Makoto NISHIDA* & Harufumi NISHIDA*: **Structure and affinities of the petrified plants from the Cretaceous of northern Japan and Saghalien. I. Petrified plants from the Upper Cretaceous of Hokkaido (1)****

西田 誠*・西田治文*: 北日本及びサハリンの白亜紀産石化植物 I. 北海道上部白亜紀産石化植物 (1)

(Pl. I—III)

The Cretaceous strata are widely piled on the so-called Sanriku-seashores between Kuji City and Miyako City, Iwate Prefecture and the central and northwest areas of Hokkaido in Japan, and are continuous to the central range of Saghalien. In Sanriku-seashores the Cretaceous strata mostly consist of the Lower Cretaceous (Barremian to Aptian) sediments, and the Upper Cretaceous sediments which are called the Taneichi Formation (Campanian; Tanai 1979) are restricted to the northern area. The Cretaceous strata in Hokkaido and Saghalien are the marine sediments of the same kind, and are subdivided into three parts, the Lower, Middle and Upper Yezo Groups (Aptian-Campanian). The Uppermost Cretaceous sediments that overlie the Upper Yezo Group are called the Hakobuchi Group, mainly of Maestrichtian.

The Taneichi Formation, the Middle and the Upper Yezo Groups have been known to bear abundant permineralized plant fragments as well as abundant marine fauna that are helpful for international correlation of these strata. The studies on the permineralized plants from the Upper Cretaceous of Hokkaido were revealed by Reiss (1907) who reported five species of three genera, including a new species of coniferous wood from Obirashibetsu, Teshio Province. Stopes and Fujii (1910) described 17 species belonging to 16 genera including 12 new genera from Oyubari, Yubari City. They are hypha, fern sporangium, fern rhizome, fern rachis, cycadean leaves, coniferous leaves, cones and both coniferous

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and dicotyledonous woods. Kershaw (1910) described a solenostelic fern rhizome. Stopes and Kershaw (1910) reported a monophyllous pine leaf and Suzuki (1910) described three genera including two new genera and three species of coniferous woods and fungus from the same locality. These are pioneer works on the petrified plants of Japan. Ten years later, Kryshtofovich (1920) and Endo (1925) described a new species of cycadeoidean trunk from Takikawa and Yubari Cities respectively, and the studies become to the second period. Ogura (1930, 1932 and 1944) described 16 species of a fern rachis, a fern rhizome, a cycadean trunk, a cycadean rachis, cones, pine leaves and coniferous woods belonging to 14 genera including 9 new genera from Yubari City. Shimakura (1937) also reported six genera and six species of petrified woods from Yubari, Mikasa and Sunagawa Cities.

After 30 years elapsed from the last work of the second period by Ogura (1944), Hashimoto (1971) registered a new species of a tree fern trunk from Nakagawa Town. This work is begining of the third period of investigation. Nishida and other stuffs and students of the Laboratory of Phylogenetic Botany in Chiba University tried short field trips several times between 1968-1974. The results of studies on the materials collected at that time were published by Nishida (1974, 1981), Nishida & Nishida, H. (1982), Nishida, H. (1981 a, b), Nishida, H. & Nishida (1979) and Ueda & Nishida (1982). They described taxodioid woods, fern rhizomes, fern rachises, pine leaves and an araucarian hypocotyle, including 8 new species and 2 new genera. In 1982 the authors tried a field excursion to Embetsu, Haboro, Obira, Tappu, Ikushumbetsu (Mikasa City) and Oyubari (Yubari City), under the guidance of Mr. Mitsutoshi Nihongi and Mr. Isamu Nakajima and collected abundant permineralized plant fragments from above mentioned localities. Moreover Mr. Nihongi kindly has sent us several permineralized plants collected by himself in Hokkaido. This paper is the first report of the results of studies on them. Detailed geological data will be reported in subsequent papers.

Materials and methods Materials studied were cellected from calcareous nodules or gravels on stream or rivulet beds of above mentioned localities. Hence the exact ages or formations in which they originate are uncertain except for some materials associated with ammonites or bivalvates in the same gravels or nodules. Micropreparations were made by peel method using 0.5 N hydrochloric acid as an etching reagent. All holotype specimens are deposited in the Laboratory of Phylogenetic Botany, Faculty of Science, Chiba University.

Araucarioxylon nihongii sp. nov. (Pl. I & Text-fig. 1).

Material. Specimen No. 822477 (holotype) is a piece of well preserved secondary wood showing araucarian structure, 1.5×2×3 cm.

Locality. Omaki-zawa, a branch rivulet of the Yubari river, Oyubari, Yubari City.

Horizon. Upper Yezo Group; Turonian.

Description. Growth rings invisible. Wood consisting of tracheids, rays and wood parenchyma, and lacking resin canal. Tracheids arranged regularly in radial rows, rectangular in outline in cross section, 31-50 μm in tangential and 34-61 μm in radial diameters. Bordered pits on radial walls of tracheids are typical araucarian type, arranged alternately and contiguously in usually 3-4, often 5, rows. They are hexagonal in outline and more or less flattened horizontally, 13-15 μm in vertical and 15-17 μm in horizontal diameters, and with circular pit apertures of 3-4 μm in diamrter. Bordered pits on tangential walls are not discernible. Rays all parenchymatous, always uniseriate, 1-5, rarely up to 9, cells high or 22-113 μm, rarely up to 200 μm, in height, and run at intervals of 1-13, average 3.9, rows of tracheids. There are 5-7, average 6.3, rays in 1 mm. Ray cells are vertically elongated rectangular in shape, 19-25 μm and 12-17 μm in vertical and horizontal widths respectively in tangential section. In a cross field, 8-12 small ovoid pits, 5 μm in diameter, arranged in 2-3 horizontal rows. Wood parenchyma abundant and evenly diffused and composed of very low cells, 31-46 μm in tangential and 19-25 μm in radial width respectively and 61-85 μm, often 39-55 μm in height.

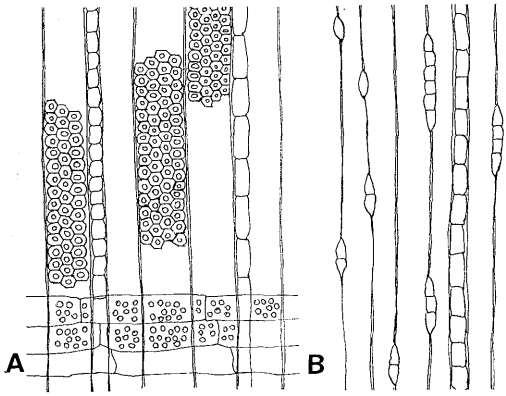

Fig. 1. *Araucarioxylon nihongii* sp. nov. Radial (A) and tangential (B) sections showing wood parenchyma consisting of very low cells.

Affinity. The new specimen exactly belongs to *Araucarioxylon* judging from the araucarian type pitting on tracheids. Abundant diffused wood parenchyma composed of typically low cells is one of characteristics of this

specimen, which is quite rare in more than 250 species of *Araucarioxylon*. We have few informations of species with wood parenchyma among *Araucarioxylon*, for example, *A. shizugawaense* Shimakura (1936) from the Jurassic of Miyagi Prefecture, *A. hujinamiense* Ogura (1960) from the Lower Cretaceous of Wakayama and Chiba (Nishida 1973) Prefectures, *A. pseudofujinamiense* Nishida & Oishi (1982b) from the Lower Cretaceous of the Kwanto Mountains and *A. inuboense* Nishida (1965) from the Lower Cretaceous of Chiba Prefecture etc. These species are also distinguished from the present specimen in the structure of the cross field, a few moderate pits, and arrangement of bordered pits on the tracheids. The pesent specimen resembles closely *A. tankoense* Stopes et Fujii (1910) from the Upper Cretaceous of Yubari in having 3-5 rowed bordered pits on the tracheids, 8 or more small circular pits in the cross field and uniseriate low rays, usually 1-8 cells high. The latter, however, dces not have any wood parenchyma. The specimen in hand is very unique in having wood parenchyma consisting of very low cells and would be a new species of *Araucarioxylon*. Specific epithet is dedicated to Mr. Mitsutoshi Nihongi who has endeavored to palaeontological survey in Hokkaido for a long time and assisted our field work there.

Oguraxylon pseudoyubariense sp. nov. (Pl. II & Text-fig. 2).

Material. Specimen No. 823513 (holotype) is a calcified fragment of secondary wood, 2×3×6 cm, and exhibits poor preservation.

Locality. A small stream near south end of Sanyu Tunnel, Oyubari, Yubari City.

Horizon. Upper Yezo Group, Turonian.

Description. Growth rings faintly visible. Transition from early to late wood abrupt. Wood consisting of tracheids, rays and wood parenchyma and lacking resin canal in normal wood. Traumatic resin canals present. In cross section, tracheids arranged regularly in radial rows, rectangular or radially elongated rectangular, 43-60 μm in radial and 34-40 μm in tangenital diameters in the early wood and tangentially elongated, 9-12 μm in radial and 26-34 μm in tangential diameters in the late wood. Bordered pits on radial walls of tracheids ordinary coniferous type, arranged separately and oppositely in one or two rows, 14-17 μm in diameter, with ovoid pit apertures, 5-7 μm in long diameter. Crassulae invisible. Bordered pits on tangential walls smaller and sparsely arranged in irregular but single row. Tracheids often have tertiary spiral thickenings which are single spiral running with intervals of 7-15 μm, and inclined 10-20 degree

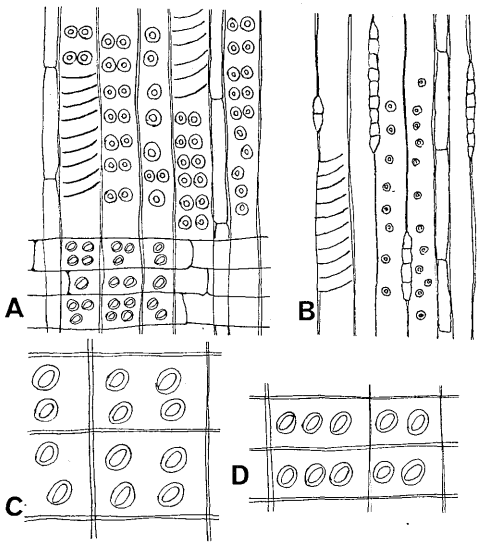

Fig. 2. *Oguraxylon pseudoyubariense* sp. nov. (A-C) and *O. yubariense* Nishida (D) for comparison. A & B: Radial and tangential sections respectively. Note tertiary spiral thickenings. C & D: Cross field of *O. pseudoyubariense* and *O. yubariense* respectively. Note half-bordered pits arranged in two horizontal rows in C instead of a singl row in D.

or nearly horizontal. Rays always uniseriate, homogeneous and all parenchymatous, 1-22, mostly 2-12, cells high or mostly 44-250 μm in height. Ray cells are vertically elongated rectangular in outline in tangential section, 12-20 μm in width and 17-27 μm in height. Ray cells are pitted only on radial walls; devoid of abietineous pitting. Rays run at intervals between 1-16 rows of tracheids, and average of 4.6, or there are 5-8, average 6.1, rays in 1 mm. There are two to four cupressoid or taxodioid half-bordered pits which are arranged in vertical pairs or horizontal two rows in the cross field in the early wood and one per cross field in the late wood. Traumatic resin canals sporadically present, arranged tangentially. Each canal is surrounded by 5-8 epithelial cells. Wood parenchyma is diffused throughout the woood, but more or less inclined to be arranged tangentially, and occluded with brown resinous substances.

Affinity. The new specimen belongs to *Oguraxylon* (Nishida 1974) which is taxodioid in ground structure, but has tertiary spiral thickenings on tracheids and first described from the Upper Cretaceous of Yubari, Hokkaido. The new specimen is similar to the type species, *O. yubariense* Nishida (1974), in general structure, but differs from the latter in the structure of the cross field. *O. yubariense* has one to three half-bordered pits which arranged horizontally in one row in the cross field (Fig. 2, D), while the new specimen has one to four pits, and if in two or more, they are arranged in vertical pairs, or in horizontal two rows (Fig. 2, C). Thus the present specimen would be a new species of

Oguraxylon.

Protocedroxylon yezoense sp. nov. (Pl. III & Text-fig. 3, 4).

Material. Specimen No. 823119 (holotype) is a piece of calcified secondary wood, 4×5×6 cm, and has been poorly preserved.

Locality. Hifumi-zawa stream, a branch of Kamikinenbetsu river, Tappu, Obira Town.

Horizon. Upper Yezo Group, Turonian.

Description. Growth rings visible. Transition from early to late wood gradual. Wood consists of tracheids, rays and wood parenchyma, and devoid of resin canal. In cross section, tracheids rectangular or more or less radially or tangentially elongated rectangular in shape, 56–65 μm in tangential and 39–41 μm in radial diameters in the early wood, 46–49 μm in tangential and 12–17 μm in radial diameter in the late wood. Tracheids often have several septular structures which seem to originate in tyleses. Bordered pits on radial walls are protopinoid, contiguously or sometimes separately arranged in single row, and somewhat flattened circular, 20–22 μm in vertical and 26–29 μm in horizontal diameters, with circular pit apertures of 7–9 μm in diameter. Bordered pits on tangential walls are separately and sparsely arranged in irregular one row. Rays always parenchymatous, mostly uniseriate, 1–28, usually 5–13, cells high, or 50–1200 μm, usually 100–580 μm in height, and run at intervals of 1–5, average 3.0, rows of tracheids. Ray cells vertically elongated ovoid or rectangular in outline in tangential section, 22–27 μm in vertical and 14–22 μm in horizontal width. Abietineous pitting is faintly visible; tangential and horizontal walls of ray cells are pitted by small simple pits of 3–7 μm in diameter; there are single or two ovoid half-bordered pits, 10–17 μm in long diameter, with ovoid or elliptical pit apertures, in the cross field. Wood parenchyma are sparsely distributed throughout the wood, and occluded with brown resinous substances.

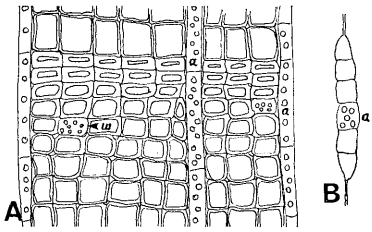

Fig. 3. *Protocedroxylon yezoense* sp. nov. A: Cross section showing a periphery of growth ring and abietineous pittings on horizontal walls of ray cells. B: Tangential section of a ray showing abietineous pittings on a tangential wall. a. abietineous pitting of ray cells. W: wood parenchyma.

Affinity. The specimen in hand would belong to the Protopinaceae in having

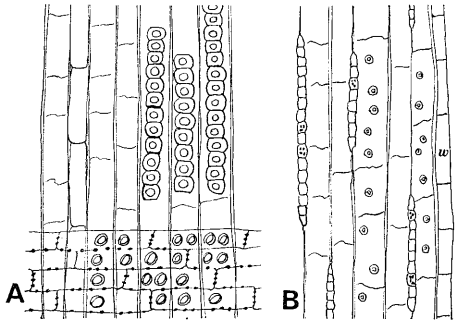

Fig. 4. *Protocedroxylon yezoense* sp. nov. Radial (A) and tangential (B) sections. Note nodular thickenings of tangential and horizontal walls of ray cells in A and abundant tyloses in both A and B. w: wood parenchyma.

protopinoid bordered pits on the tracheids, somewhat large half-bordered pits in the cross field and abietineous pitting on ray cellls. Kräusel (1949) degraded *Protocedroxylon* into *Araucariopitys* and he treated *Metacedroxylon, Paracedroxylon, Paracupressinoxylon* and *Thylloxylon* as synonyms of *Araucariopitys*. *Protocedroxylon* sensu Vogellehner (1968) includes *Araucariopitys, Metacupressinoxylon* and *Planoxylon*. *P. scoticum* (Holden) Seward (1919) from the Jurassic of West Europe, *P. lindicianum* (Kahn) Vogellehner (1968) from the Jurassic of Middle Europe, *P. haraulochicum* (Shilikina) Vogellehner (1968) from the Jurassic of East Siberia, *P. latiporosum* (Holden) Vogellehner (1968) from the Jurassic of Middle Europe, *P. araucarioides* Gothan (1910) from the Jurassic of West Europe, *P. japonicum* Nishida (1967) and *P. pseudoaraucarioides* Nishida (1973) from the Cretaceous of Japan, and *P. minense* (Ogura) Nishida et Oishi (1982a) (=*P. triassicum* Yamazaki et al. 1980) are distinguished from the present specimen in lacking wood parenchyma. *P. haraulochicum* also differs from the specimen in hand in the structure of the cross field, having small 2–5 ovoid pits instead of moderate 1–2 pits in the latter. *P. brebenhasanum* (Kahn) Vogellehner (1968) from the Jurassic of West Europe differs from the specimen in hand in having lower rays, 1–10 cells high instead of 1–28 cells high in the latter. *P. liassicum* (Kahn) Vogellener (1968) from the Jurassic of Middle Europe is distinguished from the specimen in hand in having lower rays, 2–12 cells high. The present specimen resembles *P. okafujii* Nishida et Oishi (1982a) from the Triassic of Yamaguchi Prefecture, Japan in general structure, but differs from the latter in having lower uniseriate rays, 1–28 cells high, less abundant tyloses in the tracheids and a few numbers of wood parenchyma instead of uni- and biseriate and higher rays, 1–40 cells high, very abundant tyloses and fairly abundant wood parenchyma in the latter. *Planoxylon* (Stopes 1915) was degraded

to a synonym of *Protocedroxylon* by Kräusel (1949) and Vogellehner (1965). We, however, appreciate to retain *Planoxylon* that is characteristic in having typical araucarian type of pitting on tracheids and vertical pairs of half-bordered pits in the cross field. *Protocedroxylon* and *Cedroxylon* have horizontal rows of pits in the cross field. In this respect, *Planoxylon inaii* Shimakura (1937) from the Upper Cretaceous of Saghalien was transfered to *Cedroxylon* by Nishida (1973). Moreover *Planoxylon choshiense* Nishida (1967) should be transfered to *Protocedroxylon*, judging from its protocedroid features in the cross field. It, however, differs from thespecimen in hand in lacking tyloses in the tracheids and in having uni- or bi-, sometimes triseriate rays. *Metacupressinoxylon ylossissimum* Nishida (1965) and *M. pseudotylossimum* Nishida (1965) from the Cretaceous of Chiba Prefecture, Japan, also resemble the specimen in hand in having tyloses and structure of the cross field, but differ from the latter in having lower rays, 1-12 and 1-4 cells high respectively. The other two species of *Metacupressinoxylon* in Japan (Nishida 1965) also differ from the present specimen in lacking tyloses and in having lower rays, less than 12 cells high. *Araucariopitys japonicum* Yamazaki et al. (1980) from the Triassic of Yamaguchi Prefecture resembles very closely *Protocedroxylon okafujii* collected from the same locality and differs from the specimen in hand in having traumatic resin canals and sclerenchyma in the pith, and higher rays, often more than 40 cells high. The taxonomy and nomenclature of Japanese species of protopinoid woods have been confused and we are going to proceed them in the near future.

We wish to express our thanks to Mr. Mitsutoshi Nihongi and Mr. Isamu Nakajima for their kindness in assistance to collect and donate materials studied. Gratefulness also due to Miss Satoko Kageyama for her assistance in making micropreparations of materials.

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Explanation of Plates I—III

Plate I. *Araucarioxylon nihongii*, sp. nov. A: Cross section. Wood parenchyma is dispersed. B & D: Tangential sections. Bordered pits arranged in three to four rows are shown in B. Short wood parenchyma cells are seen near the right margin of B. Note very short wood parenchyma cells in D. C: Radial section. More than six pits are seen in a cross field. A, ×35. B & D, ×88. C, ×175.

Plate II. *Oguraxylon pseudoyubariense*, sp. nov. A: Cross section showing traumatic resin canals. B & C: Tangential sections. Feeble tertiary spiral thickenings are seen in C. D & E: Radial sections. Tertiary spiral thickenings are seen in D. Half-bordered pits arranged in two horizontal rows are seen in the cross field in E. A & B, ×88. C, ×175. D, ×240. E, ×350.

Plate III. *Protocedroxylon yezoense* sp. nov. A & B: Cross sections. Note abietineous pittings of ray cells in B. C & D: Tangential sections, showing

tyloses having an appearance of septa (in C & D) and abietineous pittings (in C). E & F: Radial sections, showing uniseriate bordered pits arranged contiguously and one or two large pits in a cross field. Abietineous pittings are seen having an appearance of nodules on horizontal walls of ray cells in F. A, ×35, B, C & F, ×175. D & E, ×88.

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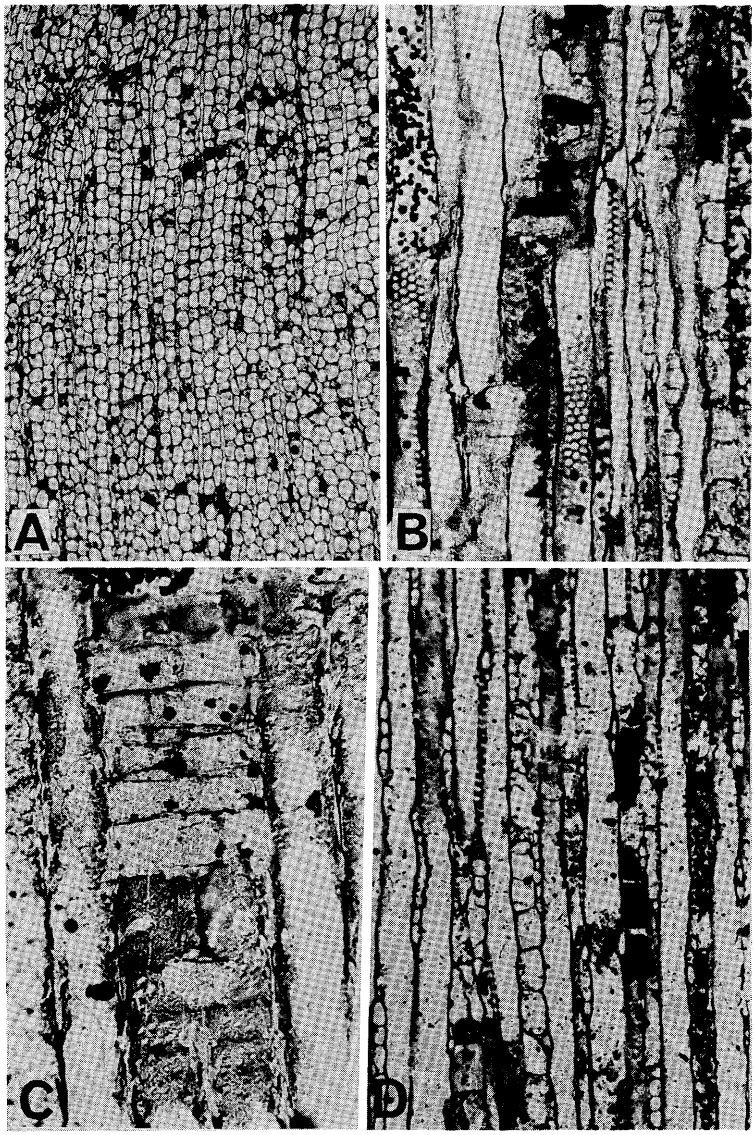
北海道の上部白亜系上部えぞ層群から得た材化石の3新種を記載した。*Araucarioxylon nihongii* は木部柔組織が極めて多く，しかも丈の低い細胞からできているという，他に例を見ない特徴をもった珍種である。大夕張の大巻沢の転石中より採集。種小名は札幌市の二本木光利氏に献名した。かつて西田（1973）は基本的にはスギ科に属する構造を示し，かつ仮導管にしばしば第3次らせん肥厚をもつ材を新属 *Oguraxylon yubariense* として大夕張のダムサイトから報告した。今回，大夕張の奥，三夕トンネルの南出口付近の小沢で得た転石から同属の新種 *Oguraxylon pseudoyubariense* を記載した。両者は図2C，Dで図示したように，直交分野の半有縁孔の配列によって区別できる。*Protocedroxylon yezoense* はナンヨウスギ型と一般的球果類型の有縁孔をもった仮導管とモミ型膜孔をもった放射組織とを併せもった Protopinaceae に属する材で，中生代に特有のものである。本種は仮導管にはチローシスを生ずるが，多くはなく，木部柔組織があり，放射組織の高さは1～28，主に3～15細胞高，直交分野に1～2個の比較的大きい半有縁孔があるのが特徴である。小平町達布一二三沢の転石中より採集した。これらの転石は上部えぞ層群（Turonian）から由来したものと思われる。

□久保田秀夫 他：**鬼怒沼湿原の植物** 141 pp. 植生図1，付表付図多数. 1983. 栃木県林務観光部環境観光課. 非売品. 鬼怒沼は栃木県北西部の群馬県境近く海抜 2,000 m の所に広がる高層湿原で，日光国立公園の特別保護地区に指定されている。尾瀬原湿原よりも交通不便だということもあって訪れる人が割合少なく，オオシラビソの林に囲まれて明るく開けた湿原の景色もよく保存されていたが，近年登山者が増すにつれて環境破壊が目立つようになったといわれる。また最近は，環境保護団体などが反対し続けていた奥鬼怒スーパー林道という県境を越える道が工事にかかるとかで，たとえ観光用車両は入れないという条件づきであるにしても俗化は目に見えているといえよう。久保田氏ら5人の昭和55年以来の詳しい植生調査の結果がまとめられて発表されたことは，まことに意義あることということができる。（伊藤 洋）



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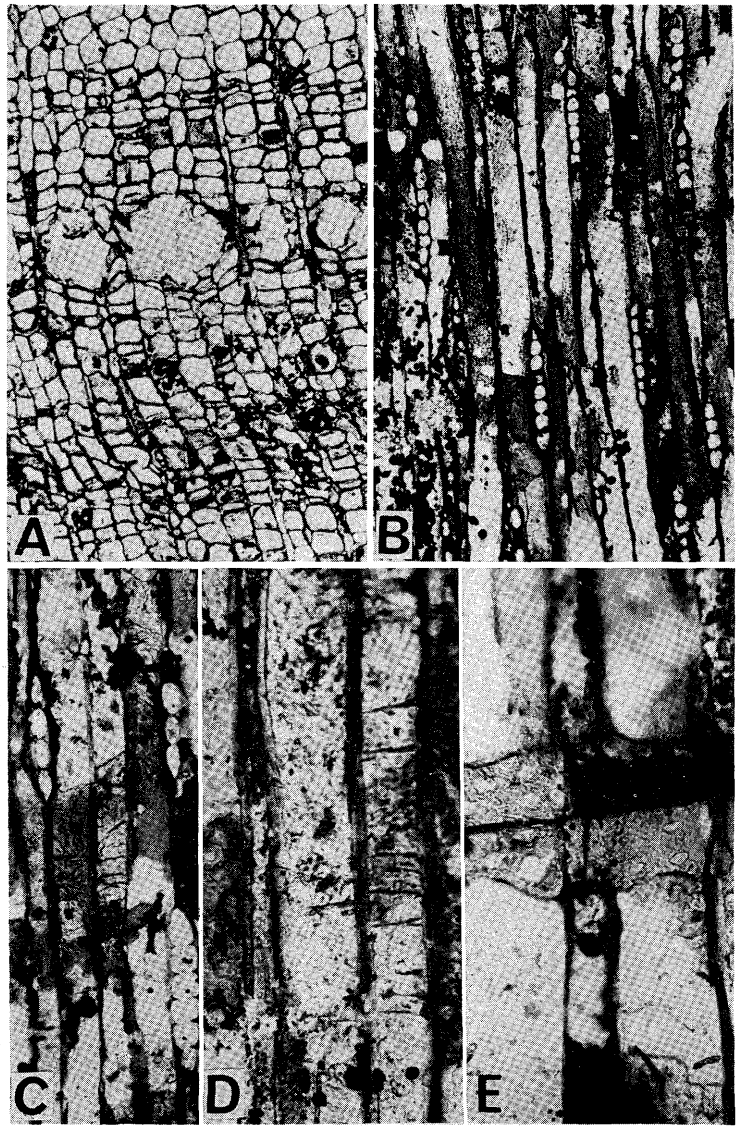

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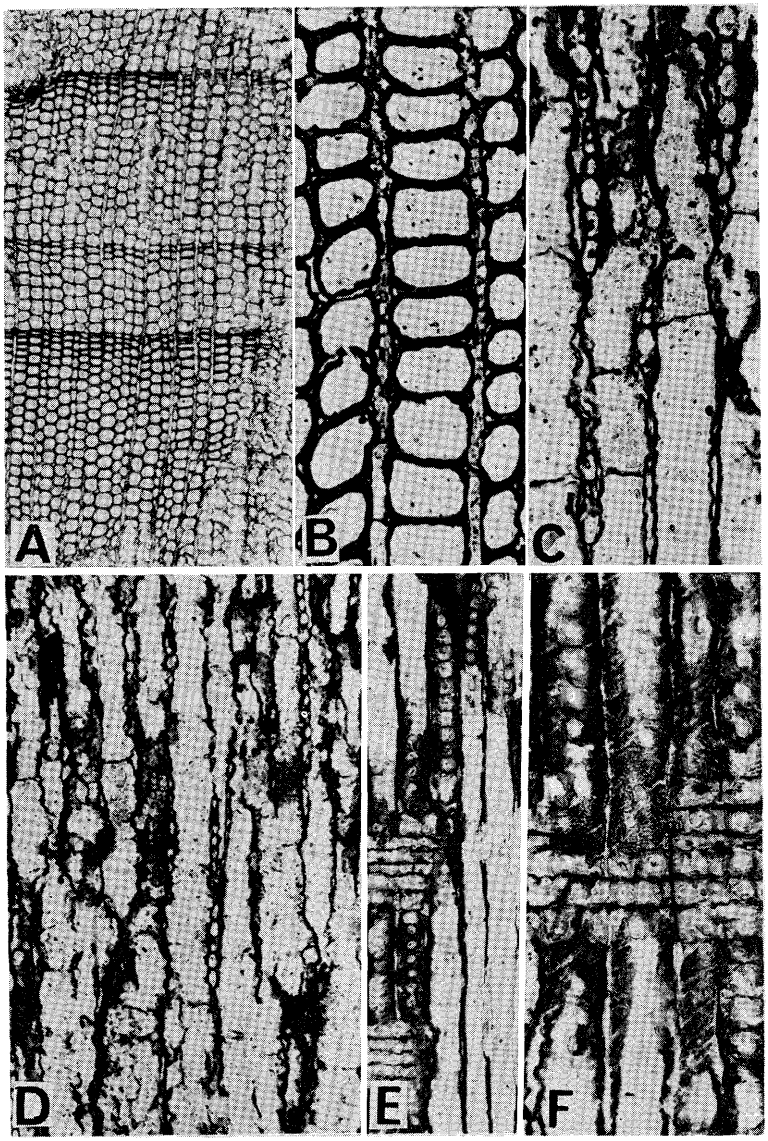

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