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Petrified Plants from the Cretaceous of the Kwanto Mountains, Central Japan I*

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Three species of coniferous woods, *Araucarioxylon kiiense* Ogura, *Dadoxylon* (*Araucarioxylon*) *japonicum* Shimakura and *Mesembrioxylon chichibuense* sp. nov., were first described from the Lower Cretaceous Sebayashi Formation in the Kwanto Mountains.

Key words: Cretaceous — Kwanto Mountains — Petrified plant — Sanchu "Graben".

The presence of petrified plants in the Lower Cretaceous Sebayashi Formation in the Kwanto Mountains of central Honshu was revealed in 1976 by discovery of a tree fern stem *Cyathocaulis naktongensis* Ogura (Nishida and Tanaka, 1982). The Sebayashi Formation is composed of shallow marine or brackish sediments having been deposited in early Cretaceous, late Barremian to early Aptian (Matsukawa, 1977).

Similar sediments of the same age are developed in Arida of Wakayama, Choshi of Chiba, and Miyako of Iwate Prefectures, in that chronological order. From Arida, *Cyathocaulis* and two species of *Araucarioxylon* are known (Ogura, 1927, 1944, 1960). *Cyathocaulis* and four species of *Mesembrioxylon*, for example, are known from Choshi (Nishida, 1962, 1963, 1966, 1967, 1973), and some coniferous woods are known from Miyako (Shimakura, 1936, 1937; Nishida, 1967). With the evidence at hand as presented above it seemed logical that coniferous woods would also occur in the Sebayashi Formation.

The second author collected a fossil trunk in February, 1981, in a valley near Sebayashi, Tano-gun, Gumma Prefecture, where the first *Cyathocaulis* of the Kwanto Mountains was found in 1976. Nishida and Tanaka (1982) have drawn a detailed map of this area. The trunk was embedded in a greyish sandstone of the lower part of the Sebayashi Formation, but in sediments about 30 m higher than those bearing *Cyathocaulis*. Subsequently we collected several additional specimens from this area.

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Materials and Methods

The original materials were silicified fragments of trunks consisting of secondary wood. Sections were made by the peel method using 20–25% aquatic solution of hydrofluoric acid as an etching reagent. Slides also were made of radial sections by hand grinding.

Results

1. **Araucarioxylon kiiense** Ogura, Jap. J. Bot. **13**: 345 (1944), Nishida, Bull. Choshi Marine Lab. No. 4: 1 (1963).
   Araucarioxylon cfr. kiiense Ogura, in Nishida, Jap. J. Bot. **18**: 88 (1962). (Fig. 1. A & B).

   Brief notes. The specimens Nos. 81102–81105 are fragments of secondary wood exhibiting araucarian type pitting on the tracheids. Growth rings are not discernible. Bordered pits on radial walls of tracheids are arranged contiguously in one to two, rarely three rows and if in two or three rows, they are arranged alternately. Rays are almost uniseriate and rarely biseriate in part, and 2–21, usually 5–10 cells high or 53–360 μm in height. Two to six, small, half-bordered pits are discernible in the cross field. No wood parenchyma nor resin canals are discernible. Tangential walls of tracheids are rarely pitted by separate bordered pits.

   Diagnostic characters of the new specimens, as mentioned above, are similar to those of *Araucarioxylon kiiense* from the Lower Cretaceous of Wakayama Prefecture (Ogura, 1944), except for the presence of bordered pits on tangential walls of some tracheids.

   Distribution. Endemic to Japan: Arida, Wakayama Prefecture (Lower Cretaceous; Barremian), Choshi, Chiba Prefecture (Lower Cretaceous; Aptian).

2. **Dadoxylon (Araucarioxylon) japonicum** Shimakura, Sci. Rep. Tohoku Imp. Univ. Ser. 2 (Geol.) **18**: 268 (1936), ibd. **19**: 5 (1937). (Fig. 1. C & D).

   Brief notes. The specimens nos. 81106–81109 are fragments of secondary wood exhibiting araucarian characters. False growth rings are visible. No resin canals nor wood parenchyma are discernible. Bordered pits on radial walls are arranged chiefly in two, sometimes one or three rows, and if in two rows, they are often oppositely arranged. Tangential walls are sparsely pitted. Rays are uniseriate, 1–23, usually 3–8 cells high or 40–630 μm in height. Four to twelve half-bordered pits are visible in the cross field. These characters mentioned above are similar to those of *Dadoxylon japonicum* from the Lower Cretaceous of Iwate Prefecture (Shimakura, 1936) and from the Upper Jurassic of Kochi Prefecture (Shimakura, 1937).

   Distribution. Endemic to Japan: Hiraiga and Koikorobe, Tanohata Village, Iwate Prefecture (Lower Cretaceous: Upper Aptian to Lower Albian), Jihara Village, Kochi Prefecture (Upper Jurassic).

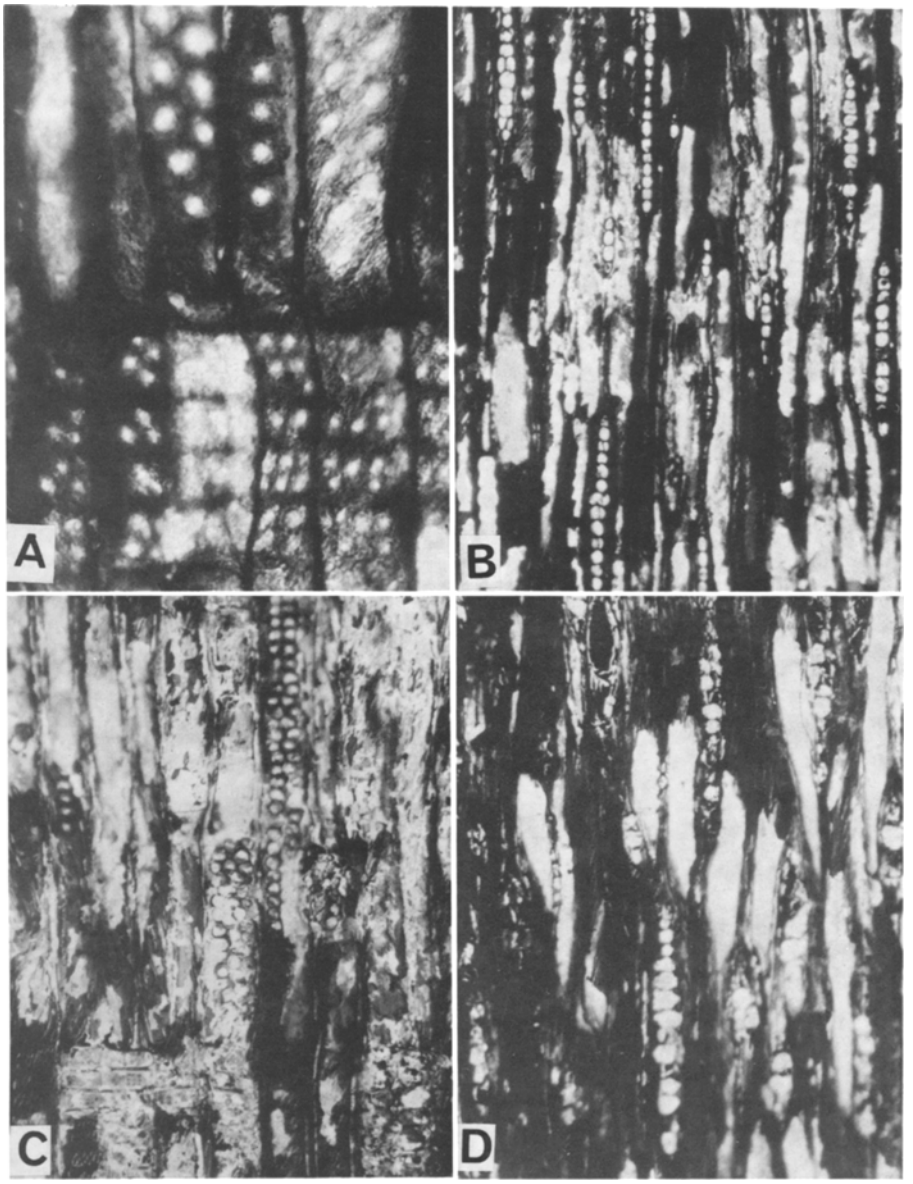

Fig 1. *Araucarioxylon kiiense* Ogura (A, B) and *Dadoxylon japonicum* Shimakura (C, D). A, C: radial sections. B, D: Tangential sections. A, ×230; B–D, ×115.

3. **Mesembrioxylon chichibuense** sp. nov. (Figs. 2–4).

Materials. The specimen no. 81101 a-e are pieces of the secondary wood collected by H. Nishida and deposited in the Laboratory of Phylogenetic Botany, Chiba University.

Description. Wood is of the coniferous type consisting of tracheids, rays and wood parenchyma, and devoid of resin canal. Growth rings are difficult to recognize at lower magnifications. Late wood is composed of two to three layers of tracheids. The

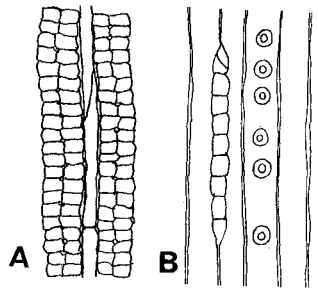

Fig. 2. *Mesembrioxylon chichibuense* sp. nov. A: Cross section showing a ray cell with very oblique end wall which causes oblique septum of ray cell in B. B: Tangential section showing a ray cell with oblique septum which originates in very oblique end wall in A.

transition from early to late wood is abrupt. In transverse section, tracheids are in radial rows, rectangular or radially elongated, 25–43 μm in tangential and 28–57 μm in radial diameters. Some tracheids are filled with black resinous substances and are distributed widely in the wood. At first glance they appear to be wood parenchyma, but they have circular bordered pits on their radial walls. The bordered pits are 22 μm in diameter, arranged in one or rarely two rows separately or in a rare case contiguously. Pits are opposite, when arranged in two rows. Bordered pits on tangential walls are smaller, 18 μm in diameter, and arranged sparsely. Crassulae are not visible. Rays are parenchymatous, uniseriate or sometimes biseriate in part, 1–20, usually 3–10 cells (80–230 μm) high. The highest ray is 758 μm, or 32 cells. The intervals of the rays are one to eleven (average 4.9) rows of tracheids, or there are six to eight (average 6.7) rows of rays in 1 mm. Ray cells are barrel shaped, rectangular or ovoid in tangential section, 15–22 μm in horizontal and 22–27 μm in vertical width. Horizontal walls are rarely pitted by small simple pits, but tangential walls are always smooth. The tangential wall of a ray cell is rarely oblique but can be seen in radial section as a long oblique line which traverses two to five tracheids (Fig. 3A) or in cross section also as long oblique line (Fig. 2A). In the cross field there is single large ovoid pit 15×21 μm in diameter, or there are two pits 12 μm in long diameter. Wood parenchyma is sparsely distributed in the wood.

Affinity. The present specimen described above is assigned to *Mesembrioxylon* (Seward, 1919) which has single large ovoid pit in the cross field, a small amount of wood parenchyma, ordinary coniferous type of pitting on the tracheary walls and an

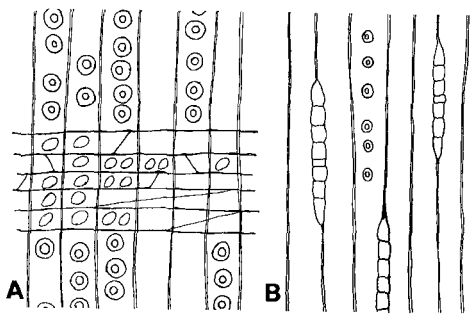

Fig. 3. *Mesembrioxylon chichibuense* sp. nov. A: Radial section. Note very oblique end walls of ray cells which cause very low ray cells in B. B: Tangential section. Very low ray cells which originate in very oblique end walls in A are seen.

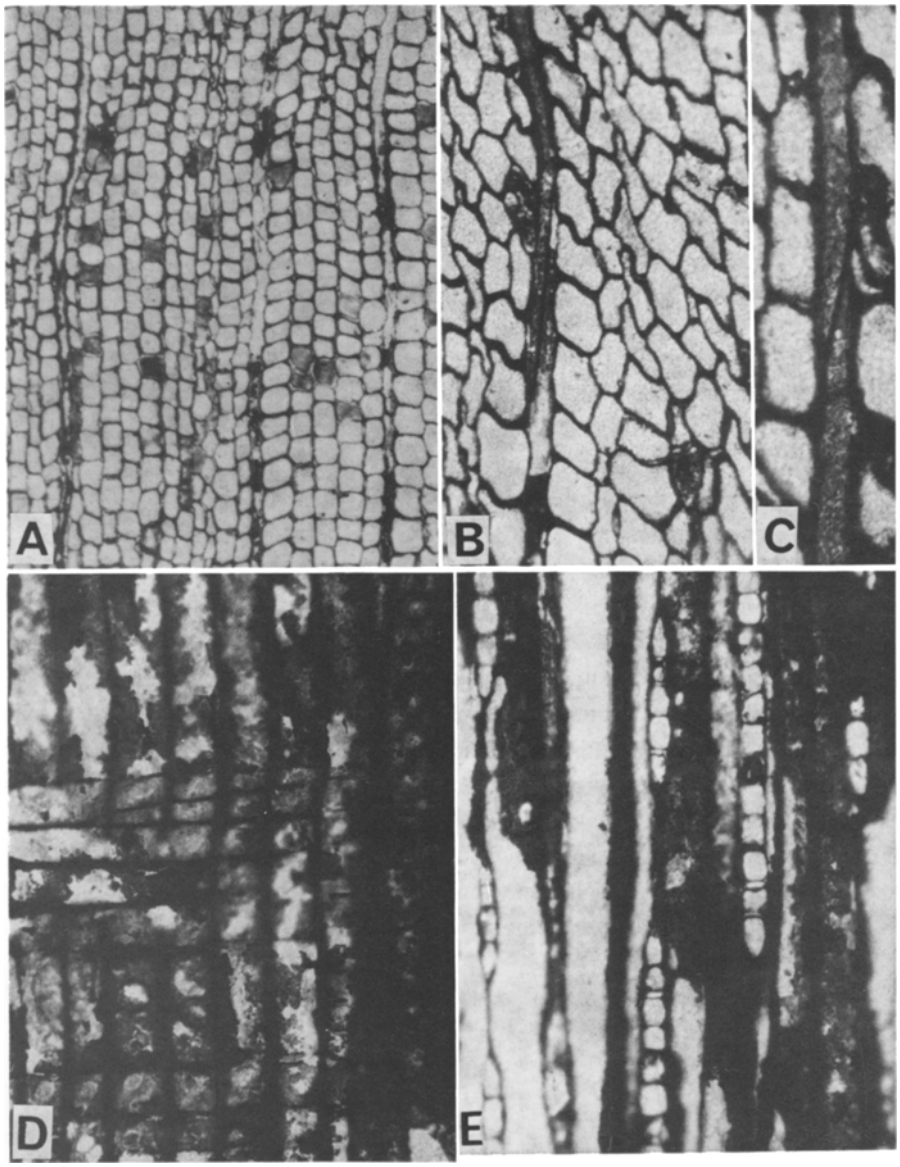

Fig. 4. *Mesembrioxylon chichibuense* sp. nov. A–C: Cross sections. D: Radial section. E: Tangential section. Very oblique end walls are seen in B, C and D. A, ×104; B, D, E, ×207; C, ×396.

absence of abietinean pits on the ray cells. In Japan and adjacent regions, seven species of the genus have been described as listed below.

M. dakotense (Torrey), Upper Cretaceous of South Saghalien (Shimakura, 1937).

M. eboracense (Holden), Upper Cretaceous of South Saghalien (Shimakura, 1937).

M. gothanii (Stopes) Seward, Upper Cretaceous of South Saghalien (Shimakura, 1937), Lower Cretaceous of Chiba Prefecture (Nishida, 1966).

M. heizyoense (Shimakura), Middle Jurassic of Korea (Shimakura, 1936).
M. nihei-takagii Nishida, Lower Cretaceous of Chiba Prefecture (Nishida, 1966).
M. pseudo-bedfordense Nishida, Lower Cretaceous of Chiba Prefecture (Nishida, 1966).
M. woburnense (Stopes) Seward, Upper Cretaceous of Wakayama Prefecture (Shimakura, 1937), Lower Cretaceous of Chiba Prefecture (Nishida, 1966).

Diagnostic Characters of the genus *Mesembrioxylon* including both *Podocarpoxylon* and *Phyllocladoxylon*, are referred to in the third report of the Cretaceous plants of Choshi by the first author (Nishida, 1966).

One of the characteristics of the new specimen is that it often has very oblique tangential end walls in the ray cell which sometimes traverse two to five tracheids in the radial section (Figs. 3A and 4D) and appear as a very oblique line when seen in cross section (Figs. 2A and 4B, C). Such end walls as these have the appearance of very low ray cells (Figs. 3B and 4E) or ray cells with oblique septa (Fig. 2B) when seen in tangential section. This feature is unknown to us in extinct and extant coniferous woods. In the height and arrangement of rays, which are uniseriate and rarely biseriate in part, and in the arrangement of pits in the cross field, our specimen is similar to those of *M. woburnense*.

M. heizyoense and *M. eboracense* differ from the present specimen in having window-like pits in the cross field. *M. dakotense* is distinguished from our specimen in having very high and multiseriate rays; 1–60 cells high and uni-, bi- rarely triseriate. *M. pseudo-bedfordense* differs in having contiguously grouped bordered pits on the tracheids instead of separately arranged pits as in the present specimen. *M. gothanii* and *M. nihei-takagii* differ in having lower rays, 1–8, usually 1–4 cells high instead of 1–23 cells high as in our specimen.

Ramanujam (1953) described about 20 species of *Mesembrioxylon* from the Mesozoic of India, none of which has conspicuously inclined end walls of ray cells. For this reason we believe our specimen to be a new species of *Mesembrioxylon*.

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