kathotiense* by Saksena, are identical. And since *A. indicum* Prakash (1959) has priority, the remaining others should, henceforth, be treated as mere synonyms of this species.

Fossil History of the genus Ailanthus — Plant remains of the genus *Ailanthus* consist of leaflets, fruits, seeds and the petrified woods, which are known to occur since the Palaeocene times. Two incomplete Samara referred to *Ailanthus confucii* were recorded from the Palaeocene flora of Khavarovskaya in the eastern U.S.S.R. (BAIKOVSKAYA, 1950 in TANAI & SUZUKI, 1963a). Since the Early Tertiary, fossils of *Ailanthus* have been commonly known from the Eocene and Miocene of North America, the Oligocene and the Pliocene of Europe, the Eocene to Miocene and Pleistocene of East Asia in the Northern hemisphere (TANAI & SUZUKI, 1963b) and from the Eocene and Mio-Pliocene of India in the Southern hemisphere. In 1948, from the Pleistocene of Honshu, Miki described several fossil seeds without wings belonging to *Ailanthus altissima* which forms the latest fossil record of this genus. The fossil history of the genus *Ailanthus* in the northern hemisphere has been dealt with in detail in a recent paper by Tanai and Suzuki (1963a), but as regards its past distribution in the Southern hemisphere so far only fossil woods, *Ailanthoxylon indicum* and *A. ghiarense*, are known to occur in the Eocene of the Deccan Intertrappean series and the Mio-Pliocene of the Cuddalore series of India (*see* p. 24).

A comparison of the past and present distribution of the genus *Ailanthus* shows that this genus is not so widely distributed in the modern flora of the world as it was during the Tertiary period (MAP. 1). In the modern flora, it is represented by seven species of lofty trees, native in southern Asia, Malaya, China and Australia. The original home of this genus is not known. The species *Ailanthus altissima* (Mill.) Swingle, is a large tree indigenous in China and is now grown extensively for ornament in Western Europe and the north-eastern United States (BRANDIS, 1907, p. 125; PEARSON & BROWN, 1932, p. 214; TROUP 1921, p. 171-174). In India the genus

is represented by four species, viz., *Ailanthus malabarica* D.C., *A. excelsa* Roxb., *A. grandis* Prain and *A. kurzii* Prain. Of these *A. excelsa* has the widest distribution and is indigenous in central and southern India and the western Peninsula. It is also extensively cultivated in many parts of India. *A. grandis* and *A. kurzii*, on the other hand, occur in restricted areas, the former in Assam and Darjeeling, while the latter is confined to the Andaman Islands. *A. malabarica* is a large deciduous tree growing in the forests of Western Ghats up to 500 ft and in South Kanara.

FOSSIL WOODS OF THE FAMILY SIMAROUBACEAE

Simarubinium Platen, 1907

Synonym: *Simarubaceoxylon* Shallom, 1959 (*see* also JAIN, 1959)

1. *Simarubinium crystallophorum* Platen: Platen, 1907: 54. Tertiary, California, U.S.A.

2. *Simarubinium engelhardti* Platen: Platen, 1907: 56. Tertiary, California, U.S.A.

Suriana Linn.

1. *Suriana inordinata* Kruse: Kruse, 1954: 259, Pl. 4, Figs. 29-32. Eocene, Eden Valley, Wyoming, U.S.A.

Ailanthoxylon Prakash, 1959

Synonym: *Ailanthoxylon* Ramanujam, 1960
Gondwanoxylon Saksena, 1963

1. *Ailanthoxylon indicum* Prakash: Prakash, 1959: 16, Pl. 2, Figs. 7-13 & Text-figs. 14-21. Eocene (Deccan Intertrappean series), Mohgaonkalan, Chhindwara district, Madhya Pradesh, India.

Synonym: *Ailanthoxylon scantiporosum* Ramanujam, 1960: 115, Pl. 20, Figs. 27-32 & Text-figs. 20-24. Mio-Pliocene (Cuddalore series), Tiruchhitambalam and Mortandra, South Arcot district, Madras, India.

Ailanthoxylon mahurzariense Shallom, 1961: 65, Pl. 1, Figs. 1-9. Eocene (Deccan Intertrappean series), Mahurzari, Nagpur district, Maharashtra, India.

Gondwanoxylon kathotiense Saksena, 1963: 31, Pl. 1, Figs. 8-12 & Text-fig. 1. Probably Deccan Intertrappean series, Kathotia, Rewa, Madhya Pradesh, India.

Ailanthoxylon pondicherriense Navale, 1964: 68, Pl. 1, Figs. 1-5 & Text-figs. 1-4. Mio-Pliocene (Cuddalore series), Usteri, near Pondicherry, South Arcot district, Madras, India.

2. *Ailanthoxylon ghiarense* (Saksena) comb. nov.

Gondwanoxylon ghiarense Saksena, 1963: 30, Pl. 1, Figs. 1-7. Probably Deccan Intertrappean series, Ghiar, Rewa, Madhya Pradesh, India.

Simarouboxylon Shallom, 1960

1. *Simarouboxylon indicum* Shallom: Shallom, 1960: 40, Pl. 1, Figs. 1-4 & Text-figs. 1A-B, Eocene (Deccan Intertrappean series), Mohgaonkalan, Chhindwara district, Madhya Pradesh, India.

Prakash, 1964: 144, Pl. 1, Figs. 1-8 & Text-figs. 1-7. Eocene (Deccan Intertrappean series), Mohgaon Kalan, Chhindwara district, Madhya Pradesh, India.

Synonym: *Simarouboxylon deccani* Prakash, 1960: 1034.

ACKNOWLEDGEMENTS

The authors are grateful to Professor S. D. Saksena, for kindly sending the type slides of the two species of *Gondwanoxylon* for further investigations. Thanks are also due to Dr. R. N. Lakhanpal for going through the manuscript.

REFERENCES

*BAIKOVSKAYA, T. N. (1950). Paleocene flora of Boureinsky Plain (In Russian). *Prob. Palaeont. Moskow.* **1**: 348-381.

BRANDIS, D. (1907). Indian trees. *London.*

CHALK, L. & RENDLE, B. J. (1929). British hardwoods, their structure and identification. *Bull. For. Prod. Res. Lond.*, **3**: 1-53.

CHOWDHURY, K. A. & GHOSH, S. S. (1964). Indian woods. **2**. *Delhi.*

CROOKSHANK, H. *et al.* (1937). The age of the Deccan Traps. General Discussion. *Proc.* 24*th Indian Sci. Congr. Hyderabad Deccan.*: 459-471.

GAMBLE, J. S. (1922). A manual of Indian timbers. *London.*

JAIN, R. K. (1959). On *Simarubaceoxylon* Shallom and its synonymy with *Simarubinium* Platen. *Curr. Sci.* **28**(12): 492.

KANEHIRA, R. (1921). Anatomical characters and identification of Formosan woods. *Taihoku.*

Idem (1924). Identification of Philippine woods by anatomical characters. *Taihoku.*

KRÄUSEL, R., MAITHY, P.K. & MAHESHWARI, H.K. (1962). Gymnospermous woods with primary structures from Gondwana rocks— a review. *Palaeobotanist.* **10**: 97-107, 1961.

KRUSE, H. O. (1954). Some Eocene dicotyledonous woods from Eden Valley, Wyoming. *Ohio J. Sci.* **54**(4): 243-268.

LANJOUW, J. *et al.* (1961). International Code of Botanical Nomenclature. *Utrecht.*

METCALFE, C. R. & CHALK, L. (1950). Anatomy of the Dicotyledons. **1**: *Oxford.*

MIKI, S. (1948). Floral remains in Kinki and adjacent districts since the Pliocene with description of 8 new species. *Miner. & Geol.* **9**: 105-144.

MOLL, J. W. & JANSSONIUS, H. H. (1908). Mikrographie des holzes der auf Java vorkommenden Baumarten. **2**: *Leiden.*

NAVALE, G. K. B. (1964). *Ailanthoxylon pondicherriense* sp. nov., from Tertiary beds of the Cuddalore Series near Pondicherry, India. *Palaeobotanist.* **12**(1): 68-72, 1963.

PEARSON, R. S. & BROWN, H. P. (1932). Commercial timbers of India. **1**: *Calcutta.*

PLATEN, P. (1907). Untersuchungen fossiler hölzer aus dem Westen der vereinigten Staaten von Nord-amerika. *Leipzig.*

PRAKASH, U. (1959). Studies in the Deccan Intertrappean Flora-4. Two silicified dicotyledonous woods from Madhya Pradesh. *Palaeobotanist.* **7**(1): 12-20, 1958.

Idem (1960). A survey of the Deccan Intertrappean Flora of India. *J. Palaeont.* **34**(5): 1027-1040.

Idem (1964). Further observations on *Simaroubaxylon indicum* Shallom. *Palaeobotanist.* **11**(3): 144-148, 1962.

RAMANUJAM, C. G. K. (1960). Silicified woods from the Tertiary rocks of South India. *Palaeontographica.* **106B**: 99-140.

REYES, L. J. (1938). Philippine woods. *Tech. Bull. Dep. Agric. Phil. Is.* **7**: 1-450.

SAHNI, B. (1940). The Deccan Traps: an episode of the Tertiary Era. *Proc. 27th Indian Sci. Congr. Madras.* 3-21.

SAKSENA, S. D. (1963). On two fossil dicotyledonous woods from South Rewa, Central India. *Palaeobotanist.* **11**(1-2): 30-37, 1962.

SHALLOM, L. J. (1959). *Simarubaceoxylon mahurzari* gen. et sp. nov.,— a new fossil wood from the Deccan Intertrappean beds of Mahurzari. *Curr. Sci.* **28** (4): 168-169.

Idem (1960). A new Simarubaceous fossil dicotyledonous wood from the Deccan Intertrappean beds of Chhindwara district. *Bull. bot. Soc. College Sci. Nagpur.* **1**(1): 37-42.

Idem (1961). *Ailanthoxylon mahurzarii* sp. nov., new fossil dicotyledonous wood from the Deccan Intertrappean beds of Mahurzari. *Palaeobotanist.* **8** (1-2): 65-68, 1959.

TANAI, T. & SUZUKI, N. (1963a). On the genus *Ailanthus* from the Tertiary of Japan. *Trans. proc. palaeont. Soc. Japan N.S.* **52**: 135-144.

Idem (1963b). Miocene floras of South-western Hokkaido, Japan. *Geol. Surv. Japan,* Special Volume (in press).

TROUP, R. S. (1921). The silviculture of Indian Trees. **1**: *Oxford.*

WEBBER, I. E. (1936). Systematic anatomy of the woods of the Simarubaceae. *Amer. J. Bot.* **23** (9): 577-587.

WILLIS, J. C. (1957). A dictionary of the flowering plants and ferns. *Cambridge.*

EXPLANATION OF PLATES

PLATE 1

Ailanthoxylon indicum Prakash, 1959
Syn. *Gondwanoxylon kathotiense* Saksena, 1963

(All photographs are from Saksena's type slides)

1. Cross-section of the fossil wood showing shape, size and distribution of vessels and the aliform-confluent parenchyma. Compare it with that of the modern wood, placed adjacent. × 35.

2. Cross-section of the modern wood of *Ailanthus malabarica.* × 35.

3. Tangential longitudinal section showing the form, size and distribution of the xylem rays. Note close resemblance of the rays with that of the modern wood, shown adjacent. × 45.

4. Tangential longitudinal section of the modern wood of *Ailanthus malabarica.* × 45.

PLATE 2

Ailanthoxylon indicum Prakash, 1959
Syn. *Gondwanoxylon kathotiense* Saksena, 1963

(All photographs are from Saksena's type slides)

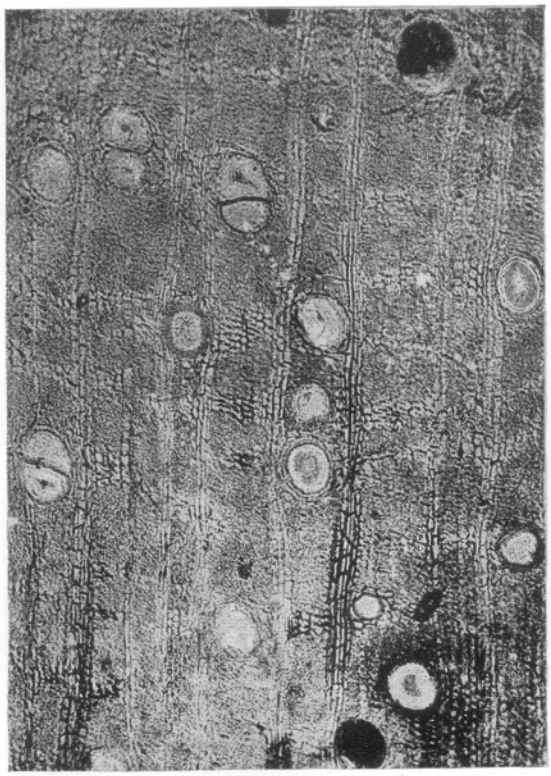
5. Tangential longitudinal section of the fossil magnified to show the nature of the xylem rays and the parenchyma strands. × 110.

6. Radial longitudinal section of the fossil wood showing the homogeneous ray tissue. × 110.

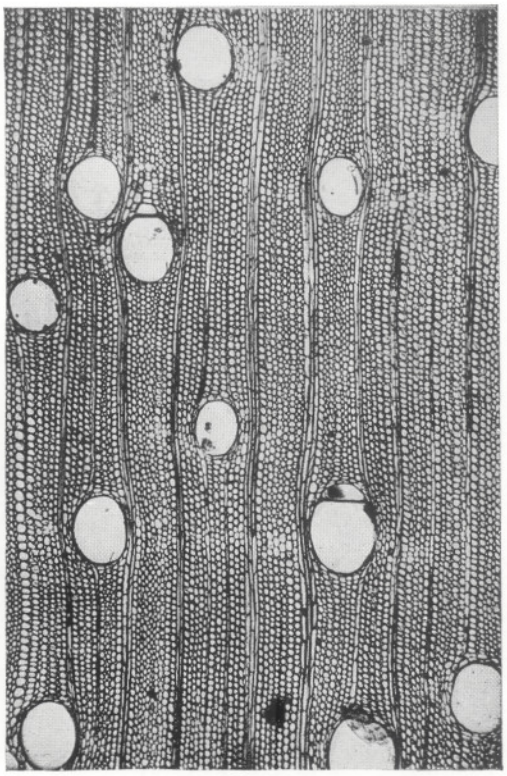
7. Vessel-parenchyma pits of the fossil wood. × 350.

8. Cross-section of the modern wood of *Ailanthus excelsa* to show the broad xylem rays and abundant aliform to confluent parenchyma. × 35.

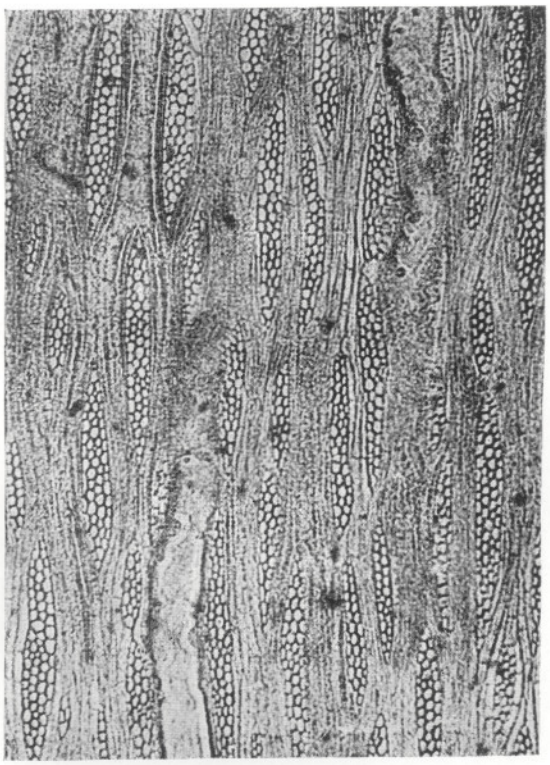
9. Tangential longitudinal section of the modern wood of *Ailanthus excelsa* showing shape, size and



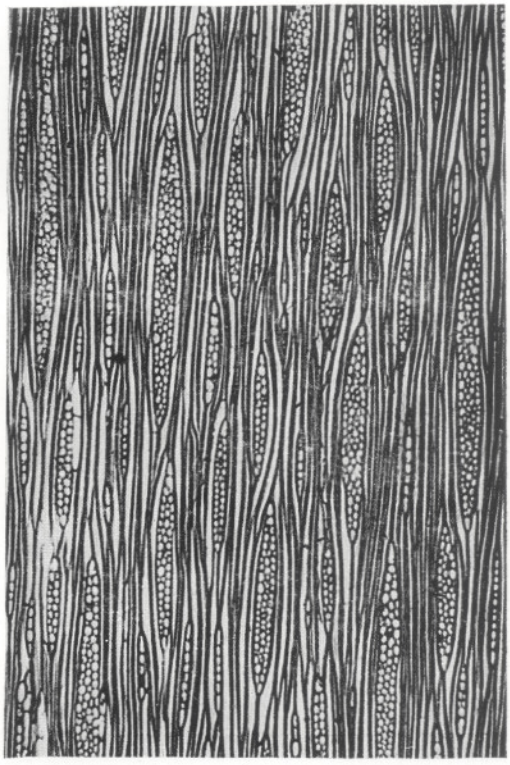
1



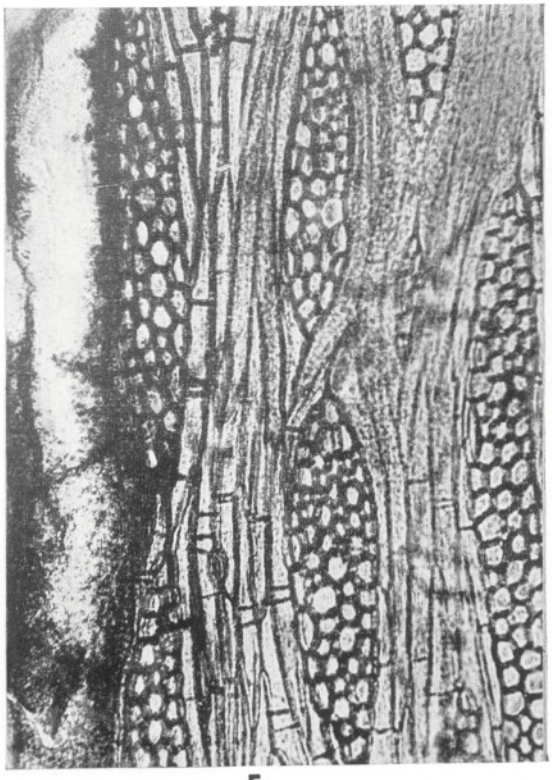
2



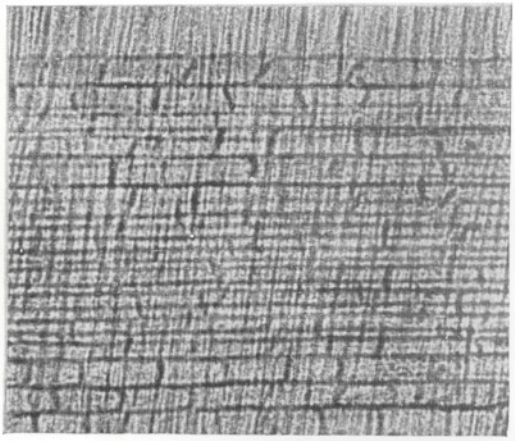
3



4

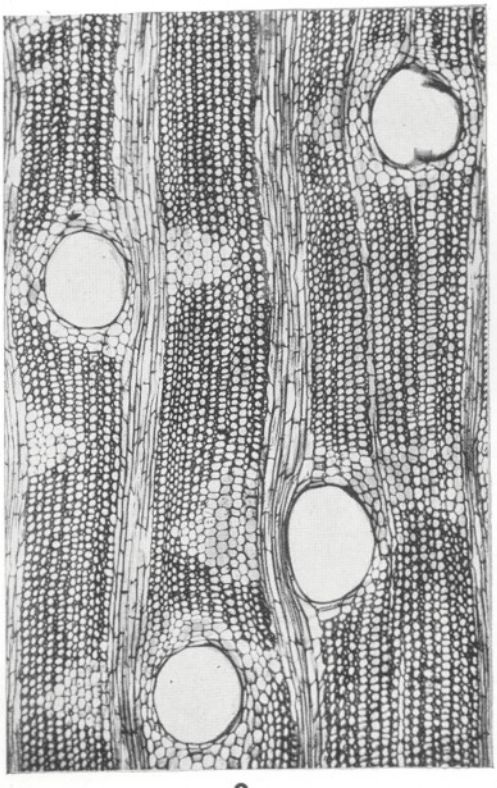


5

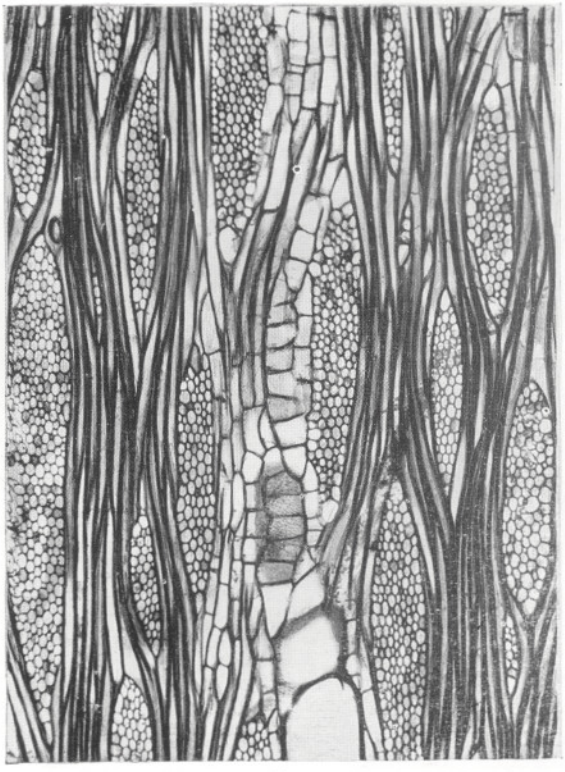


6

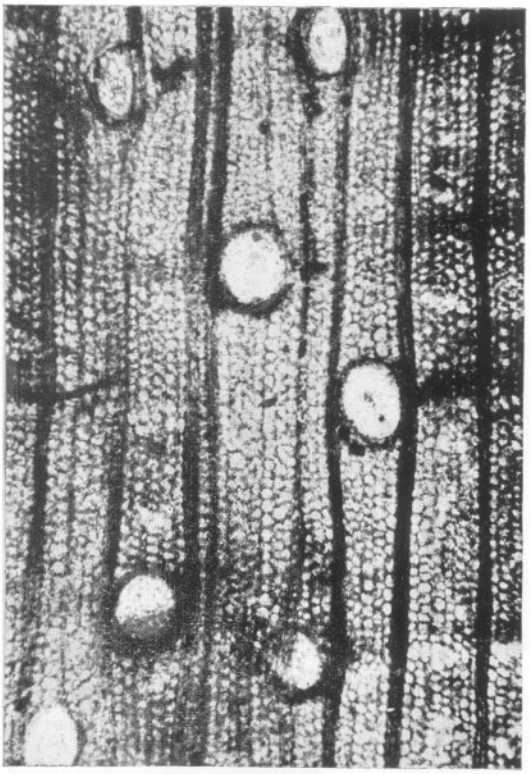
7



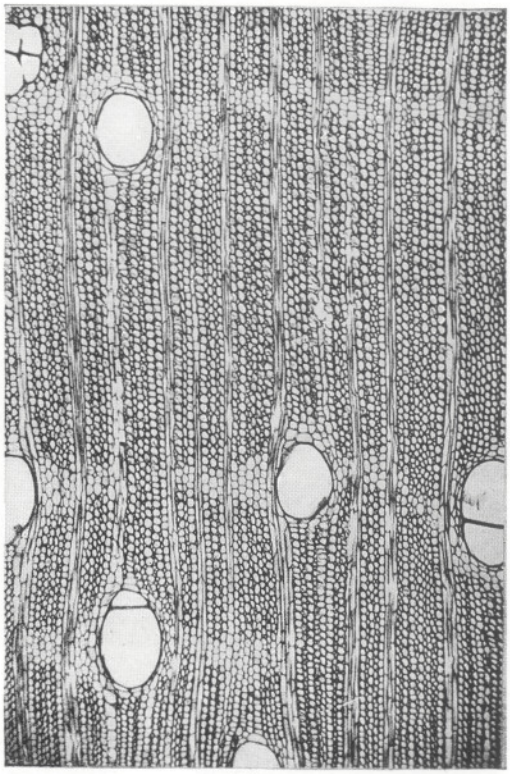
8



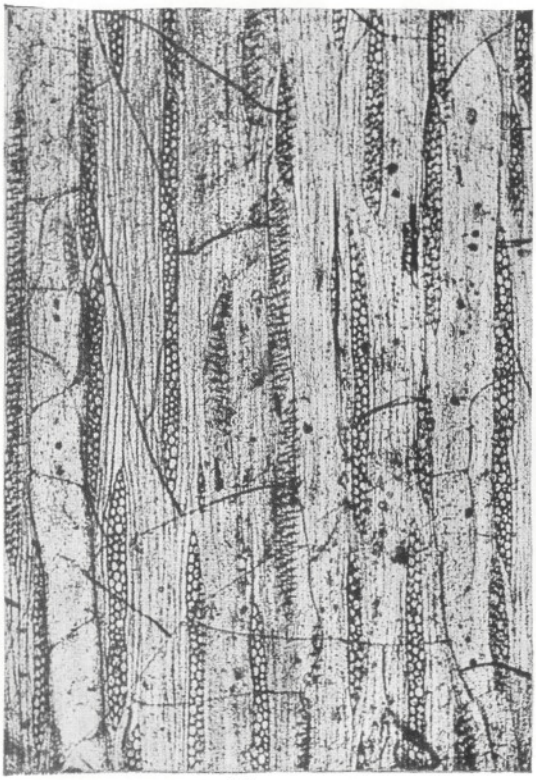
9



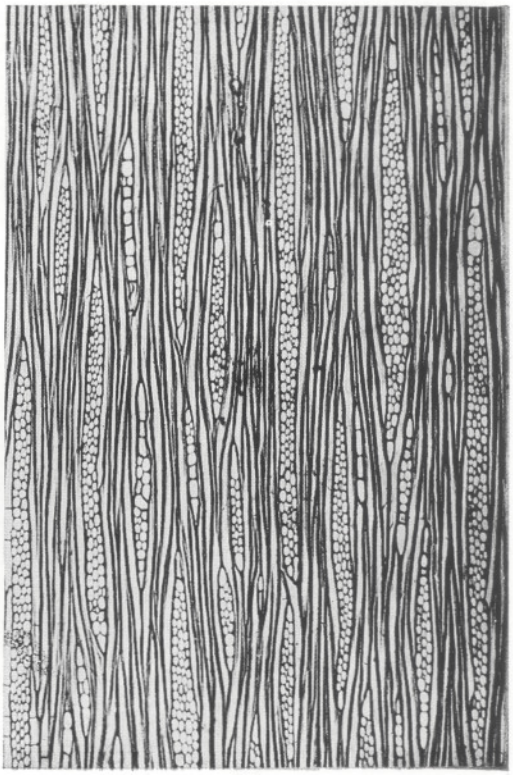
10



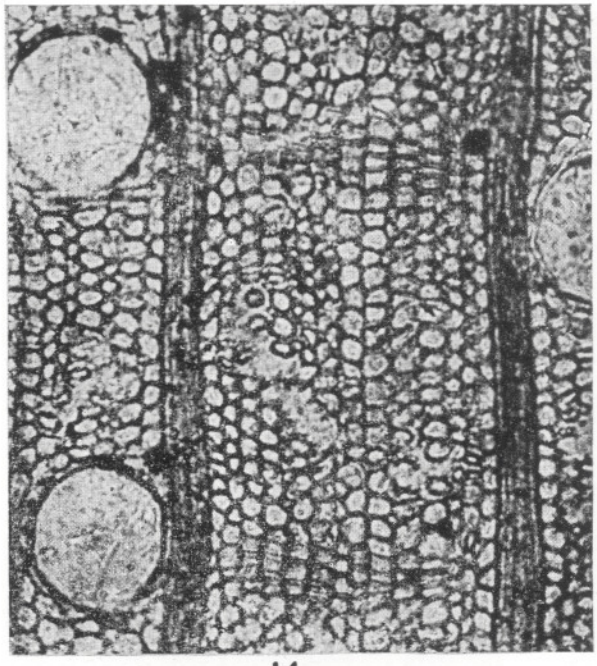
11



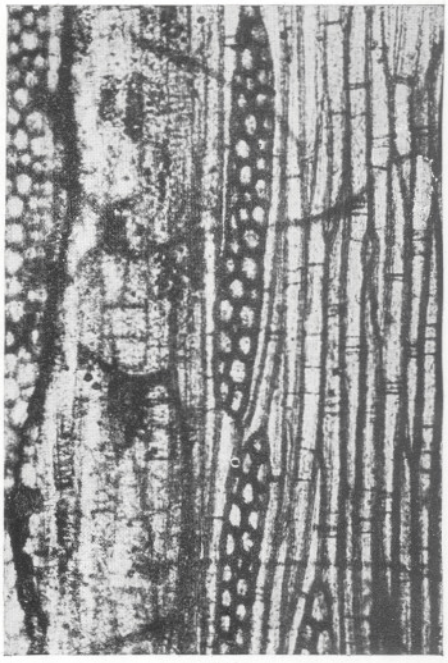
12



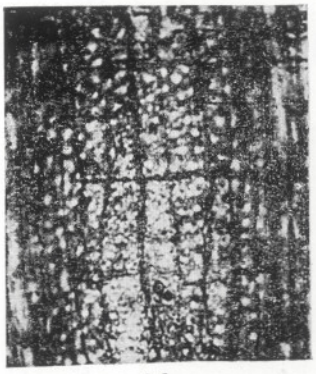
13



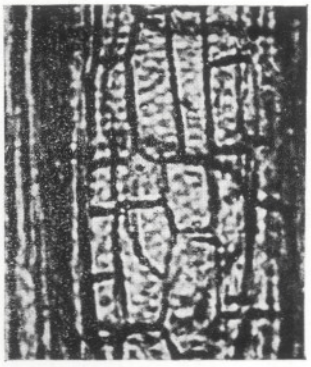
14



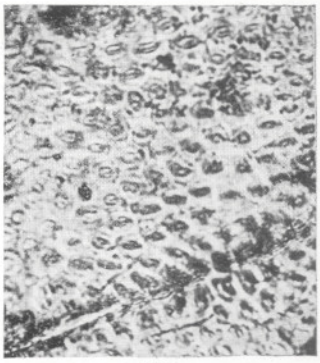
15



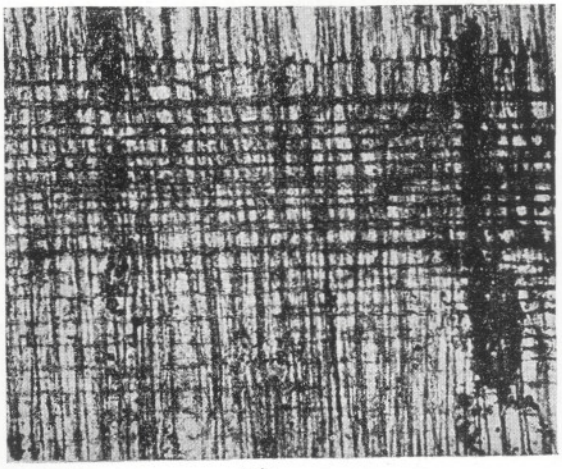
16



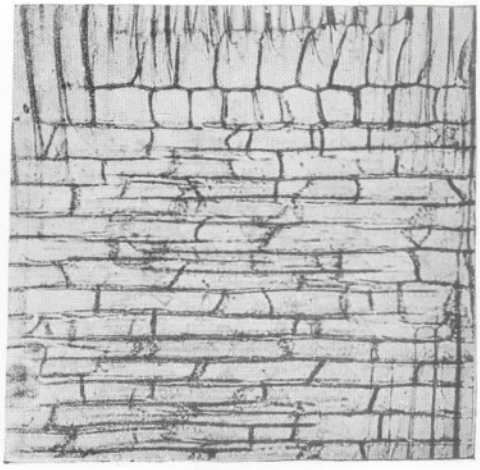
18



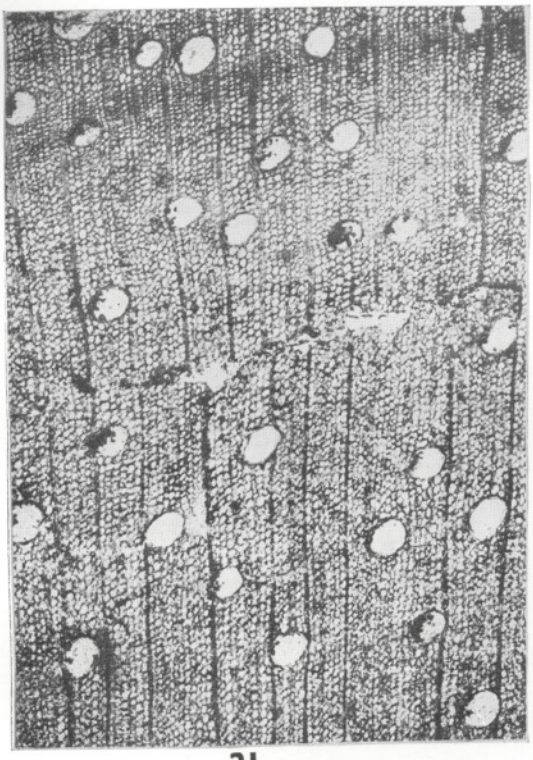
19



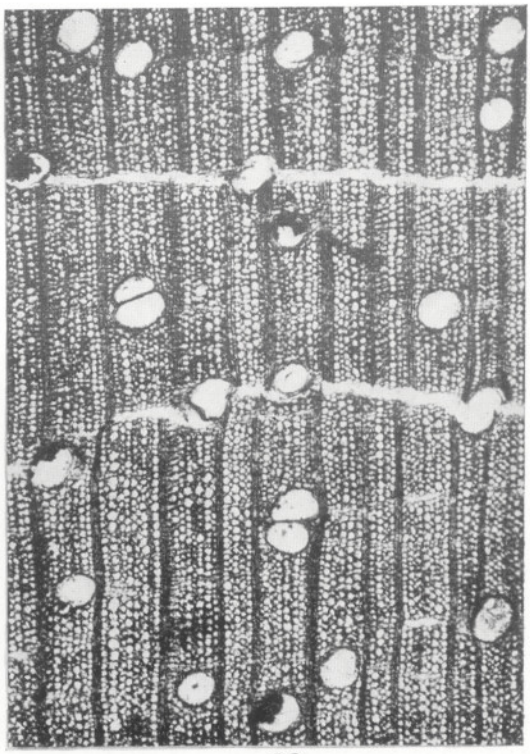
17



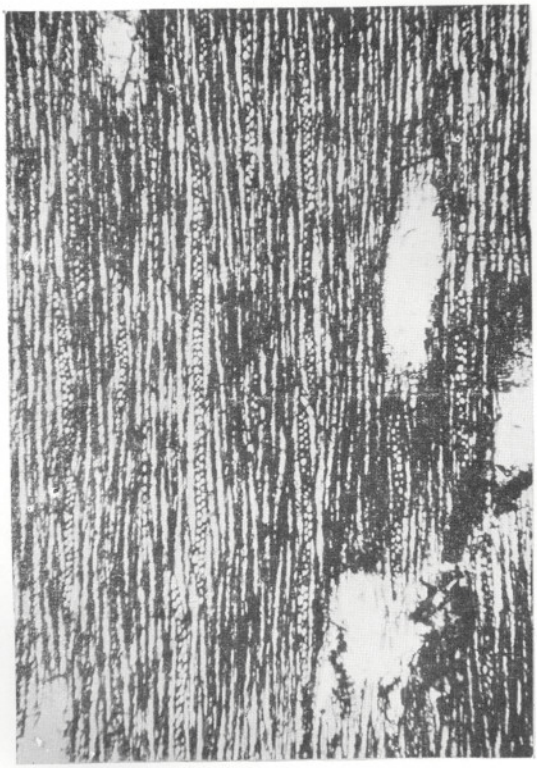
20



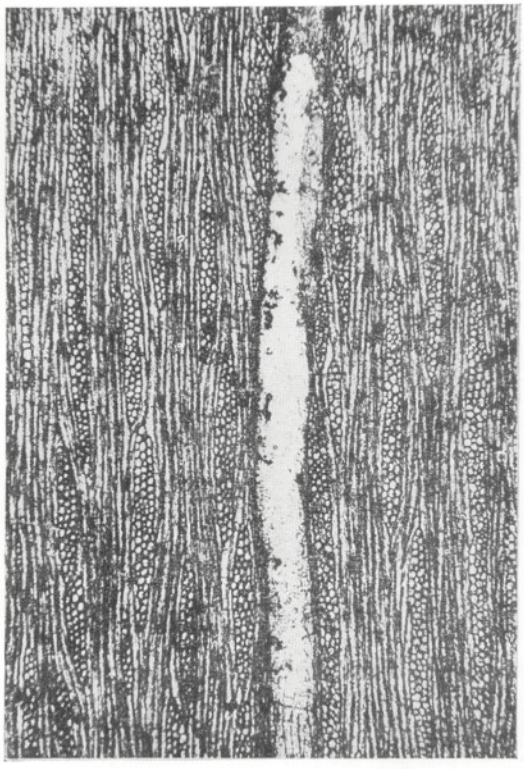
21



22



23



24

structure of the xylem rays and parenchyma strands. × 45.

PLATE 3

Ailanthoxylon ghiarense (Saksena) comb. nov.
1963, *Gondwanoxylon ghiarii* Saksena

(All photographs are from Saksena's type slides)

10. Cross-section of the fossil wood showing shape, size and distribution of vessels and the aliform-confluent parenchyma. Note similarity with the modern wood shown adjacent. × 35.
11. Cross-section of the modern wood of *Ailanthus grandis*. × 35.
12. Tangential longitudinal section of the fossil wood. Note distribution, shape and size of the xylem rays closely resembling those of the modern wood shown adjacent. × 45.
13. Tangential longitudinal section of the modern wood of *Ailanthus grandis*. × 45.

PLATE 4

Ailanthoxylon ghiarense (Saksena) comb. nov.
1963, *Gondwanoxylon ghiarii* Saksena

(All photographs are from Saksena's type slides)

14. Part of cross-section of the fossil wood magnified to show the alignment of the fibres and the aliform to confluent parenchyma. × 118.
15. Tangential longitudinal section of the fossil wood showing the xylem rays and the parenchyma strands. × 110.
16. Vessel-parenchyma pits of the fossil wood. Compare with those of *Ailanthus grandis* shown in fig. 18. × 220.
17. Radial longitudinal section showing heterogeneous ray tissue of the fossil wood. Note close resemblance to that of the modern wood shown in fig. 20. × 110.
18. Vessel-parenchyma pits of the modern wood of *Ailanthus grandis*. × 220.
19. Intervessel pit-pairs of fossil specimen No. 33074 cf. *Ailanthoxylon ghiarense* (Saksena) comb. nov. × 600.
20. Radial longitudinal section of the modern wood of *Ailanthus grandis*. × 110.

PLATE 5

Ailanthoxylon ghiarense (Saksena) comb. nov.
1963, *Gondwanoxylon ghiarii* Saksena
Wood specimen No. 33074 cf. *Ailanthoxylon ghiarense*

21. Cross-section of the fossil wood from region near the pith showing size and shape of vessels, sparse vasicentric parenchyma with narrow lateral extensions and the uniseriate to biseriate narrow rays. × 35.
22. Cross-section from the same piece of fossil wood from region away from the pith showing more abundant vasicentric parenchyma with broader aliform extensions and the wider xylem rays. × 35.
23. Tangential longitudinal section of the fossil wood from region near the pith showing 1-2 seriate and high xylem rays. × 45.
24. Tangential longitudinal section of the same fossil wood from the region away from pith showing 1-4 seriate and shorter rays. × 45.