NEW FOSSIL CONIFEROUS WOODS FROM THE RAJMAHAL HILLS, BIHAR, INDIA

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ABSTRACT

Three Jurassic conifer woods from the Rajmahal hills, Bihar, are described as *Circoporoxylon amarjolense* n. sp., *Dadoxylon agathioides* n. sp., and *Taxaceoxylon* n. gen. *Taxaceoxylon* sp. cf. *rajmahalense* (BHARDWAJ) Kräusel & Jain.

INTRODUCTION

ALTHOUGH fossil conifer woods occur in great abundance in the Rajmahal Hills, Bihar, yet so far, only four genera namely *Dadoxylon*, *Cupressinoxylon*, *Podocarpoxylon* (=*Mesembrioxylon* Seward) and *Taxoxylon* have been described from this area.

The present paper deals with three petrified woods belonging to three different genera; *Circoporoxylon*, *Taxaceoxylon* and *Dadoxylon*. The first two woods were collected by Dr. M. N. Bose at Amarjola, a village in the Pakaur district of the Rajmahal Hills, in May 1951 and the third wood by Dr. C. P. Varma and party at Mandro, a fossil locality in the Rajmahal Hills, in December 1954-55.

It is for the first time that a species of the genus *Circoporoxylon* Kräusel has been reported from India. The genus *Taxoxylon* Unger now described as *Taxaceoxylon* Kräusel & Jain was first described by Bhardwaj (1952) from the Jurassic of the Rajmahal Hills. *Dadoxylon* Endlicher was first reported from an unknown locality of this area by Sahni (1931) after which several species of the genus have been described.

DESCRIPTION

1. *Dadoxylon agathioides* n. sp.

Pl. 1, Figs. 1-6 & Pl. 3, Figs. 14, 15; Text-figs. 1-4

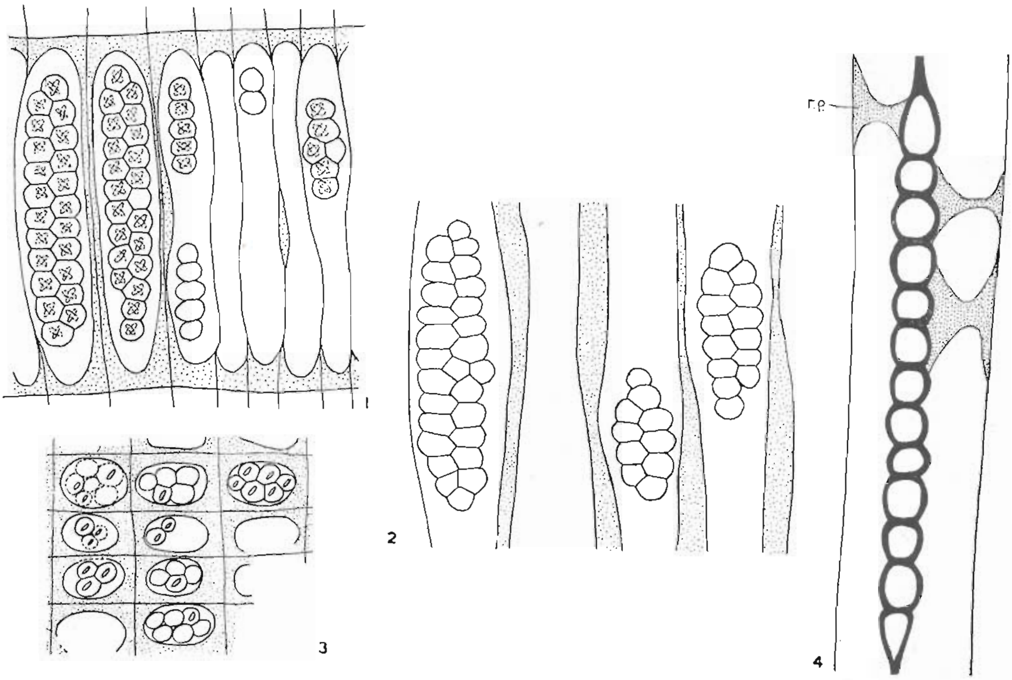
Decorticated secondary wood, measuring 7 cm. × 3 cm. in size.

Growth Rings — Present but more or less indistinct, elements compact, thick walled, angular with round lumen, 13-25 μ in diameter. Resinous tracheids abundant near the medullary rays, quite different from the normal tracheids in transverse view (PL. 1, FIG. 1). Wood parenchyma absent, rays numerous and simple.

Tracheids — Broad, radial diameter 31-48 μ, ends often sharply curved (PL. 1, FIG. 3), radial walls pitted, pits sometimes single, mostly one or two seriate, forming short rows or groups at the ends of the tracheids or separated by the vacant parts of the wall. The uniseriate pits, contiguous, always flattening each other, 13 × 10-23 × 13 μ in size. Pits in two seriate groups more or less hexagonal, alternate, contiguous, often zig-zag or irregularly arranged, groups sometimes triseriate in the middle (PL. 1, FIG. 4; TEXT-FIG. 2) terminating on both ends with a single rounded, in some cases rather large pit. The apertures look cross-like and resemble the crossing oblique pores of two opposite pits, as they occur in some species of *Agathis*. Greguss (1955, pp. 73, 74; PLS. 4, 10 & 11) describes and figures them of *Agathis australis*, *A. macrophylla* and *A. microstachya*. These crossing apertures belong to opposite walls and under the microscope appear in two different planes, but in our wood the whole structure seems to belong to only one wall (PL. 1, FIG. 6; TEXT-FIG. 1). At the ends, the crossing bars are more or less roundedly enlarged.

Resinous Tracheids — Profusely distributed mostly near the medullary rays, in size and pitting like normal tracheids, distinguished only by their resinous contents, the resin normally extending through the whole lumen in the form of biconcave plates (PL. 1, FIG. 2; TEXT-FIG. 4).

Cross-field Pits — 2-8, sometime in groups of 5-6, circular to angular, separate or conti-



TEXT-FIGS. 1-4 — *Dadoxylon agathioides* n. sp. 1, Part of radial section showing 1-2 seriate groups of pitting with cross apertures. × 250. 2, part of radial section showing groups of 2-3 seriate pits. × 250. 3, part of radial section through Medullary rays showing cross-field pits. × 250. 4, part of Tangential section showing simple medullary rays and resin plates (r.p.). × 250.

guous, 10 μ wide, bordered with elliptic aperture measuring 7×3 μ (PL. 3, FIGS. 14 & 15; TEXT-FIG. 3).

Medullary Rays—Simple, uniseriate, occasionally partly biseriate, 2-20 cells high (average 8 cells in 24 counts) (PL. 1, FIG. 5).

Comparison with living woods — The pitting is typically araucarioid as in the living Araucariaceae, but their typical arrangement in groups has never been figured. Greguss (1955, p. 132, PL. 12) mentions it for *Agathis moorei*; some of his drawings (*A. robusta*, PL. 15) show a similar distribution of the pits, at least when they are uniseriate. Similar groups have also been recognized in *Araucaria humboldtiensis* Buch. (GREGUSS, 1955, PL. 25). Resin tracheids also occur in both cases. The description and the figures of *Agathis australis* (PENHALLOW, 1907, pp. 54-55; TEXT-FIGS. 4, 5 & 6; JANE, 1956, FIGS. 47A & 156B) closely resemble the corresponding fossil features. But there is no safe distinction between *Araucaria* and *Agathis*. We only can say that the fossil shows anatomical relations to both of them, even if it seems to be more towards *Agathis*.

Comparison with fossil forms — There are not many fossil woods comparable to *Agathis*. The name *Agathoxylon* was first used by Hartig (1848, p. 188) for a wood from the German Keuper (*A. cordaianum*). He has not given any detail of his specimen. The arrangement of the tracheidal and ray pits agree with *Araucaria*, while the presence of 'Zellfasern' or xylem parenchyma is the only character which is absent or very rarely found in *Araucaria*. Perhaps these 'Zellfasern' are the resinous tracheids? Hartig has not given any figure or particular description which may be taken as its diagnosis. Evans (1934, p. 370; TEXT-FIGS. 57-66) attributes woods from New Zealand lignites to *Agathis*, later he named them *Agathoxylon australe* (1937, p. 190). There is no doubt that this Pliocene wood probably agrees with the living *Agathis australis*. It is the same with *Agathis resinifera* Patton (1958, p. 131, PL. 22, FIGS. 12-17; PL, 23, FIGS. 1-7) from Australia. This wood was identified as *Agathis* by the nature of the bark and shows true resin tracheids. The arrangement of its pits is different from our fossil. Neither description nor figures were given for *Dammara fossiles* Unger (1865, p. 12). Ettingshausen described a cone, scales and leaves as *Dammara oweni* (1887, p. 155, PL. 1, FIGS. 22-24; PL. 2, FIG. 3) and united with it a silicified wood (PL. 6, FIGS. 13-15) but it is impossible to decide whether it comes from *Agathis* or *Araucaria*. *Agathoxylon hungaricum* (ANDREANSKY) Greguss at last (1952, p. 156, PL. 9, FIGS. 1-9; PL. 10, FIGS. 10-12) (=*Simplicioxylon hungaricum* Andreansky, 1949, p. 1, FIGS. 1-6) a wood from the Lower Cretaceous of Hungary is of doubtful affinity (a *Podocarpoxylon*?).

Perhaps one could also mention *Woodworthia arizonica* Jeffrey (DAUGHERTY & STAGNER, 1941, p. 90, PL. 32, FIGS. 1-4), in which the pits of the tracheids form biseriate clusters at the ends of the tracheids, but it seems that the uniseriate pits cover the whole length of the tracheid (Not to speak of doubtful structures as "Abietineous" leaf traces). *Mesembrioxylon bedfordense* (STOPES) Seward (1919, p. 207, FIG. 721) (=*Podocarpoxylon bedfordense* Stopes; 1915, p. 223, PL. 21, TEXT-FIG. 64) too possesses small, uniseriate groups of pits but differs from our wood by the cross-field pitting. *Araucarioxylon huzinamiense* Ogura and *A. mineense* Ogura from the Japanese Triassic show tyloses in the tracheids which at first sight resemble resin plates (Ogura, 1960, p. 501-509) but their walls never have the biconcave shape of the resin plates. Similar tyloses are known from *Xenoxylon latiporosum* (OGURA, 1960; WATARI, 1960).

As far as we can see the Rajmahal wood belongs to the family Araucariaceae and, perhaps, is related to *Agathis* and therefore it seems best to bring it to *Dadoxylon* Endlicher. So far as we know none of the many *Dadoxylon* species show nearer relations to our wood, and therefore we describe it as a new species, *Dadoxylon agathioides*.

Diagnosis — Growth rings present but indistinct, pits only on the radial walls, arranged in groups over short distances, one to several, alternate, contiguous, hexagonal, with cross-shaped aperture. Resinous tracheids abundant, no xylem parenchyma. Medullary rays simple, uniseriate, 2-20 cells high. Cross-field pits 2-8 per field, more or less round, with elliptical aperture.

Type Specimen No. — 24288/255, B.S.I.P. Museum.

Locality — Mandro, Rajmahal Hills, Bihar, India.

Horizon — Rajmahal Stage (Jurassic), Upper Gondwana.

2. *Circoporoxylon amarjolense* n. sp.

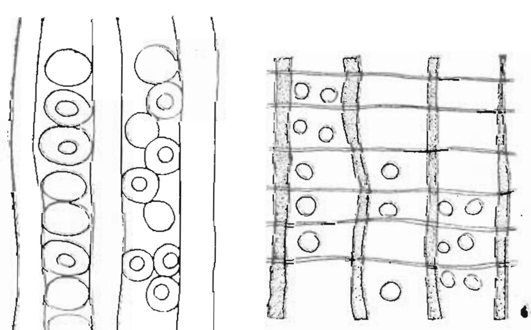
PL. 2, FIGS. 7-9 & PL. 3, FIG. 16; TEXT-FIGS. 5 & 6

Decorticated secondary wood measuring 5 × 1·5 cm. in size.

Growth Rings — Distinct, variable in size, 10-40 tracheids wide with a gradual transition from early to late wood (PL. 2, FIG. 9). Resinous parenchyma absent.

Tracheids — In the spring wood wide, thin walled, mostly rectangular to squarish, radially longer than broad, 30 × 20 μ in size; in the late wood tangentially flattened, compressed, thick walled with circular or oval lumen, 13-20 μ in diameter. Radial walls pitted, pits uni- or biseriate, bordered, usually well preserved, separated from each other or occasionally slightly contiguous, circular, 13 μ wide or where oval, 16 × 13 μ in size. Pore circular or oval, 7 μ in diameter or 7 × 10 μ in size (PL. 2, FIG. 8; TEXT-FIG. 5), where in double rows, mostly opposite, occasionally subopposite and alternate. Rims of Sanio absent. Tangential walls not pitted. In most of the tracheids highly inclined or horizontally irregularly distributed spiral markings are seen and they are the etching marks or striations, so often mistaken for genuine spiral thickenings.

Medullary Rays — Simple, very near to each other, sometimes only one tracheid apart, uniseriate, very rarely partly biseriate,



5 6

TEXT-FIGS. 5-6 — *Circoporoxylon amarjolense* n. sp. 5, part of two tracheids in radial section showing 1-2 seriate, opposite and alternate bordered pits. × 550. 6, part of radial section through medullary rays showing circular simple cross-field pits. × 425.

1-15 cells high (in an average of 32 counts 5-6 cells high), cells radially longer than broad (PL. 3, FIG. 16).

Cross-field Pits — Simple, (" Eiporen ") and circular, 5-7 μ in diameter, solitary or in pairs (PL. 2, FIG. 7; TEXT-FIG. 6).

Comparison with living conifers — The wood is characterized by its cross-field pitting. We find large simple pits in the cross-field of *Sciadopitys*, species of *Pinus*, some species of *Podocarpus*, *Microcachrys*, *Dacrydium*, *Pherosphaera*, and especially *Phyllocladus* (SEWARD, 1919, p. 204; GOTHAN, 1905, p. 14; 1910, p. 37), but in all these cases, the pores are never circular (KRÄUSEL, 1949, p. 97). Only the monotypic podocarpaceous *Acmopyle pancheri* Pilger described from new Caledonia is said to possess large, circular, simple to slightly bordered cross-field pits, 1 per field, in the marginal cells, commonly 2 (PHILLIPS, 1941, p. 282; see KRÄUSEL, 1949) and if this is true, *Acmopyle pancheri* Pilger would be the only living conifer of this type.

Comparison with fossil forms — Kräusel (1949, p. 156) established the genus *Circoporoxylon* to include fossil wood with circular, simple cross-field pores. The original diagnosis of the genus stands as, " Gebaut wie *Phyllocladoxylon* oder *Podocarpoxylon*, die Eiporen des Krf. jedoch kreisförmig oder höchstens queroval, doch nie schräg-elliptisch " (KRÄUSEL, *l.c.*). Normally the tracheids of *Circoporoxylon* and of many living Podocarpaceae possess separate, opposite, circular radial pits and it is well known that in some species we also find alternate, flattened pits (SEWARD, 1919, p. 204). The present wood agrees with this diagnosis and therefore has been referred to *Circoporoxylon* Kräusel. Of the hitherto known species of *Circoporoxylon* (TABLE I) from the Mesozoic and Tertiary beds, only a few are comparable to our wood. In *C. shanense* (SAHNI) Kräusel and *C. woburnense* (STOPES) Kräusel, xylem parenchyma is absent, while *C. sewardi* (SAHNI) Kräusel and *C. McGeei* (Knowlton) Kräusel have distinct growth rings. *C. shanense* and *C. sewardi* differ from our wood in having 1-2 cells high medullary rays and one single large, simple pore in the cross-field. From *C. McGeei* it is differentiated due to the presence of high medullary rays and xylem parenchyma. The Cretaceous species *C. hortii* (STOPES) Kräusel differs in having multiseriate medullary rays.

C. priscum (PRILL) Kräusel comes nearer to our specimen due to the similar radial pits and medullary ray pitting but it differs mainly due to the presence of xylem parenchyma. ?*Circoporoxylon* sp. Grabowska (1957, p. 276, PL. 31, FIG. 4) could belong to this species. But the wood is badly preserved and there is no proof that the pits of the cross-field really are round and simple. Perhaps *Cupressinoxylon koettlitzi* (SEWARD, 1919, p. 195) from Franz Josef Archepelago (of doubtful age), ought to be compared. After Seward's description it possesses distinct growth rings and 2-4 circular, (simple ?) pores in the cross-field, but after his figure (718 E, p. 196) it is impossible to decide whether the pits are really round and simple or just badly preserved bordered pits of originally Taxodiacean or Cupressacean type. Eckhold (1921, p. 490) also thinks it to be a *Protocupressinoxylon*.

As the comparison has shown, our specimen is different from all the species of *Circoporoxylon* known up till now and therefore it is a new species and we name it after its locality Amarjola as *Circoporoxylon amarjolense* n. sp.

Diagnosis — Growth rings distinct, radial pits of the tracheids uni- and biseriate, circular, separate, opposite or sometimes alternate, medullary rays uniseriate, simple, 1-15 cells high, cross-field pores one or two, small, circular, and simple (" Eiporen ").

Type Specimen No. — 31835/52, B.S.I.P. Museum.

Locality — Amarjola, Amrapara, Dist. Pakaur, Rajmahal Hills, Bihar, India.

Horizon — Rajmahal Stage (Jurassic), Upper Gondwana.

N.B. — When Kräusel described *Circoporoxylon* (KRÄUSEL, 1949, p. 156) he did not fix the type species. It will be *Circoporoxylon priscum* (PRILL) Kräusel (1949, p. 116) (=*Podocarpoxylon priscum* Prill, in Kräusel, 1919a, p. 257, PL. 18, FIG. 7; TEXT-FIGS. 35-39) described from the Miocene of Silesia, Germany.

3. *Taxaceoxylon* n. gen.

Taxaceoxylon sp. cf. *rajmahalense* (BHARDWAJ) Kräusel & Jain

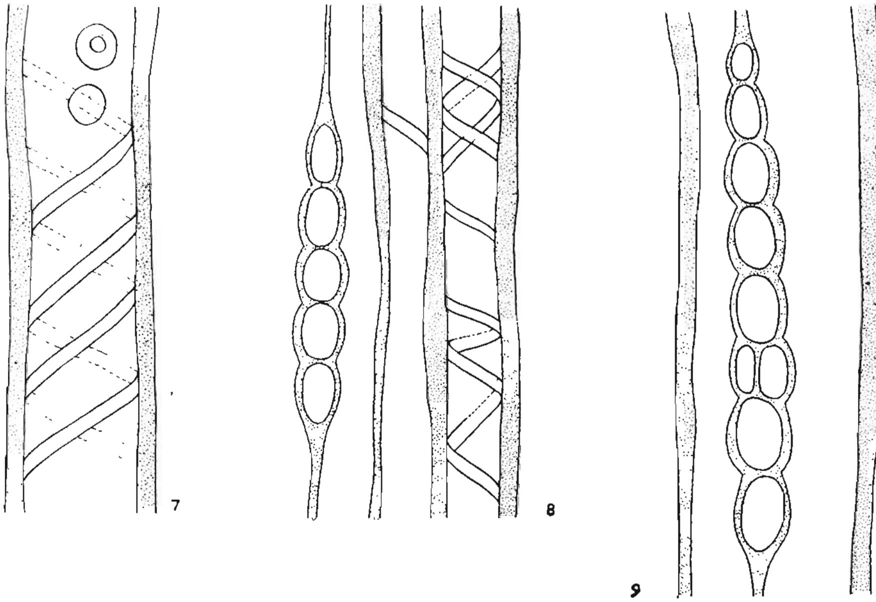
Pl. 2, Figs. 10 & 11 and Pl. 3, Figs. 12 & 13; Text-figs. 7-9

A piece of secondary wood, 6 cm long and 2 cm broad.

TABLE 1

NAME OF SPECIES	GENERAL GROWTH RINGS DISTINCT OR INDISTICT	TRACHEIDS: Pits uniseriate or multiseriate	TRACHEIDS: Pits separate or contiguous	TRACHEIDS: Pits alternate or opposite	TRACHEIDS: Tangential pits present or absent	BARS OF SANIO PRESENT OR ABSENT	WOOD PARENCHYMA PRESENT OR ABSENT	MEDULLARY RAYS: Uniseriate or biseriate	MEDULLARY RAYS: Average height in cells	MEDULLARY RAYS: Horizontal walls pitted or unpitted	CROSS-FIELD PITS: Circular or elliptical	CROSS-FIELD PITS: Bordered or simple	CROSS-FIELD PITS: Average number
Circoporoxylon amarjolense n. sp.	+	±	±	±	—	—	—	+	1-15	—	+	—	1-4
C. shanense (Sahni) Kräusel	—	+	+	...	—	—	—	+	1-2	—	+	—	1 large
C. sewardi (Sahni) Kräusel	+	+	+	...	—	+	+	+	1-4	—	+	—	1 large
C. hortii (Stopes) Kräusel	—	+	+	...	—	—	—	±	1-80	—	+	—	1-2 large
C. McGeei (Knowlton) Kräusel	+	±	+	—	+	—	+	+	1-49	—	+	—	1-2
C. goepperti (Conwentz) Kräusel	+	+	—	...	—	—	—	+	1-25	—	+	...	1
C. woburnense (Stopes) Kräusel	—	±	—	—	—	+	—	+	1-25	—	+	—	1-2
C. glyptostrobinum (Schmalhausen) Kräusel	—	±	+	—	—	—	+	—	—	+	+	—	1-2 large
Circoporoxylon priscum (Prill) Kräusel	—	±	±	—	—	+	+	+	1-2	—	+	—	1-4

(+) primary character; (—) alternative character; (±) mixed occurrence.



TEXT-FIGS. 7-9 — *Taxaceoxylon* sp. cf. *rajmahalense* (BHARDWAJ) Kräusel & Jain. 7, a tracheid in radial view showing spiral thickening and circular bordered pits. × 425. 8, tangential section showing spiral bands on the walls of tracheids and simple medullary rays. × 425. 9, tangential section showing single partly biseriate medullary rays. × 425.

Growth Rings — Distinct with gradual transition from early to late wood. Rings 20-40 tracheids wide. Early wood tracheids wide, 17-30 μ × 10 μ in size; radially longer than tangentially broad. Late wood elements compressed tangentially with an almost circular lumen 10 μ in diameter (PL. 2, FIG. 10). Xylem parenchyma and resin canals absent.

Tracheids — 13-30 μ wide, walls 7-10 μ thick, only the radial walls pitted, pits bordered, uniseriate, circular, 10 μ in diameter, usually not occupying the whole tracheid wall, pores circular, 6 μ wide (TEXT-FIG. 7). Rims of sanio absent. Spiral thickening visible both on the radial and tangential walls, some times single but mostly double, the spirals then running parallel, both in the same direction or clock and anti-clockwise, distance 10-30 μ, inclination against the wall of the tracheid 40-70° (PL. 3, FIGS. 12-13; TEXT-FIGS. 7, 8).

Medullary Rays — Simple, uniseriate, rarely partly biseriate (PL. 2, FIG. 11; TEXT-FIG. 9) 1-22 cells high (on average of 32 counts 5-6 cells) ray cells parenchymatous with smooth horizontal tangential walls. Cross-field pits not preserved.

Comparison with living conifers — Spiral thickenings occur in the *Taxales* and in *Pseudotsuga*, *Picea*, and *Larix*, but these members of *Pinaceae* can be eliminated, as our wood shows neither resin ducts nor abietineous pitting. It is easy to distinguish a taxacean wood from other coniferous woods, but it seems to be impossible to separate their genera (KRÄUSEL, 1949, p. 97). Even the elaborate descriptions of Greguss (1955, pp. 147-151) do not help very much because they show that the number of spirals in a tracheid is, if at all, only of very little diagnostic value.

Torreya and *Cephalotaxus* differ from the fossil as their horizontal ray walls are pitted. Perhaps the monotypic *Nothotaxus chienei* (CHANG) Florin (1948a, pp. 387-389) comes nearest to our fossil. Its description of Greguss (1955) are contradictory. On p. 86, we read " spiral thickenings closely spaced at intervals of 6-8 μ, oriented almost horizontally or slightly slanting " while on p. 151 " those at right or oblique angles to the vertical walls follow each other at distances of 2-3 μ while single ones are 8-10 μ apart ". Greguss could examine only a young twig and his figures (PL. 78) show nearly horizontal spirals while others are strongly inclined.

Comparison with fossil woods—The main features of our fossil are: (1) distinct growth rings, (2) tracheids with uniseriate, separate, circular radial pits with small, circular apertures, (3) distinct spiral thickenings mostly in double parallel running pairs, inclined up to 70°, (4) simple, uniseriate or partly biseriate medullary rays with smooth horizontal walls, (5) lack of resin canals or resinous parenchyma.

Woods with spirally thickened tracheids are as old as the Permo-Carboniferous. *Taxopitys* was first described by Kräusel (1928, pp. 46-47) from the Permian of S.W. Africa and is said to be also a member of the Lower Carboniferous flora of Siberia (SHILKINA, 1960, pp. 123-126) while *Prototaxoxylon* Kräusel & Dolianiti and *Parataxopitys* Maniero (KRÄUSEL & DOLIANITI, 1958) come from the Brazilian Permian. As they possess centripetal wood, they are no coniferous at all. The wood of *Brachyphyllum spiroxylum* Bose (1952) from the Indian Jurassic and *Prototaxoxylon intertrappeum* Prakash & Srivastava (1961) (=*Spiroxylon intertrappeum* Prakash & Srivastava, 1959, pp. 446-448) show araucarioid pitting of the tracheids.

As far as we know all the other comparable woods with spiral thickenings are much younger, mostly Tertiary. *Taxites scalariformis* from the Tertiary of Hungery described by Göppert (1841, p. 727) was renamed *Taxoxylum Goepperti* by Unger (1847, p.33) [=*Taxoxylon scalariforme* (GÖPPERT) Seward in Seward 1919, p. 202]. The diagnosis of *Taxoxylon* was elaborated by Kraus (1870) who specifies, " the presence of thick walled tracheids with spiral thickenings, uniseriate pitting, simple medullary rays and the absence of resin cells or ducts ". Many other woods described as *Taxoxylon* (or *Taxites*), mostly from the Tertiary brown coal of Europe, show only spiral striations and no true spiral thickenings (KRÄUSEL, 1919, pp. 242, 244; 1949, pp. 146, 148). The type of Unger's *Taxoxylon* undoubtedly has to be the first described species *T. scalariforme*. It was reinvestigated by Kräusel (1919a, p. 217) and he found true spiral thickenings in the tracheids but they resemble those in some abietineous woods especially *Pseudotsuga*. The new slides now in the Palaeobotanical collection of the Senckenberg Museum at Frankfurt a.M. show two kinds of rays, simple ones and large ones, the interior tissue of the latter is mostly destroyed, but it is highly probable that they contained horizontal resin ducts and *Taxoxylon scalariforme* (=*Taxites scalariformis*) is an abietineous wood. The name *Taxoxylon* therefore, becomes invalid, for the woods without resin ducts.

Kräusel (1949, p. 149) has shown that only a few woods described as *Taxoxylon* really belong to the Taxaceae. As far as we find, *Taxoxylon torreyanum* Shimakura (1936), *Taxoxylon antiquum* (BOESHORE & GRAY) Kräusel (1949, p. 148) and *Taxoxylon rajmahalense* Bhardwaj (1952) are the only representatives. As the name *Taxoxylon* Unger is invalid for taxacean woods, we replace it by *Taxaceoxylon*. The form genus *Taxaceoxylon* n. gen. comprises fossil woods agreeing with the living Taxaceae in possessing simple rays, tracheids with spiral thickenings, their pits mostly round, uniseriate or biseriate opposite. The type species is *Taxaceoxylon torreyanum* (SHIMAKURA) n. comb. compared by the author (1936, p. 297) with *Torreya*, the same as *Torreya antiqua* Boeshore and Gray (1936, p. 524) [= *Taxoxylon antiquum* (BOESHORE & GRAY) Kräusel, 1949, p. 148]. From both these species our wood is distinguished not only by higher rays (a feature of utterly doubtful value) but also by the arrangement of the spiral thickenings and the lack of tangential pitting. Only *Taxaceoxylon rajmahalense* (BHARDWAJ) n. comb. (= *Taxoxylon rajmahalense* Bhardwaj, 1952) agrees with our wood in most of the features. It is not only of the same age but shows growth rings, uniseriate round, separate radial pits of the tracheids, and lacks xylem parenchyma. It is true, that the rays are lower and the distance between the bands of the spirals are much smaller, but we think that the first named feature is of no importance and the second one of little diagnostic value. Thus we think it highly probable that both woods come from the same Taxacean species. Unfortunately the cross-field of our wood are not preserved. There remains some doubts, and we prefer to call our fossil, *Taxaceoxylon* sp. cf. *rajmahalense* (BHARDWAJ) kräusel and Jain.

DISCUSSION

Our wood from the Rajmahal Hills agrees with the Taxaceae of to-day which are now essentially a northern family. The oldest Taxads are the monotypic *Palaeotaxus rediviva* Nathorst (1908) of the Upper Triassic of South Sweden, and *Taxus jurassica* Florin from the Jurassic of Yorkshire, England (FLORIN, 1944, p. 575). From the Jurassic of India, Seward & Sahni (1920, p. 35) described a *Torreya* like plant *Torreyites constricta* (FEISTM.) Sew .& Sahni, from the middle Jurassic of India (Vemavarum on the East Coast) and their ? *Torreyites* sp. from the same locality is highly doubtful. Ganju (1947, p. 75) reported another species of *Torreyites*, *T. sitholeyi* and a *taxus*-like leaf, *Taxites lanceolata* from the Rajmahal Hills, Bihar. Bhardwaj's *Taxoxylon rajmahalense* (1952, pp. 234-240) also comes from Bihar. It has been compared with the living *Nothotaxus*.

In view of these southern and northern records of Taxaceae, we are now in a position to support the view of Florin (1940a, p. 76) that in the Mesozoic, the Taxaceae were after all not strictly confined to the northern hemisphere and thus, we think that Florin (1940a, p. 84) was right in not agreeing with the opinion of Studt (1926, p. 209) " that all the conifers originated in the northern temperate zone, from whence they spread both northward to the Artic region and southward to southern lands, including Antarctica ".

Type Specimen No.— 31834/52, B.S.I.P. Museum.

Locality — Amarjola, Amrapara, Dist. Pakaur, Raj mahal hills, Bihar, India.

Horizon — Rajmahal Stage (Jurassic) Upper Gondwana.

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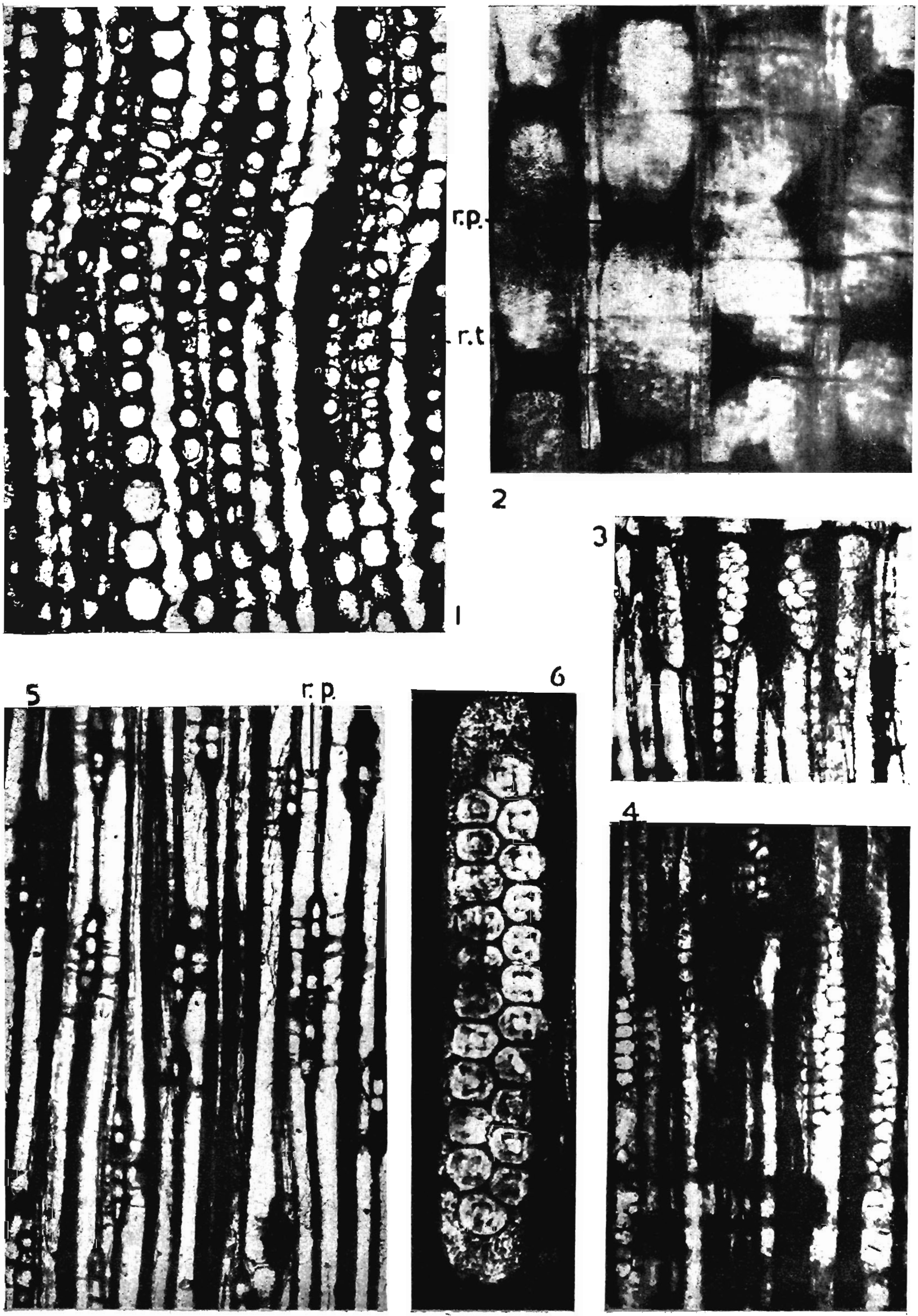
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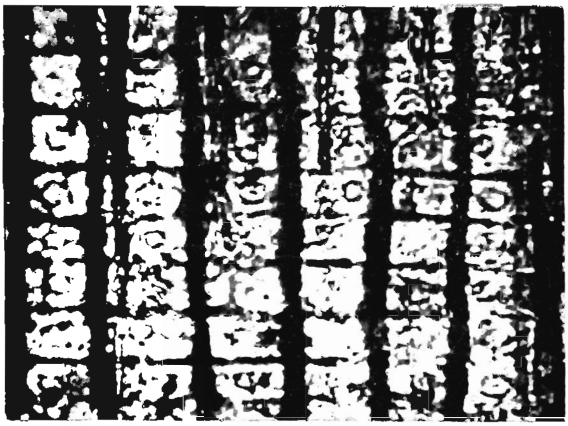

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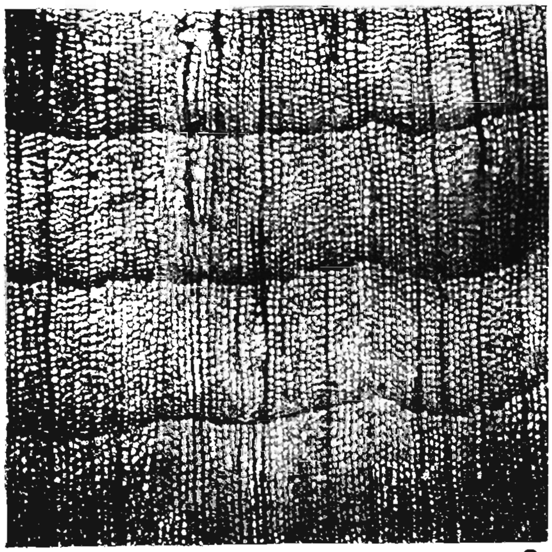

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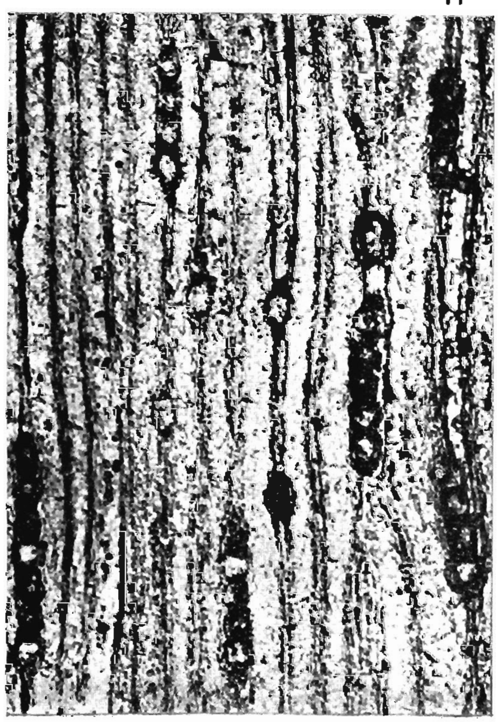

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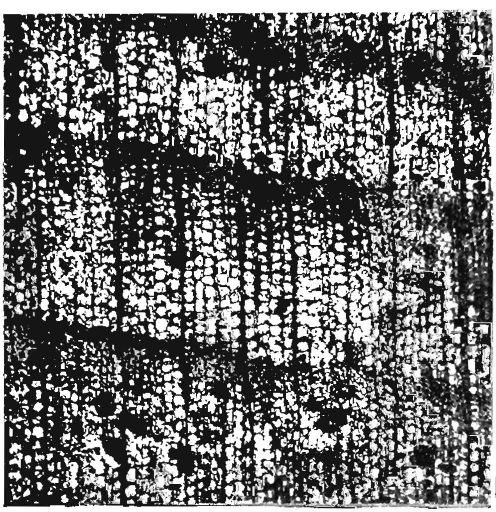

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EXPLANATION OF PLATES

PLATE 1

Dadoxylon agathioides n. sp.

1. Part of a cross section showing resinous tracheid (r.t.) near the medullary rays. Note the small, thick walled elements. × 120.
2. Radial section showing biconcave resin plates (r.p.). × 450.
3. Radial section showing groups of pits and curved ends of the tracheids. × 200.
4. Radial section showing scattered groups of pits. × 200.
5. Tangential section showing simple medullary rays with resin plates (r.p.). × 120.
6. A tracheid in radial view showing pits with cross apertures. × 500.

PLATE 2

Circoporoxylon amarjolense n. sp.

7. Part of radial section through medullary rays showing structure of cross-field pits. × 400.
8. Radial section showing arrangement of bordered pits. × 450.
9. Cross section showing distinct growth rings. × 100.

Taxaceoxylon sp. cf. *rajmahalense* (BHARDWAJ) Kräusel & Jain

10. Cross section showing distinct growth rings. × 35.
11. Tangential section showing simple medullary rays. × 200.

PLATE 3

Taxaceoxylon sp. cf. *rajmahalense* (BHARDWAJ) Kräusel & Jain

12. Tangential section showing spiral thickenings. × 400.
13. Radial section showing spiral thickenings and circular bordered pits. × 380.

Dadoxylon agathioides n. sp.

14 & 15. Parts of radial section through medullary rays showing structure of cross-field pits. × 500 & × 550.

Circoporoxylon amarjolense n. sp.

16. Tangential section showing simple medullary rays. × 100.