The Palaeobotanist, **27**(2): 174-181, 1981.

A NEW FOSSIL PALM FROM KONDHALI, DISTRICT NAGPUR, MAHARASHTRA

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ABSTRACT

A fossil palm wood, *Palmoxylon kondhaliensis* sp. nov., originally from Deccan Intertrappean beds and collected loose from a nalla near Kondhali Village has been described. The wood belonging to the Reniformia section of Stenzel (1904) has complete bark with marks of slightly elevated leaf scars and vertical cracks.

सारांश

कोन्धाली, नागपुर जनपद, महाराष्ट्र से प्राप्त एक नवीन ताड़काष्ठाश्म – त्र्यंबक शंकर महाबले एवं के० एम० कुलकर्णी

मूलतः दक्खन अन्तर्ट्रेपी संस्तरों से संबंधित तथा कोन्धाली गाँव के समीपस्थ नाले से एकत्रित एक अबद्ध ताड़काष्ठाश्म, **पामॉक्सीलॉन कोन्धालियेन्सिस**, का वर्णन किया गया है। स्टॅन्ज़ॅल (1904) के रेनिफ़ॉर्मिया खंड से संबंधित इस काष्ठाश्म पर थोड़े उठे हुए पर्ण दागों एवं उर्ध्व दरारों से युक्त पूर्ण छाल विद्यमान है।

INTRODUCTION

A WELL preserved fossil palm stem measuring 49×20 cm was collected by one of us (T.S.M.) at Kondhali, a forest village 10 miles south-west of Nagpur. It is a complete piece of stem, chocolate brownish in colour and shows well-preserved periderm, cortex, dermal, sub-dermal and central zones. On its outer side the distinct rings of leaf-scars and vertical cracks are clearly visible (Pl. 1, fig. 1). The specimen was not found *in situ* in the Iutertrappean beds, but was lying buried under the soil and debris in a nalla nearby. Probably it was washed away out from the original strata and redeposited there.

DESCRIPTION

Periderm — This is 0·6 cm broad, with somewhat sparse fibrovascular bundles, measuring 250×96-960×440 μm, 4-6 per sq cm, irregularly oriented. The dorsal caps are reniform, radially elongated. The bundles have blunt auricular lobes. The median sinus is deep to shallow with 1-5 metaxylem elements lodged in the vascular part. F/V ratio in these bundles is 1 : 1 to 3 : 2. Phloem is rarely preserved (Text-figs 4-6). Radiating parenchyma is present in 1-6 tiers all around the vascular bundles (Text-fig. 3). Its cells are cigar-shaped and measure 62×32 μm. The ground parenchyma is of compact cells without intercellular spaces. Fibre bundles, 55-120 μm, are circular to oval and irregularly distributed (Text-figs 2, 3).

Cortex — It is 0·6 cm broad. Numerous fibre bundles, 40-120 μm, in diameter are crowded in the cortex. Leaf-trace bundles and small fibrovascular bundles (192×128 μm) also occur in the cortex. They are regularly oriented. Their dorsal caps are reniform. Auricular lobes of the vascular bundles are round. The median sinus is shallow and vascular part extruded. It includes 2-5 metaxylem elements, 44-48 μm (Text-figs 2, 7-10, 12; Pl. 1, figs 4, 5). F/V

TABLE 1 — COMPARISON OF *PALMOXYLON* n. sp. WITH OTHER SPECIES OF *PALMOXYLON*

CHARACTERS	*B. blanfordi* SCHENK (1882)	*P. indicum* SAHNI (1931)	*P. sagari* SAHNI (1931)	*P. khalsa* SAHNI (1964)	*P. intertrappeum* SAHNI (1931)	*P. geometricum* SAHNI (1964)	*P. sclerodermum* SAHNI (1931) SHUKLA (1946)	*P. arcotense* RAMANUJAM (1953)	*P. chhindwarense* PRAKASH (1958)	*P. dakshinense* PRAKASH (1958)	*Palmoxylon kondhaliensis* sp. nov. No. 151/TSM/KNDL
1	2	3	4	5	6	7	8	9	10	11	12
Region	Central	Dermal, subdermal, almost central	Subdermal	Subdermal	Complete basal part of the tree trunk	Central	Dermal, subdermal	Dermal, subdermal central	Dermal, subdermal central	Dermal, subdermal	Periderm, cortex, dermal, subdermal, central
Shape of the dorsal cap	Reniform	Reniform	Reniform	Reniform	Cordate	Cordate	Cordate	—	Reniform	Reniform	Reniform, cordate
Fibre bundles	Absent	Absent	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Present in cortex only
Stegmata	Absent	Absent	Absent	Absent	Absent	Absent	Present	Absent	Absent	Present	Absent
Radiating parenchyma	All around the fibro-vascular bundles	Present	Present around the vascular part	Present around the vascular part	Absent	Absent	Present only around the vascular part of leaf-trace bundles	Absent	Absent	Present in dermal zone only	Absent
Tabular parenchyma	A few layers around the vascular bundles	1-2 layers	2-3 layers over the dorsal cap	Absent	Absent	1-2 layers	Absent	Absent	1-2 layers around the dorsal caps	Present in dermal zone only	Absent
Ground Tissue	Lacunar, cells cylindrical, slightly stellate	Not compact, slightly lacunar	Cells oval, air spaces small	Lacunar, cells rod-like, sometimes branched	Compact in dermal zone, lacunar in other zones	Very lacunar, cells of various geometric	Compact shapes	Highly lacunar, cells narrow, rectangular of various shapes forming loosely fitted meshes with conspicuous intercellular spaces	Dermal compact, subdermal — lacunar, Central lacunar, thin-walled cells	Compact, thin-walled round — oval cells in dermal zone and slightly lacunar in subdermal zone, cells in central zone of various shapes forming loose meshes	Less compact — lacunar cells oval-cigar-shaped
Special character	—	Metaxylem elements 3-5	—	Usually 3-4 layers of metaxylem elements in leaf trace bundles	—	Ground tissue cells of regular geometric forms, rod-shaped & Y-shaped	Radiating parenchyma around the vascular part of leaf-trace bundle, fibre bundles in dermal zone	—	Highly lacunar consisting of narrow, more or less rectangular cells of various shapes forming loose meshes	—	Metaxylem elements mostly one, rarely two
Locality & Geological horizon	Near Jhansi, unknown	—	Sagar, Eocene; Deccan traps	Unknown Unknown	Sindhi Vihira, Wardha Dist., Eocene, Deccan Traps	Sind, Tertiary	Seoni, M.P. Eocene Deccan Traps	South Arcot, Cuddalore, Tertiary, Sandstone series, Miocene-Pliocene	Chhindwara, Eocene, Deccan Traps	—	Kondhali, M.S. Eocene, Deccan Traps

ratio is 1:1 to 1·3:1. Ground parenchyma is not well-preserved but shows round and elongated cells.

Dermal Zone — This zone is distinct from the cortical zone and is about 1·5 cm broad (Text-figs 1, 12). The fibrovascular bundles are elliptic, 495×360-880×512 μm, closely packed, laterally compressed and regularly oriented, their vascular part being towards the centre. The dorsal caps are reniform to cordate, auricular lobes round and the median sinus is deep. Vascular part has a single large vessel, 108×128 μm, rarely two. Phloem is in the form of a single triangular patch (Text-figs 13-19; Pl. 1, figs 6, 8). The frequency of vascular bundles on the outermost part of the periphery is 190-220 per cm². F/V ratio is 1:0·75 to 3:1. Crowding of the fibrovascular bundles in this part makes a sort of continuous sheath of sclerenchyma around the stem leaving only a little space for the ground tissue. A small amount of compact ground parenchyma, composed of oval and thin-walled cells, 40×28-60×32 μm, has scarcely any intercellular spaces (Text-fig. 13).

Subdermal Zone — It is 2·5 cm broad. The fibrovascular bundles of this zone merge imperceptibly with fibrovascular bundles of the subdermal zone. They lie farther apart, more or less circular and irregularly oriented, their distribution in this region being 50-70 per cm² (Text-figs 1, 20; Pl. 1, figs 2, 7). Dorsal caps are reniform, auricular lobes round and median sinus deep. They have one partly excluded metaxylem element, 80-160 μm, 2-3 protoxylem elements and single patch of phloem (Text-figs 21, 24-26; Pl. 1, fig. 7). F/V ratio is 1:1 to 3:2. The ground parenchyma is less compact, composed of more or less thin-walled oval cells. The cells are irregularly ellipsoidal; those near the main bundles, tangentially flattened measuring 40×29-60×32 μm (Text-fig. 21; Pl. 1, fig. 9).

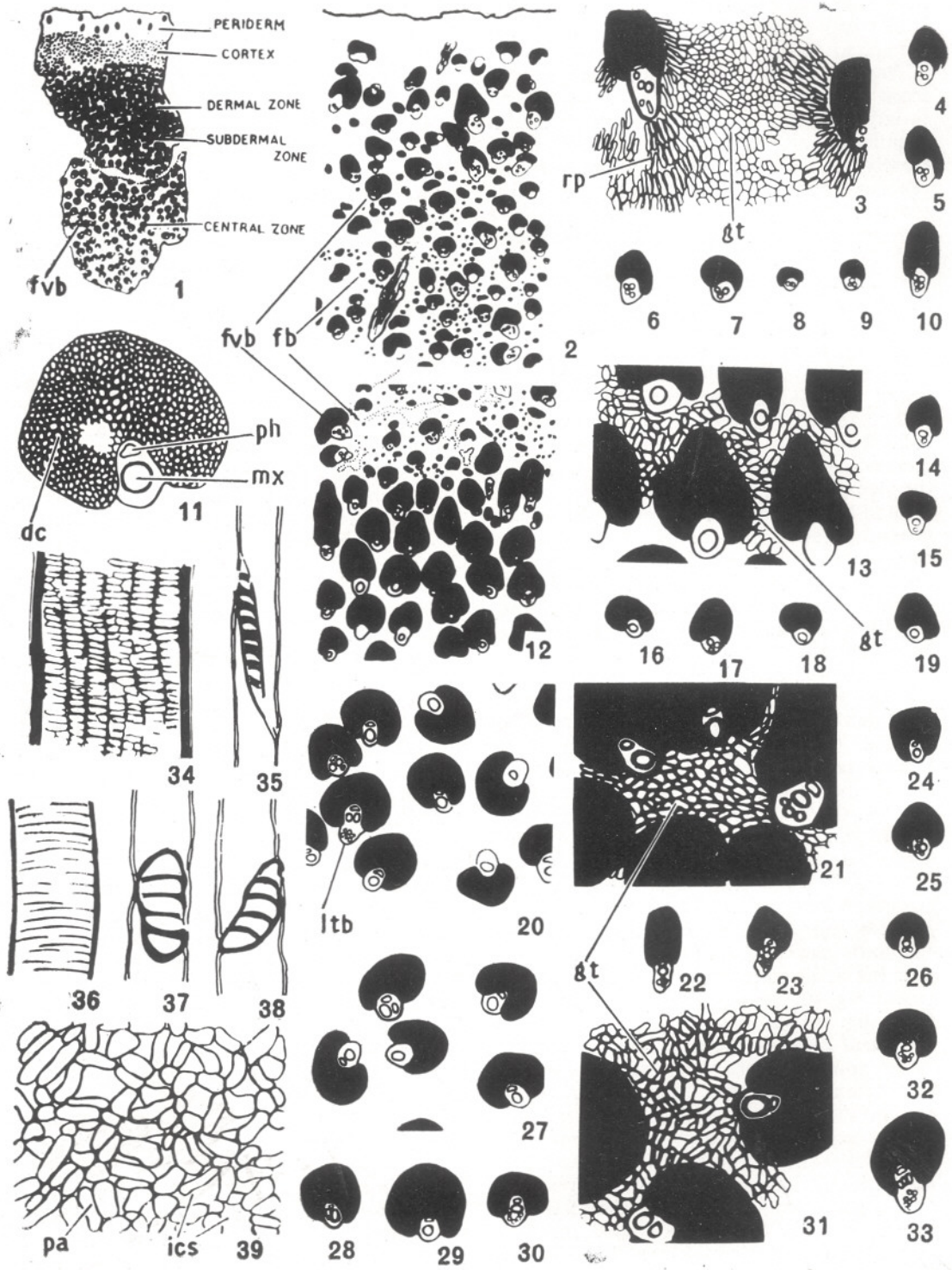
Central Zone — The fibrovascular bundles in this zone are more or less circular, irregularly oriented, scattered farther apart, 30-35 per cm² (Text-figs 1, 27; Pl. 1, figs 3, 13, 17). Dorsal caps are reniform with round auricular lobes. F/V ratio is 1:1 to 2:1. Median sinus is deep. Phloem is represented by a single triangular patch. Vascular part may be included or partly excluded, having a single large metaxylem element 160-190 μm. The bundles have rarely two metaxylem elements (Text-figs 11, 28-31; Pl. 1, figs 10, 13). Ground parenchyma is less lacunar, made up of thin-walled cigar-shaped cells, 28×18-120×30 μm (Text-figs 31, 39). They form at some places regular polygonal meshes (Text-fig. 39; Pl. 1, fig. 11).

In longitudinal section the cells are contiguous and lie in vertical rows with small intercellular spaces (Pl. 1, figs 12, 15). Metaxylem elements, 160-190 μm, have 6-7 vertical rows of pits (Text-fig. 34; Pl. 1, fig. 16). The end walls are oblique with 4-8 transverse bars, sometimes forked (Text-figs 35, 37, 38; Pl. 1, fig. 18). The protoxylen elements are 30-50 μm and have annular thickenings (Text-fig. 36).

Leaf-trace Bundles — These are present throughout the cross section but are seen mostly in the subdermal and central zones. They are 864×688-960×650 μm and are easily distinguished by their long and far protruding vascular part which includes a pair of large vessels and 2-4 medium-sized vessels, 36-56 μm in diameter (Text-figs 22, 23, 32, 33; Pl. 1, figs 14, 17).

AFFINITIES

The specimen belongs to the Section 'Reniformia' of Stenzel (1904) as the fibrovascular bundles have reniform dorsal caps. In a few bundles in the subdermal zone the caps have a slight tendency towards cordate form. They are, however, distinctly reniform in the central region. Ground parenchyma is less lacunar to lacunar. Its dorsal part is somewhat lacunar. Ground parenchyma are comparable with some of the previously described *Palmoxyla* but distinct from them all in many respects (see Table 4). For example, it shows similarities with *Palmoxylon blanfordi* Schenk (1882), *P. indicum* Sahni (1931), *P. sagari* Sahni (1931), *P. intertrappeum* Sahni (1931), *P. geometricum* Sahni (1931), *P. scleroderm-mum* Sahni (1931), *P. arcotense* Ramanujam (1953), *P. chhindwarense* Prakash (1958), and *P. dakshinense* Prakash (1958). It, however, differs from *P. indicum*, *P. sagari*, *P. blanfordi* and *P. dakshinense* as they have radiating and tabular parenchyma which is absent in our wood. *P. khalsa* Sahni (1964) resembles in the nature of its lacunar ground tissue but differs from it in having radiating parenchyma around the vascular part. *P. geometricum* and *P. chhindwarense* also have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TEXT-FIG. 1

similar lacunar ground parenchyma, but these two species differ from the present fossil wood in having 1-2 layers of tabular parenchyma around the dorsal cap. In *P. geometricum* the cells of the ground parenchyma have various geometric shapes. Such geometric shapes of the cells of ground parenchyma are not present in our palm. The ground parenchyma in *P. sclerodermum*, *P. arcotense* and *P. intertrappeum* somewhat resembles our fossil wood. *P. sclerodermum* resembles it in having radiating parenchyma around the vascular part of the leaf-trace bundles and in the absence of radiating and tabular parenchyma around the normal fibrovascular bundles. But the present wood differs from it in the absence of fibre bundles in dermal zone. In *P. sclerodermum*, the fibre bundles are present. The present fossil wood resembles *P. arcotense* in the absence of both radiating and tabular parenchyma, but the ground parenchyma in both is somewhat similar. The pattern of the meshes formed by them, however, is entirely different. It is highly lacunar, net-like, with conspicuous intercellular spaces in *P. arcotense*; but in the present wood the cells are compact. Radiating and tabular parenchyma are absent in our wood as in *P. intertrappeum* although the ground tissue is more or less similar in them. In *P. intertrappeum* the dorsal caps, however, are cordate, whereas in the present wood they are reniform. Thus it differs from all the known species of *Palmoxylon* and hence has been named as *Palmoxylon kondhaliensis* sp. nov. The specific name is given after the village Kondhali from where it was recovered.

DIAGNOSIS

Palmoxylon kondhaliensis sp. nov.

Periderm 0·6 cm broad, fibrovascular bundles 4-6 per cm², dorsal caps reniform, median sinus deep to shallow; vascular part with 1-5 metaxylem elements; F/V ratio 1 : 1 to 3 : 2, fibre bundles present; cells of the ground tissue oval, compact. *Cortex* 0·6 cm broad with numerous fibre bundles; fibrovascular bundles with reniform dorsal caps; median sinus shallow; vascular part with 2-3 metaxylem elements; F/V ratio 1 : 1 to 1·3 : 1; ground parenchyma not preserved. *Dermal zone* 1·5 cm broad, fibrovascular bundles crowded, 190-220 per cm², regular in orientation; dorsal caps reniform, median sinus deep, having a single metaxylem element; F/V ratio 1 : 0·75 to 3 : 1. Leaf-trace bundles with 2 metaxylem ele-

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TEXT-FIG. 1.— **1.** T.S. of specimen showing periderm, cortex, dermal, sub-dermal and central zones × 3/4. **2.** T.S. of specimen showing periderm and cortex: Fibrovascular bundles — fvb, fibre bundles — fb × 8. **3.** T.S. of periderm showing compact ground tissue — gt, oval fibrovascular bundles and radiating parenchyma rp × 16. **4-6.** Fibrovascular bundles from periderm with 1-3 metaxylem elements × 8. **7-10.** Fibrovascular bundles from the cortex with reniform dorsal caps × 8. **11.** A typical fibrovascular bundle from the central zone with reniform dorsal cap — dc with round auricular lobes, a single metaxylem element — mx and a phloem patch — ph × 25. **12.** T.S. of transitional zone between cortex and the dermal zone showing a part of the cortex and dermal zone. Note the regular orientation of the fibrovascular bundles in the dermal zone × 8. **13.** T.S. of dermal zone showing fibrovascular bundles with cordate to reniform dorsal caps and vascular part with a single metaxylem element. Note the compact ground tissue gt × 16. **14-19.** Fibrovascular bundles from the dermal zone with reniform dorsal caps and one metaxylem element, rarely two (fig. 17) × 8. **20.** T.S. of subdermal zone with irregularly oriented fibrovascular bundles with a single metaxylem element. Note the leaf-trace bundle — ltb × 8. **21.** T.S. of subdermal zone showing less compact ground tissue — gt and vascular part with one metaxylem element, and phloem a single patch × 16. **22, 23.** Leaf-trace bundles from the subdermal zone × 8. **24-26.** Fibrovascular bundles from the subdermal zone with reniform dorsal caps and vascular part with one metaxylem element × 8. **27.** T.S. of central zone showing fibrovascular bundles having irregular orientation. Dorsal caps reniform and vascular part with 1-2 metaxylem elements × 8. **28-30.** Fibrovascular bundles with the central zone having 1-2 metaxylem elements × 8. **31.** T.S. of central zone showing partly cut fibrovascular bundles with a single metaxylem element in the vascular part and phloem as a single patch. Note the lacunar ground tissue — gt × 16. **32, 33.** Leaf-trace bundles from the central zone × 8. **34.** Wall of a metaxylem element with seven vertical rows of pits × 200. **35.** End-plate of a metaxylem element with seven transverse bars × 33. **36.** A protoxylem element with annular thickenings × 200. **37, 38.** End-plates of metaxylem element with 4 transverse bars × 33. **39.** T.S. of ground tissue in central zone with small and large intercellular space — ics, parenchyma cells — pa × 50.

ments; ground tissue compact and the cells oval. In *subdermal zone* the fibrovascular bundles 50-70 per cm², irregularly oriented; dorsal caps reniform, median sinus deep, vascular part with 1-2 metaxylem elements; F/V ratio 1:1 to 3:2; ground parenchyma less lacunar, cells oval. In *Central zone* fibrovascular bundles 30-35 per cm², irregularly oriented; dorsal caps reniform, median sinus shallow, vascular part with 1-2 metaxylem elements; F/V ratio 1:1 to 2:1; leaf-trace bundles present, vascular part with 2-3 metaxylem elements. Ground tissue less lacunar to lacunar and its cells are cigar-shaped.

Holotype — Specimen no. 151/TSM/KNDL. Museum, Department of Botany, University of Poona.

Locality — Kondhali, District Nagpur, Maharashtra State.

Horizon — Deccan Intertrappean Series.

Age — Eocene.

REFERENCES

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

RAMANUJAM, C. G. K. (1953). *Palmoxylon arcotense* sp. nov.: a fossil palm resembling the living genus *Livistona* from South India. *Palaeobotanist*, **2**: 89-91.

SAHNI, B. (1931). Materials for a monograph of the Indian petrified palms. *Proc. Acad. Sci. U.P.*, **1**: 140-144.

SAHNI, B. (1964). *Revisions of Indian Fossil Plants, Part III— Monocotyledons.* Birbal Sahni Institute of Palaeobotany, Lucknow, India.

*SCHENK, A. (1882). Die von Begrudern Schlagintweit in Indie gesammelten fossilen Holzer. *Engl. Bot. Jhrb.*, **3** (4): 353-358.

SHUKLA, V. B. (1946). *Palmoxylon sclerodermum* Sahni from the Eocene beds of Nawargaon, Wadha District, C.P. *J. Indian bot. Soc.*, **25** (3): 105-116.

STENZEL, K. G. (1904). Die Fossile Palmenhölzer. Paleontologie und des orients. *Nitt. des. geol. u. Pal. Inst. des Univ. Wien.*, **16**: 107-187.

*Not seen in original.

EXPLANATION OF PLATE

PLATE 1

1. Holotype specimen no. 151. × 1/10.
2. T.S. showing periderm. × 2.
3. T.S. of central zone. × 2.
4. T.S. showing the distribution of the fibrovascular bundles — fvb and fibre bundles.
5. T.S. of cortex showing fibrovascular bundles. × 36.
6. T.S. of dermal zone showing fibrovascular bundles with regular orientation. Note the single metaxylem element in the vascular part. × 20.
7. T.S. of subdermal zone showing the fibrovascular bundles with slightly irregular orientation. Note the single metaxylem element in the vascular part. × 20.
8. Fibrovascular bundles from dermal zone with reniform dorsal caps and single metaxylem element in the vascular part. × 40.
9. A fibrovascular bundle from the subdermal zone with reniform dorsal cap and a single metaxylem element. × 40.
10. A typical fibrovascular bundle from the central zone. × 40.
11. Lacunar ground tissue from the central zone in T.S. Intercellular spaces and ground parenchyma cells. × 60.
12. L.S. of ground tissue showing vertical rows of cells. × 40.
13. T.S. of central zone showing irregularly oriented fibrovascular bundles and vascular part with 1-2 metaxylem elements. Note the lacunar ground tissue. × 20.
14. A leaf-trace bundle with reniform dorsal cap vascular part with three metaxylem elements and seven protoxylem elements. × 30.
15. L.S. showing cells of ground parenchyma in vertical rows. × 20.
16. Wall of a metaxylem element with annular thickenings. × 120.
17. T.S. of central zone showing fibrovascular bundles and a leaf-trace bundle. × 20.
18. End-plate of a metaxylem element with three bars, one of which is forked. × 120.

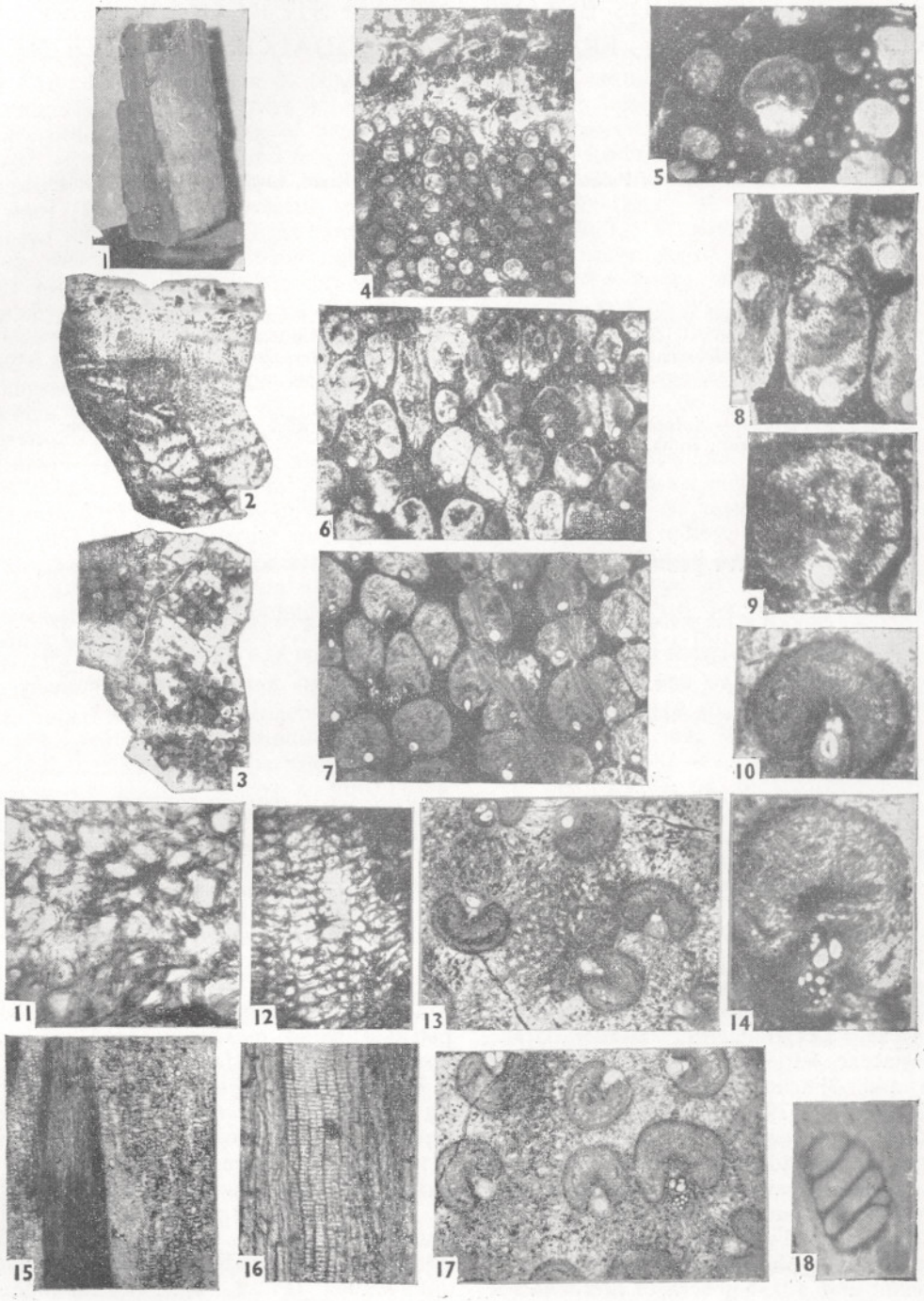

PLATE 1