

ON A COLLECTION OF MESOZOIC PLANTS FROM KAGBENI-MUKTINATH, THAKKHOLA VALLEY, NEPAL

G. BARALE

Laboratoire de Paléobotanique et L. A. n° 11, Université Claude-Bernard, Lyon-I

J. P. BASSOULLET

Laboratoire de Micropaléontologie, Université de Paris VI

&

M. N. BOSE

Birbal Sahni Institute of Palaeobotany, Lucknow-226007, India

ABSTRACT

Some fragmentary plant remains collected from the upper part of the Kali Gandaki Valley, near the village Kagbeni, form the subject matter of this paper. The collection includes a specimen of ?*Taeniopteris* sp. cf. *T. spatulata* McClelland, two species of *Ptilophyllum* (*P. acutifolium* Morris and *P. sp. cf. P. cutchense* Morris) and a few pieces of petrified araucarian woods. All the wood pieces have been referred to a new species of *Araucarioxylon*, viz., *A. nepalensis*.

The plant bearing beds (Kagbeni Sandstones) are supposed to be the basal part of Lower Cretaceous.

INTRODUCTION

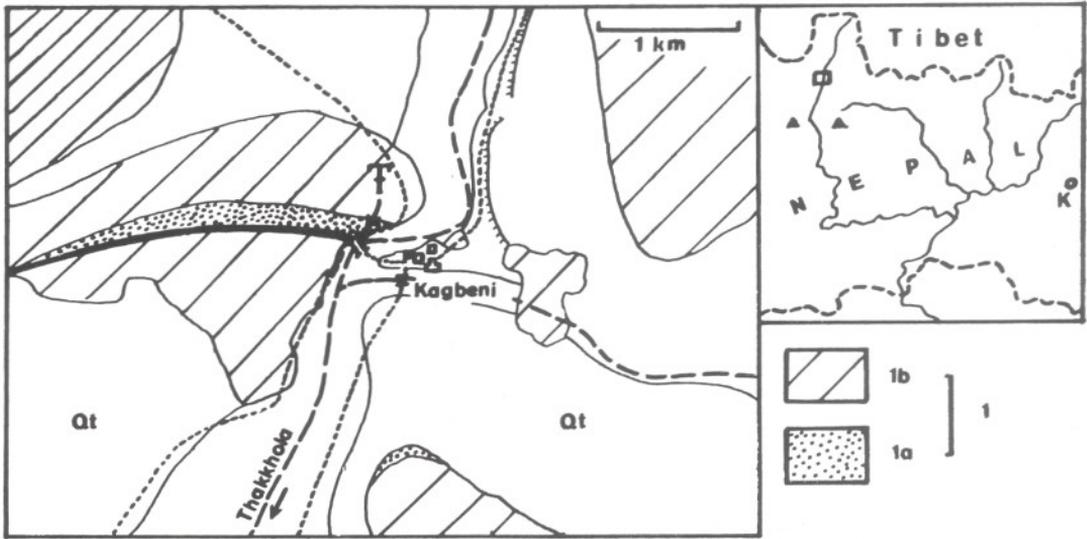
THE plant remains described in this paper come from the central part of the Nepalese Himalaya, more precisely from the Thakkhola Valley (upper part of the Kali Gandaki Valley), near the village Kagbeni. The fossiliferous outcrop was discovered by Bordet *et al.* (1964) who had then mentioned the presence of cycadophytic fronds and araucarian woods. In later publications (Bordet *et al.*, 1967, and Mouterde in: Bordet *et al.*, 1971) the occurrence of *Nilssonia orientalis*, *Okozamites abbreviatus* and *Ptilophyllum* (*Williamsonia pecten*) was reported.

Kagbeni (or Kag) is located in the northern part of the Higher Himalaya of Nepal, about 10 km north of Dhaulagiri-Annapurna range (Map—"Esquisse géologique de la Thakkhola", x = E 30; y = S 12, 1968). In this area outcrop the Mesozoic folded formations of the Tibetan Series. At Kagbeni, the Thakkhola River cuts a faulted anticline structure approximately E-W direction of axis which is visible on the right bank (Text-fig. 1). The south flank is subvertical and the north steeply dipping northward (50° to 70°). They are composed of Cretaceous rocks: the Chukh

Formation. Bassoullet and Mouterde (1977) divided this Formation into two: the Kagbeni sandstones ("Wealden" Mouterde in: Bordet *et al.*, 1971) formed essentially of sandstones, (150 m) and the Dzong sandstones, at the upper part, composed of a thick succession of green sandstones and shales, with some intercalations of limestones (about 600 m).

The Kagbeni sandstones can be studied on the right bank of the Thakkhola River, above the bridge, along a path. After the fault, the following succession can be observed northward (from Bordet *et al.*, 1971):

1. Grey sandstones alternating with dark shales 11.5 m.
2. Sandstones in massive layer with cross bedding at the upper part, with two thin intercalations of silty black shales 15 m.
3. Grey shales 1 m.
4. Succession of clear-coloured sandstones in massive layers (3 to 8 m) and alternation of shales and sandstones in this bed with thin layers of coal 44 m.
5. Alternation of shales and finely banded sandstones in thin beds 8 m.



TEXT-FIG. 1 — Geological sketch map of Kagbeni region showing the fossiliferous beds in the Kagbeni sandstones, 1: Chukh Formation divided into—1(a), Kagbeni sandstones and 1(b), Dzong sandstones. [Qt: Quaternary, T: Fossiliferous Bed]

6. Massive layer of grey sandstones with remains of plants (coarse sandstone at the lower part with pebbles of quartz and lenses with fragments of silicified woods)10 m.
7. Above the terminal part of the Kagbeni sandstones there is alternation of thin bedded sandstones and shales, and massive layers of sandstones45 m.

All the plant remains come from Bed no. 6. The present collection was made by one of us (J. P. B.) and it comprises mainly leaves of *Ptilophyllum*, a specimen of ? *Taeniopteris* and a few pieces of petrified woods. Most of the wood pieces are not well preserved. From two of the specimens, besides thin sections, fairly good peel sections could be obtained.

DESCRIPTION

? *Taeniopteris* sp. cf. *T. spatulata* McClelland
Pl. 1, fig. 2

The specimen is incomplete both at base and apex. It is 7.3 cm long and 0.9 cm broad at its broadest region. The lamina has entire margin and is attached laterally to the midrib. Midrib is stout, about 1 mm wide; lateral veins are not preserved.

Due to poor state of preservation the specimen, at best, can be referred to *Taeniopteris*. It shows close similarity, in gross features, with some of the specimens of *T. spatulata* McClelland described by McClelland (1850, pl. 16, fig. 1), Oldham and Morris (1863, pl. 6, figs. 1, 5) and Feistmantel (1979, pl. 1, figs. 10-13, 18) from the Rajmahal Hills, Vemavaram and Sriperumbudur, India.

Collection — No. JM 144/1 of Laboratoire de Paléobotanique, University of Lyon I.

Locality — Thakkhola River Section, near Kagbeni.

Age — ?Lower Cretaceous.

Ptilophyllum acutifolium Morris

Pl. 1, figs. 3, 5-6

The collection has several fragmentary leaves, measuring 10-12 cm in length and 3-4.5 cm in breadth. Pinnae are attached at an angle of 30°-45° on the upper surface of rachis, almost concealing it. Rachis about 2-3 mm wide. Pinnae closely set or slightly distant, 3-3.5 cm long and 0.2-0.3 cm broad, apical and basal pinnae shorter; apex acute; acroscopic margin rounded, basisopic margin slightly decurrent. Veins arising from entire base, parallel, 6-8 in

number, simple or forked, when forked mostly once.

The specimens agree with the lectotype and some of the specimens of *Ptilophyllum acutifolium* Morris figured by Bose and Kasat (1972, pl. 1, figs. 1, 3-5) from Kutch. They also resemble, in external features, *P. sakrighaliensis* Sah described by Bose and Kasat (1972). The specimen figured in Pl. 1, fig. 5 is comparable to some of the specimens of *P. acutifolium* figured by Oldham and Morris (1863, pl. 20, fig. 2; pl. 22, fig. 1). The specimens of *P. acutifolium* from Nepal may also be compared, in external features, with some of the larger leaves of *P. pectinoides* (Phillips) described by Harris (1969, text-fig. 3C) from Yorkshire and *P. acutifolium* described by Pineda (1969) from Jurassic of de Tecomatlán. Both *P. ukrainense* Doludenko (1963, pl. 2, fig. 3) and *P. caucasicum* Doludenko & Svanidze (1964, pl. 1, fig. 4) resemble in gross morphology with *P. acutifolium* from Nepal. But in the absence of cuticle it is not possible to compare them further.

Collection — Nos. JM 144/4, JM 144/8 and JM 144/10 of Laboratoire de Paléobotanique, University of Lyon I.

Locality — Thakkhola River Section, near Kagbeni.

Age — ?Lower Cretaceous.

Ptilophyllum sp. cf. *P. cutchense* Morris

Pl. 1, figs. 1, 4

Leaves are simply pinnate, linear-lanceolate; major part of lamina uniformly broad, gradually tapering towards apex, 7·1-11 cm long and 1·2-2 cm broad. Rachis concealed, about 1-1·5 mm wide. Pinnae are mostly closely set or rarely slightly distantly placed, attached on the upper side of rachis at an angle of about 48°-60°. Near the middle region pinnae are 0·7-1·2 cm long and 0·15-0·25 cm broad; apex acute or sub-acute; acroscopic margin swollen, basisopic margin decurrent. Veins obscure.

Some of the fronds, especially the one figured in Pl. 1, fig. 1, resemble the type specimen of *Ptilophyllum cutchense* Morris figured by Bose and Kasat (1972, pl. 1, fig. 7). The basal pinnae of the specimen figured in Pl. 1, fig. 1 are more like the pinnae of the type specimen, but in this

specimen the pinnae towards distal end have more acute apices. The specimens also resemble the other specimens of *P. cutchense* described from Kutch by Feistmantel (1876) and Bose and Kasat (1972, pl. 2, fig. 14). They do not compare with any of the specimens described from the Rajmahal Hills by Oldham and Morris (1863), Feistmantel (1877) and Bose and Kasat (1972) because the pinnae of the Rajmahal specimens have mostly obtuse apex.

The specimens from Nepal somewhat resemble the specimen described by Feistmantel (1879, pl. 8, fig. 12) as *Otozamites acutifolius*, but in the latter species pinnae apices are not so acute as in *P. sp. cf. P. cutchense*. *O. acutifolius* Feistmantel has recently been referred to *P. cutchense* by Bose and Kasat (1972, p. 119). In overall shape *P. sp. cf. P. cutchense* may be compared with *P. pecten* (Phillips) described by Harris (1969) from Yorkshire, but in the latter species the pinnae are not so closely set. Moreover, in *P. pecten* the pinnae apices are obtuse. The pinnae of the present specimens also resemble *P. okribense* Doludenko and Svanidze (1969, pl. 73, fig. 7). *P. okribense* has mostly broader pinnae with less acute apices.

Collection — Nos. JM 144/9 and JM 144/13 of Laboratoire de Paléobotanique, University of Lyon I.

Locality — Thakkhola River Section, near Kagbeni.

Age — ?Lower Cretaceous.

Araucarioxylon nepalensis n. sp.

Pl. 2, figs. 7-12

Diagnosis — Secondary wood with distinct 1400-1800 μ wide *growth rings*. Transition from early to late wood abrupt. *Late wood* 6-33 cells wide; cells compactly placed, composed of thick-walled, usually squarish-rectangular tracheids arranged in radial rows. *Early wood* 48-60 cells wide, with radially arranged thin-walled polygonal-squarish tracheids. *Parenchyma* absent. *Pits* on radial walls of tracheids 1-2 seriate (mostly uniseriate), alternate, generally contiguous, polygonal (mostly hexagonal) with circular-oval orifices; pits on tangential wall absent. *Bars of Sanio* absent. *Xylem rays* homogeneous, uni-

seriate, 1-8 cells high, 6-10 per mm; tangential section showing elongated, barrel-shaped cells. *Pits in cross field* 1-5, cupressoid, bordered, circular to oval in shape. *Resin canals* not visible.

Holotype— No. JM 144/1 of Laboratoire de Paléobotanique, University of Lyon I.

Locality— Thakkhola River Section, near Kagbeni.

Age— ?Lower Cretaceous.

Comparison— *Araucarioxylon nepalensis* closely resembles *Dadoxylon (Araucarioxylon) jurassicum* Bhardwaj (1953) and *D. santalense* Sah & Jain (1964) described from the Rajmahal Hills, Bihar. In all these species pits on radial walls of tracheids are 1-2 seriate. In *D. santalense* they are mostly uniseriate. Xylem rays in *A. nepalensis* are uniseriate and 1-8 cells high, whereas, in *D. (Araucarioxylon) jurassicum* they are 1-11 cells and in *D. santalense* 1-10 cells. In the nature of pits in cross-field, the present species resembles most *D. santalense*. The former has 1-5 pits, whereas, the latter has 2-6 pits. In *D. (Araucarioxylon) jurassicum* pits in cross-field varies from 4-8 in number.

D. (Araucarioxylon) novaezeelandiae (Stopes) Seward (1919) from the Cretaceous of Amuri Bluff, New Zealand and *D. (Araucarioxylon) sidugawaense* Shimakura (1936) from the Jurassic of Japan may be compared with *A. nepalensis* in the nature of well marked growth rings, 1-2 seriate pits on radial walls and uniseriate xylem rays. In *D. (Araucarioxylon) novaezeelandiae* xylem rays are 3-4 cells high and it has 5-6 pits in the cross-field and in *D. (Araucarioxylon) sidugawaense* xylem rays are 1-14 cells in height and it has 1-2 cross-field pits. *D. (Araucarioxylon) sidugawaense* comprises xylem parenchyma, whereas, in *A. nepalensis* parenchyma is absent.

DISCUSSION

Bordet *et al.* (1967, 1971) had reported the occurrence of *Nilssonia orientalis*, *Otozamites abbreviatus* and *Ptilophyllum (Williamsonia) pecten*. Our collection includes mostly

Ptilophyllum which have been referred to two species, viz., *P. acutifolium* Morris and *P. sp. cf. P. cutchense* Morris. Besides, we have a specimen which has been doubtfully referred to *Taeniopteris*. Both *Otozamites* and *Nilssonia* are missing. Araucarian woods, mentioned by Bordet *et al.* (1971), are also present in our collection and they all belong to a single species, viz., *Araucarioxylon nepalensis* n. sp.

On the basis of this floral assemblage alone it is rather difficult to assign a definite age to the Kagbeni sandstones. However, the overwhelming dominance of *Ptilophyllum* and *Araucarioxylon* suggests a more Upper Jurassic-Lower Cretaceous age. In India, the genus *Ptilophyllum* is rather rare in the undoubted Lower Cretaceous beds and they have *Onychiopsis* and *Weichselia*. Both these genera are so far missing at Kagbeni. It is likely that the fossiliferous beds near Kagbeni may be of somewhat similar age as the Rajmahal Hills. The older beds in Rajmahal Hills, too, have a large number of *Taeniopteris spatulata*, species of *Ptilophyllum* and *Araucarioxylon*. But on the available meagre data, at present, it is not possible to say whether the Kagbeni sandstones belong to the Gondwana.

According to Bordet *et al.* (1971, p. 157) the age of the Kagbeni sandstones is Wealden because under the continental sandstones with plant remains, especially the S and to the NE of the Muktinath basin, slates contain a rich Upper Tithonian fauna of Ammonites and above the sandstones lie black lower schists of Neocomian age (doubtful), but the complex of sandstones which is in continuity contains a fauna of Ammonites belonging to the Lower Aptian.

ACKNOWLEDGEMENT

We are grateful to Drs H. K. Maheshwari and M. B. Bande of Birbal Sahni Institute of Palaeobotany, Lucknow for their help in connection with the work on *Araucarioxylon*.

REFERENCES

- BASSOULLET, J. P. & MOUTERDE, R. (1977). Les formations sédimentaires mésozoïques du domaine tibétain de l'Himalaya du Népal. *Colloque intern. C.N.R.S. "Ecologie et Géologie de l'Himalaya"*. Paris, 1976. (In Press).
- BHARDWAJ, D. C. (1953). Jurassic woods from the Rajmahal Hills, Bihar. *Palaeobotanist*, 2: 59-70.
- BORDET, P., KRUMMENACHER, D., MOUTERDE, R. & REMY, J. M. (1964). Sur la stratigraphie des

- séries secondaires de la Thakkhola (Népal central). *C. R. Ac. Sc., Paris*, **259** (7): 1425-1427.
- BORDET, P., COLCHEN, M., LE FORT, P., MOUTERDE, R. & REMY, J. M. (1967). Données nouvelles sur la géologie de la Thakkhola (Himalaya du Népal). *Bull. Soc. geol. Fr.*, **7**(9): 883-896.
- BORDET, P., KRUMMENACHER, D., MOUTERDE, R. & REMY, J. M. (1968). Esquisse géologique de la Thakkhola (Map 1/75.000°). *Publ. C.N.R.S. Paris*.
- BORDET, P., COLCHEN, M., LE FORT, P., MOUTERDE, R. & REMY, M. (1971). Recherches géologiques dans l'Himalaya du Népal, région de la Thakkhola. Chapitre V: Les Formations Mésozoïques de la Thakkhola: 118-175. *C.N.R.S. Paris*.
- BOSE, M. N. & KASAT, M. L. (1972). The genus *Ptilophyllum* in India. *Palaeobotanist*, **19**(2): 115-145.
- DOLUDENKO, M. P. (1963). New species of *Ptilophyllum* from the Jurassic of the Western Ukraine. *Bot. Zh.*, **48**(6): 796-805.
- DOLUDENKO, M. P. & SVANIDZE, T. (1964). Some Jurassic *Ptilophyllum* fronds of Ukraine and Georgia and their correlation with Indian species of this genus. *Int. geol. Congr. 22nd Session. Report of Soviet Geologist Problems*, **9**: 111-122.
- DOLUDENKO, M. P. & SVANIDZE, T. (1969). The late Jurassic flora of Georgia. *Acad. Sci. U.S.S.R.*, **178**: 1-116.
- FEISTMANTEL, O. (1876). Jurassic (Oolitic) flora of Kach. In: "Fossil flora of the Gondwana System". *Mem. geol. Surv. India*, Ser. 11, **2**(1): 1-80.
- FEISTMANTEL, O. (1877). Jurassic (Liassic) flora of the Rajmahal group, in the Rajmahal Hills. *Mem. geol. Surv. India Palaeont. indica*, Ser. 2, **1**(2): 1-110.
- FEISTMANTEL, O. (1879). Outliers on the Madras Coast. In: "Fossil flora of the Upper Gondwanas". *Mem. geol. Surv. India Palaeont. indica*, Ser. 2, **1**(4): 1-34.
- HARRIS, T. M. (1969). The Yorkshire Jurassic flora III. Bennettitales. *Br. Mus. nat. Hist.* i-vi + 186. London.
- KRÄUSEL, R. & JAIN, K. P. (1964). New fossil coniferous woods from the Rajmahal Hills, Bihar, India. *Palaeobotanist*, **12**(1): 59-67.
- MCCLELLAND, J. (1850). Report of the Geological Survey of India, for the season of 1848-49. *Geol. Surv. India, Calcutta*.
- OLDHAM, T. & MORRIS, J. (1863). Fossil flora of the Rajmahal Series in the Rajmahal Hills. In: "Fossil flora of the Gondwana System". *Mem. geol. Surv. India Palaeont. indica*, Ser. 11, **1**(1): 1-52.
- PINEDA, ALICIA SILVA (1969). Parte I. Plantas fósiles del Jurásico Medio de Tecomatlán, Estado de Puebla. *Paleontologia Mexicana*, **27**: 1-38.
- SAH, S. C. D. & JAIN, K. P. (1964). Some fossil woods from the Jurassic of Rajmahal Hills, Bihar, India. *Palaeobotanist*, **12**(2): 169-180.
- SEWARD, A. C. (1919). *Fossil Plants*. IV. 1-XVI + 1-543. Cambridge.
- SHIMAKURA, M. (1936). Studies on fossil woods from Japan and adjacent lands. Contribution. I. *Sci. Rep. Tohoku Univ.*, Ser. II, **18**(3): 267-310.

EXPLANATION OF PLATES

PLATE 1

1. *Ptilophyllum* sp. cf. *P. cutchense* Morris, No. JM 144/9. × 1.
2. ? *Taeniopteris* sp. cf. *T. spatulata* McClelland, No. JM 144/1. × 1.
3. *Ptilophyllum acutifolium* Morris, No. JM 144/4. × 1.
4. *Ptilophyllum* sp. cf. *P. cutchense* Morris, No. JM 144/13. × 1.
5. *Ptilophyllum acutifolium* Morris, No. JM 144/8. × 1.
6. *P. acutifolium*, a few pinnae enlarged to show the veins, No. JM 144/10. × 2.

PLATE 2

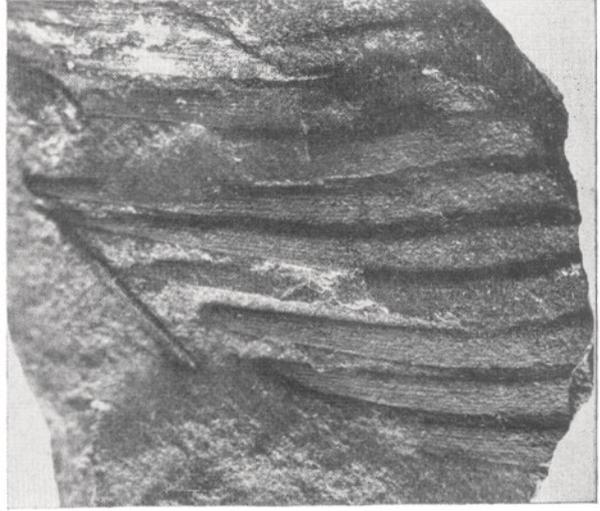
- Araucarioxylon nepalensis* n. sp.
7. Cross section, showing growth rings; Slide no. JM 144/1-1. × 40.
 8. Tangential section, showing the height and distribution of xylem rays; Slide no. JM 144/1-3. × 40.
 9. A few rays enlarged; Slide no. JM 144/1-3. × 100.
 10. Radial section, showing arrangement of pits on radial walls; Slide no. JM 144/1-2. × 200.
 11. A portion from the above magnified; Slide no. JM 144/1-2. × 500.
 12. Radial section, showing cross-field pits; Slide no. JM 144/1-2. × 500.



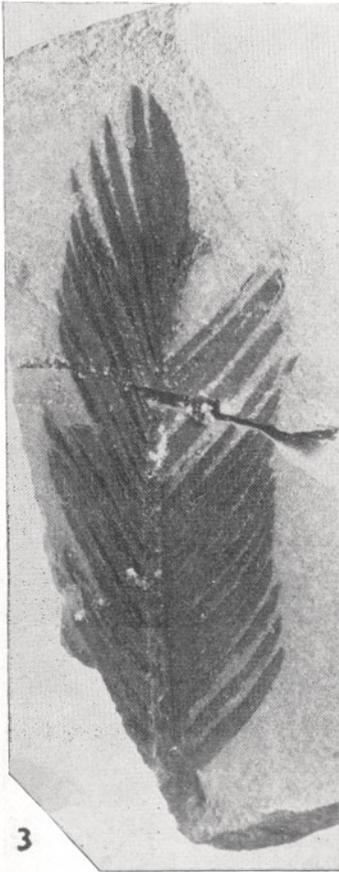
1



2



6



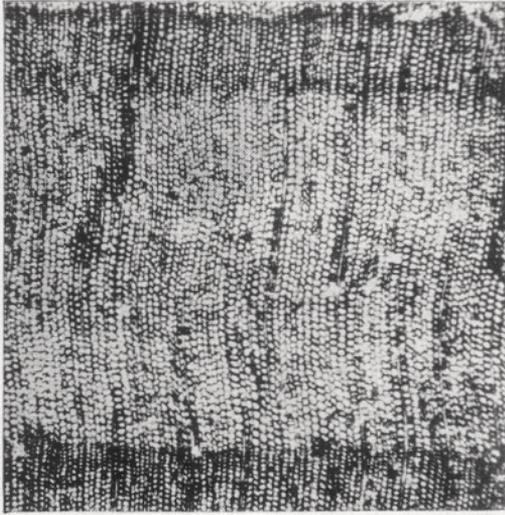
3



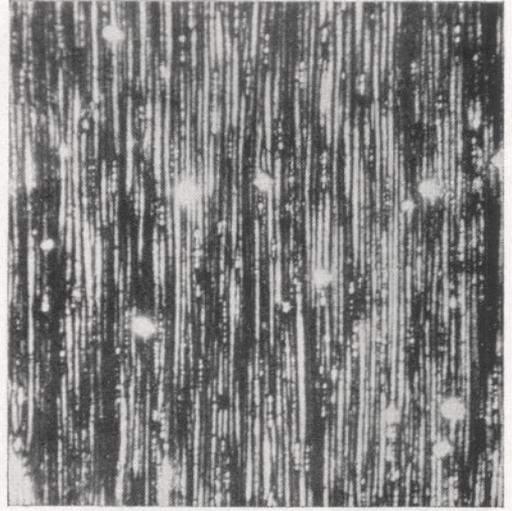
4



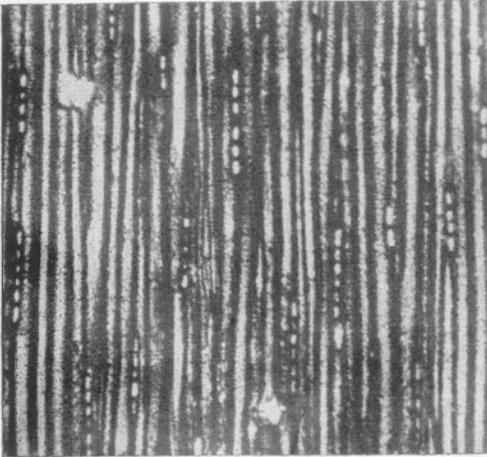
5



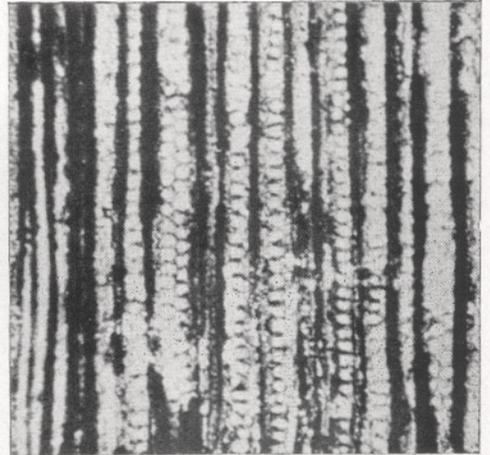
7



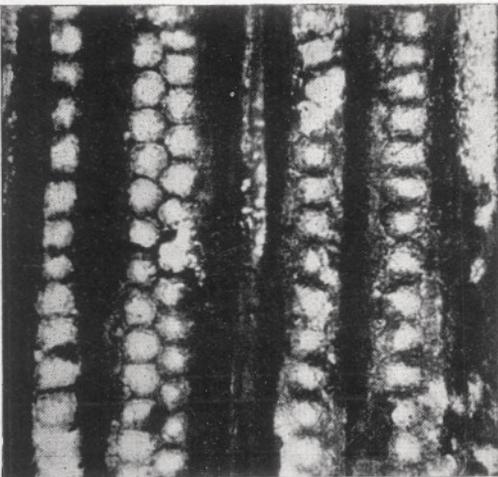
8



9



10



11

12

