Mitsuo SUZUKI*: A new fossil wood of *Paraphyllanthoxylon* (Euphorbiaceae) from the Miocene of Kobe

鈴木三男*: 神戸市中新統産トウダイグサ科の材化石の一新種

(Pls. VI & VII)

About 56 years ago, a large silicified trunk was discovered in the Miocene strata at a site of track-laying work of Kobe Dentetsu in Kobe City. The fossil trunk is very large in size with 80 and 120 cm in diameters and 230 cm in height. It had been kept as an ornamental stone at a garden of a private hospital in the city until it was presented to the Kobe Municipal Arboretum in January of this year. Because the preservation of the internal structure of the fossil is fairly good, I can fortunately study and describe it as a new species of the Euphorbiaceae, *Paraphyllanthoxylon kobense*. This species shows the closest resemblance in many anatomical features with *Paraphyllanthoxylon pseudo-hobashiraishi* (Ogura) Mädel (=*Phyllanthinium pseudo-hobashiraishi* Ogura) discovered from the Palaeogene of Najima and Tobata, Fukuoka Prefecture (Ogura 1932b, Watari 1943, Mädel 1962). Fossil woods of the Euphorbiaceae are rather rare from the Tertiary of Japan, while Watari (1956) reported an occurrence of *Aleurites miocenica* Watari from the Miocene of Ishikawa Prefecture.

Paraphyllanthoxylon kobense M. Suzuki, sp. nov. Pls. VI & VII.

Material: The specimen, No. 67001 (holotype), is a large silicified trunk, 80 and 120 cm in diameters and 230 cm in height. The preservation of internal structure is fairly good but it is more or less crushed radially and tangentially. Therefore, some measured characteristics such as width of growth rings, pore density, pore size and the density of rays may be more or less different from the true value.

Locality: Suzurandai, Kobe, Hyogo Prefecture.

Horizon: Shirakawa Formation, Kobe Group (Miocene).

Holotype: The holotype thin sections are deposited in the Fossil Plant Collection, College of Liberal Arts, Kanazawa University. Isotype thin sections

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and the silicified trunk are deposited in the Forest Museum, Kobe Municipal Arboretum.

Description: Wood diffuse porous. Growth rings faintly distinct, because the pore size and its density quite similar between in the late wood and in the following early wood; width fairly uniform, 1.2-3.8 mm wide. Pores evenly distributed and numerous, 50-82 pores (mean 59.6 pores) or 19-28 multiple pore groups in a square mm. Pores usually in multiples with 2-5 pores (mostly 3 or 2 pores) or sometimes solitary. The multiples mostly in radial row and the outline of multiple pores are radially long elliptical as if it were a single pore; fairly uniform in size. Solitary pores radially elongated elliptical and modelately large, about 180 and 120 μm in radial and tangential diameters respectively; thin-walled. Vessel elements moderately short, 420-700 (mean 558) μm long; end walls oblique with exclusively simple perforation plates. Intervessel pits dense and alternate in arrangement; horizontally elongated polygonal in outline; about 8 and 10 μm in vertical and horizontal diameters respectively; apertures slit-like and horizontally orientated. Spiral thickenings invisible. Thin-walled tyloses often present as if they were septa of vessels.

Wood fibers constitute the ground mass of the wood; septate; polygonal in cross section, 10-25 μm in diameter with walls of 2-5 μm thick.

Wood parenchyma scanty paratracheal; almost same size with wood fibers in cross section; sometimes with crystals.

Rays heterogeneous; 8-11 rays per mm length in tangential section; uniseriate or multiseriate. Multiseriate rays 2-4, mostly 3 or 4, cells wide. Uniseriate rays 20-30 (mean 23.1) μm and multiseriate ones 45-70 (mean 61.1) μm or more, rarely up to 100 μm, in width. Rays 120-1000, mostly 250-700 (mean 497) μm and sometimes up to 1200 μm or more in height. Multiseriate rays constitute from uniseriate wings of 1-6, mostly 1-4, cells high and central cores of multiseriate parts. Uniseriate rays and uniseriate wings consist of wholly upright cells; 8-25, 25-100 and 20-75 μm in tangential, vertical and radial diameters respectively. Central cores consist of procumbent cells; 8-20, 10-28 and 40-200 μm in tangential, vertical and radial diameters respectively. Crystals often present in the upright cells. Pits between upright cells and vessels oval or horizontally long elliptical in outline; about 8 and 8-20 μm in vertical and horizontal diameters respectively; arranged alternately and sometimes nearly in scalariform.

Affinity The outstanding anatomical features of the present fossil are as follows: (1) pores are quite evenly distributed and fairly numerous, (2) pores are medium size and usually in radial multiples, (3) a multiple pore group looks like a single pore with elliptical outline, (4) vessels have simple perforations and alternately arranged intervessel pits, (5) wood fibers are septate, and (6) rays are typically heterogeneous with 1-4 cells wide. These and many other features of the fossil mostly agree with those of *Paraphyllanthoxylon* (*Phyllanthinium*) *pseudo-hobashiraishi* (Ogura) Mädel (Ogura 1932b, Mädel 1962). It was discovered from the Palaeogene of Najima, near Fukuoka City, where a famous large silicified trunk named "Hobashiraishi", *Quercinium hobashiraishi* Ogura (1932a), is lying at the seashore and kept as a national monument. Eleven years after the discovery, Watari (1943) also found a large silicified trunk of the species from the Palaeogene of Tobata City, Fukuoka Prefecture. On the other hand, Watari (1956) reported an occurrence of large trunk of *Aleurites miocenica* Watari in the Miocene of Oosugidani, Ishikawa Prefecture. Its wood structure is quite different and easily distinguishable from the present fossil by its ring porosity and uniseriate rays. Therefore, only two species of euphorbiaceous fossil wood, which are mentioned above, have been hitherto reported from the Tertiary of Japan.

As is generally known, the wood structures in the Euphorbiaceae are full of variety and heterogeneous. In a revisional study on fossil wood of the family, Mädel (1962) offers to classify the fossils into four groups of form-genera basing on the differences in anatomical characteristics of the living woods. The four groups are as follows: (1) *Putranjiva*-group with *Putranjivoxylon* Ramanujam, (2) *Glochidion*-group with *Paraphyllanthoxylon* Bailey and *Securinegoxylon* Mädel, (3) *Bridelia*-group with *Bridelioxylon* Ramanujam, and (4) Crotonoideae-group with *Euphorbioxylon* Felix, *Heveoxylon* Kruse and *Aleuritoxylon* Mädel, while some fossil species are left as undefinited ones. When we consider the anatomical features of the present fossil, it will be easily understandable that the fossil surely belongs to *Paraphyllanthoxylon* of the second group, because it has septate fibers, exclusively simple perforations, rather scarce wood parenchyma and distinct heterogeneous rays. According to Mädel (1962) and Daniou & Dupéron-Laudoueneix (1978), there are about 13 species of *Paraphyllanthoxylon*. Four species are known from North America. *P. arizonense* Bailey (1924) is from the Cretaceous of Arizona; it differs from the present fossil

in its fewer pores and wider rays. *P. pfefferi* (Platen) Mädel (Platen 1908, Mädel 1962) is from the Neogene of California; it also differs in its larger pore number of multiples. *P. idahoense* Spackman (1948) is from the Cretaceous of Idaho; although it shows some resemblance to the present fossil, it differs in its moniliform outline of multiple pores according to the round outline of each pore, while that of the present fossil is elliptical. *P. alabamense* Cahoon (1972) is from the Upper Cretaceous of Alabama; it differs in its fewer pores and lower uniseriate wings of multiseriate rays. On the other hand, four species are known from Europe under the generic name, *Paraphyllanthoxylon*. *P. lignitum* Dupéron-Laudoueneix (Daniou & Dupéron-Laudoueneix 1978) is from the Eocene of Charente, France; it differs from the present fossil in its large pore number in multiples and wider rays. Although I can not quote the original literature on two fossils from the Tertiary of France, *P. yvardi* Koeniguer and *P. teldense* Prive, it will be reasonable to consider that those two fossils do not belong to *Paraphyllanthoxylon* but to other genera, because Daniou & Dupéron-Laudoueneix (1978) say that the former species has non-septate fibers and the latter has scalariform perforations. Then they also introduce an occurrence of *P. romanicum* Petrescu from the Upper Cretaceous of Romania, and the species may also differ from the present fossil in its larger pores. Three species of *Paraphyllanthoxylon* and one species of *Phyllanthinium* are known from India. *Paraphyllanthoxylon tertiarum* (Ramanujam) Mädel (Ramanujam 1956, Mädel 1962) is discovered from the Neogene of Madras; it differs from the present fossil in its absence both of tyloses in vessels and crystals in ray cells. *P. sahnii* (Prakash) Mädel (Prakash 1958, Mädel 1962) is from the Palaeogene of Madhya Pradesh; it differs also in its fewer pores and wider rays. *P. keriense* Dayal (1968) is from the Eocene of Madhya Pradesh; it differs in its very few pores. Although *Phyllanthinium bangalamodense* Navale (1960) is classified into the same genus with *P. pseudo-hoboshiraishi*, which shows the closest resemblance with the present fossil, it is quite different from the present fossil in very fewer pores, abundant wood parenchyma and others. Only one species, *Paraphyllanthoxylon capense* Mädel (1962) is known from the Upper Cretaceous of South Africa; it fairly resembles the present fossil in several features but also differs in its fewer pores and absence of crystals in ray cells. The Japanese fossil, *Paraphyllanthoxylon pseudo-hobashiraishi* (Ogura) Mädel shows the closest resemblance to the present fossil and it differs only in some minute anatomical features, i. e.,

a little fewer pore density (23-40 pores per square mm) and the less degree of heterogeneity of rays (uniseriate wings of multiseriate rays mostly 1-2 cells high). Therefore, the present fossil seems to be a new member of *Paraphyllanthoxylon* and a closely related species to *P. pseudo-hobashiraishi*.

The investigation on wood structure of some living euphorbiaceous representatives indicates that the wood structure of the present fossil and *P. pseudo-hobashiraishi* fairly resemble those of *Bishoffia*, *Phyllanthus*, *Glochidion* and some others which are distributed mainly in tropics and subtropics, and quite different from those of the species which are distributed in the warm temperate region in Japan. Therefore, the occurrence of the present fossil may indicate the presence of the warmer climate in the Miocene than the present in Japan.

References

Bailey, I. W. 1924. The problem of identifying the wood of Cretaceous and later dicotyledons: *Paraphyllanthoxylon arizonense*. Ann. Bot. **38**: 439-451. Cahoon, E. J. 1972. *Paraphyllanthoxylon alabamense*—A new species of fossil dicotyledonous wood. Amer. J. Bot. **59**: 5-11. Daniou, P. & M. Dupéron-Laudoueneix. 1978. Identification d'un bois fossile d'Euphorbiaceae dans les dépôts détritiques du Sud de la Charente. Compt. Rend. 103e Congr. nat. Soc. sav., Nancy, 1978. Sci. II: 187-200. Dayal, R. 1968. A new fossil wood of Euphorbiaceae from the Deccan Intertrappean beds of Madhya Pradesh. The Palaeobotanist **16**: 148-150. Mädel, E. 1962. Die fossilen Euphorbiaceen-Hölzer mit besonderer Berücksichtigung neuer Funde aus der Oberkreide Süd-Afrikas. Senck. leth. **43**: 283-321. Navale, G. K. B. 1960. *Phyllanthinium bangalamodense*: a new species of fossil Euphorbiaceous wood from the "Cuddalore series" of India. The Palaeobotanist **9**: 11-16. Ogura, Y. 1932a. On the structure of "hobashira-ishi", a famous silicified trunk at Najima near Fukuoka City. Jap. J. Bot. **6**: 173-181. —— 1932b. On the structure of a silicified wood found near "hobashira-ishi" at Najima near Fukuoka City. Jap. J. Bot. **6**: 183-190. Platen, P. 1908. Untersuchungen fossiler Hölzer aus dem Westen der Vereinigten Staaten von Nordamerika. Sitzungsb. Naturforsch. Ges. Leipzig **34**: 1-155, 161-164. Prakash, U. 1958. Studies in the Deccan Intertrappean flora—4. Two silicified woods from Madhya Pradesh. The Palaeobotanist **7**: 12-20. Ramanujam, C. G. K. 1956. Fossil woods of Euphorbiaceae from the Tertiary rocks of South Arcot District, Madras. J. Indian Bot. Soc. **35**: 284-307. Spackman, W. Jr.

1948. A dicotyledonous wood found associated with the Idaho Tempskyas. Ann. Mo. Bot. Garden **35**: 107–115. Watari, S. 1943. Studies on the fossil woods from the Tertiaty of Japan. III. A large silicified trunk of *Phyllanthinium pseudo-hobashiraishi* Ogura from the Palaeogene of Tobata City. Jap. J. Bot. **13**: 255–260. —— 1956. A large wood of *Aleurites* from the Miocene of Ishikawa Prefecture, Honsyu. Bot. Mag. Tokyo **69**: 468–473.

Explanation of Plates VI & VII

Pl. VI. *Paraphyllanthoxylon kobense* M. Suzuki.

1: Cross section (×40) showing diffused arrangement of medium size pores.
2: Cross section (×100) showing multiple pores with two to several pores.
3: Tangential section (×100) showing 1–4 seriate heterogeneous rays.

Pl. VII. *Paraphyllanthoxylon kobense* M. Suzuki.

4: Radial section (×100) showing wood parenchyma with chambered crystals. 5: Radial section (×200) showing upright cells with crystals. 7: Radial section (×100) showing alternate intervessel pits. 8: Radial section (×100) showing a simple perforation (S) and thin-walled tyloses (T) in vessels.

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神戸市の森林植物園の展示館にある珪化木の同定の依頼をうけた。この珪化木は直径80×120センチメートル，高さ2.3メートルもある大きなもので，昭和3年頃，神戸電鉄の鉄道敷設工事の時，神戸市北区鈴蘭台の神戸層群白川累層（中新世）から出土したものである。材構造の保存は比較的良く，次のような特徴をもっている。それは，(1)道管は中位の大きさで均一に分布し，年輪界は目立たない，(2)道管はほとんどが放射方向に2–5個が複合し，時に単独，いずれもその輪廓が放射方向に長い楕円形をしている，(3)道管の穿孔は単一で，道管相互の壁孔は交互状で密に分布している，(4)隔壁木繊維をもつ，そして(5)放射組織は異性で1–4細胞幅，直立細胞に結晶をもつ，などである。以上の形質は福岡県名島および戸畑の古第三紀層から報告されているニセホバシライシ（*Paraphyllanthoxylon pseudo-hobashiraishi* (Ogura) Mädel）にその大すじにおいて極めてよく一致し，ただ，ニセホバシライシの方が道管の分布密度がすこし低い，放射組織がかなり同性的になる，などの比較的軽度の相違があるのみである。*Paraphyllanthoxylon* は1924年にBaileyがアリゾナの白亜紀産の材化石をもとに立てた形態属で，現在までに北米，ヨーロッパ，インド，アフリカおよび日本の，白亜紀から新第三紀にかけての地層より約13種が知られている。本化石はそのいずれの種とも材構造が異なっており，これをニセホバシライシに最も近い新種 *Paraphyllanthoxylon kobense*

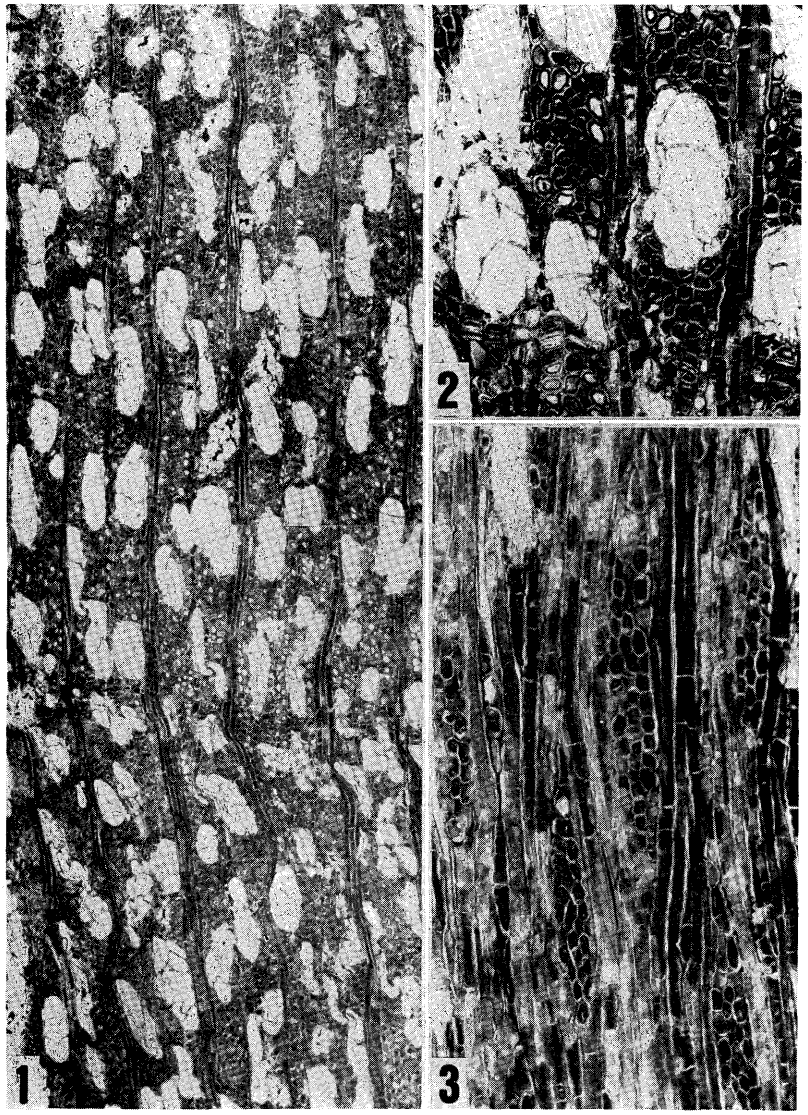
として記載した。

トウダイグサ科は非常に大きな科で，多分に異質なものを含んでいると考えられているが，その材構造も極めて多形である。その中で，ニセホバシライシや本化石は，小倉謙先生や亘理俊次先生も言っているように，コミカンソウ亜科のカンコノキ属，コミカンソウ属，またハズ亜科のアカギ属などによく似ている。これらの仲間で大木となるものは，現在ではいずれも熱帯から亜熱帯に分布している。従ってこれらの化石種の存在は，それらが生育していた当時の，現在より温暖な気候の存在を示しているのかも知れない。

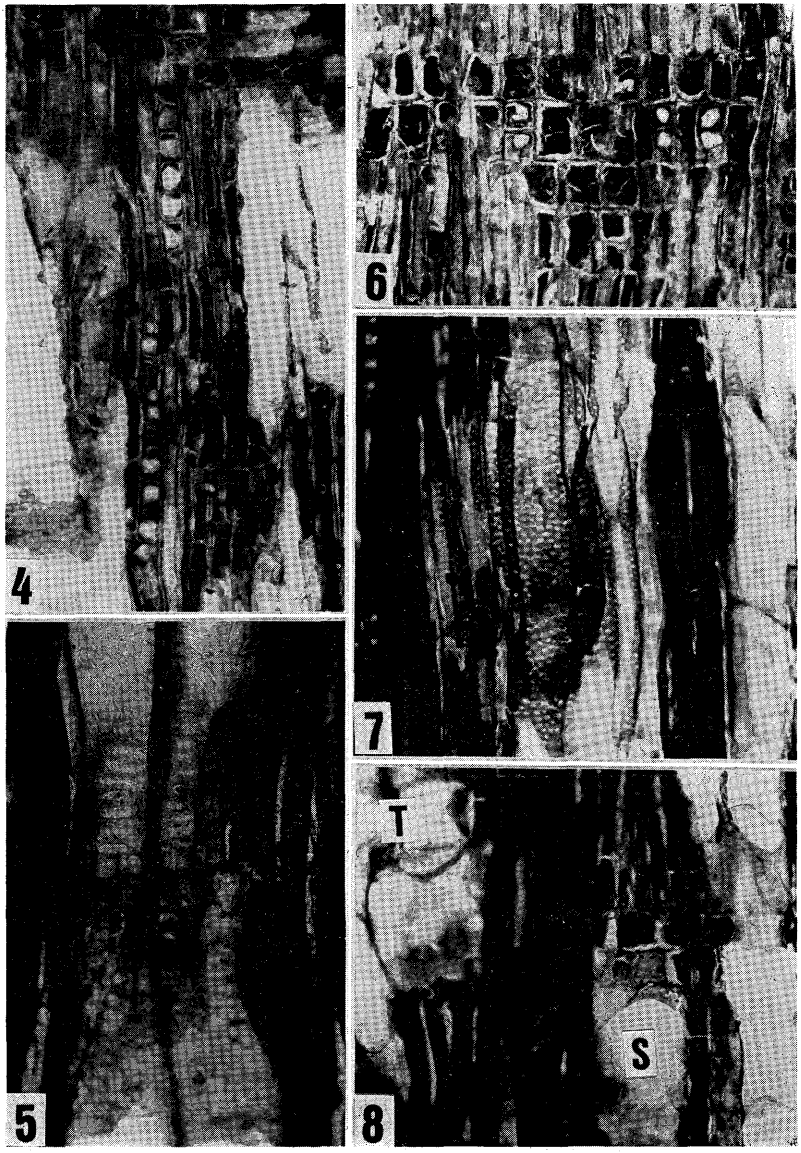
なお，本研究の遂行にあたっては，神戸市教育研究所の前田保夫先生に種々の便宜および教示をいただいた。ここに記して感謝いたします。

□阿部近一：**徳島県野草図鑑＜下＞** 319 pp. 1984. 徳島新聞社，徳島．¥2500. 昨年8月に出版されたものの続編で，各頁1種，時に2種が分類順に配列され，カラー写真に簡単な解説がつけられている。（金井弘夫）

□宮本 淳(訳)： レオ・レオーニ，**平行植物**(Leo Leoni: La Planta Parallela) 307 pp. 1980. 工作舎，東京．¥1,800. 私のところは博物館だからいろいろな質問がくるが，慶応大学経済学部の学生が「平行植物について知りたい」と本を持ってやって来たのには少々驚いた。同校の一般教養物理で指定図書になっているとのことである。本書は一見学術書のような体裁をもっているが，植物学の本ではない。すべてが著者（イタリアのグラフィック・デザイナー）の空想，と言って悪ければ思索の産物である。それにしても発見のいきさつ（たとえば，1970年大阪大学の上高地清正は奈良の久茂山でフシギネ *Anaclea* を発見した），研究の経過，進化の径路，植物の学名，土名（たとえば，*Artisia magistra* マネモネ科マイヒメマネモネ……学名のリストがついているが，現行の属名と同じ綴りのものは一つもなかった），学会の模様（たとえば，1982年に東京で国際平行植物学会議が開催される），引用文献，年表といった具合に，植物を知らない人が読んだら本当にこういう植物があると思い込みそうである。非ユークリッド植物学とでも言おうか。翻訳者は大変だったことだろう。非ユークリッド幾何学は思考の産物から実在となったが，平行植物は植物学では認知されることはないだろう。芸術的な認識論として頭の体操のつもりで読めばよいのだろうが，私の頭はそれほど柔軟ではなかった。（金井弘夫）



M. SUZUKI: A new fossil wood of *Paraphyllanthoxylon*



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