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A Note on Tertiary *Sciadopitys* (Coniferopsida) from Japan

By

Kazuhiko UEMURA

Department of Geology, National Science Museum, Tokyo

Abstract Cuticular features of the leaves of *Sciadopitys* (Sciadopityaceae) are described on the basis of the specimen from the Miyata Formation (Late Miocene) in Akita Prefecture, Northeast Honshu, Japan. This Miyata specimen is more similar to the European Miocene species of *S. tertiaria* MENZEL emend. WEYLAND *et al.*, rather than the modern *S. verticillata* (THUNB.) SIEB. et ZUCC. in Japan. Pre-Quaternary records of *Sciadopitys* indicate that the genus was widespread in Japan during Miocene and Pliocene times.

Introduction

As reviewed by FLORIN (1922, 1963), the genus *Sciadopitys* and allied leaf-forms often described under the genus of *Sciadopitytes* have been known from the Mesozoic and Cenozoic rocks in the Northern Hemisphere. The genus *Sciadopitys* has a long history like that of *Ginkgo*, and therefore the fossil occurrence has been noticed by many paleobotanists. From the Japanese Mesozoic, OGURA (1932) described structurely preserved leaves of *Sciadopitys*, showing the double vascular bundles, single stomatal band having numerous papillae, and other characters.

From the Tertiary of Japan and the Korean Peninsula, magafossil remains of *Sciadopitys* have been reported, though the records are not numerous, These fossils include leaves, cone-scales and woods.

The author reexamined the leaves which were formerly described under the name of *S. shiragica* HUZIOKA, from the Miyata Formation (Late Miocene) in Akita Prefecture, Northeast Honshu, Japan (HUZIOKA and UEMURA, 1973). In this short paper, the author newly describes cuticle features of the Miyata specimen. Furthermore, megafossil records of the genus *Sciadopitys*, together with pollen records, from Cenozoic beds in East Asia are briefly summarized.

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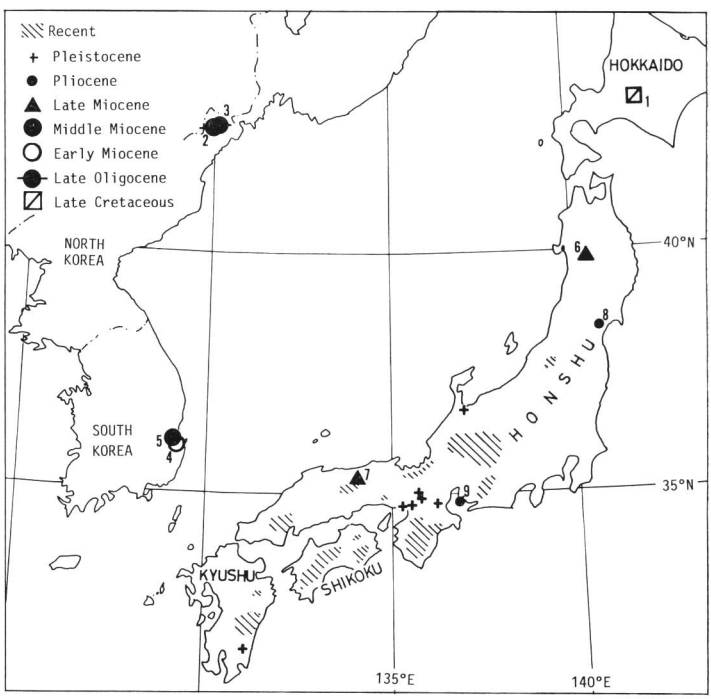
Cenozoic Records of *Sciadopitys* in East Asia

In the younger Tertiary the genus *Sciadopitys* has been distributed in both the eastern and western parts of Eurasia (FERGUSON, 1963). The genus disappeared in the early Early Pleistocene in the latter area (BOULTER and CHALONER, 1970; HAMMEN *et al.*, 1971), and finally confined to its present area in the Japanese Islands. Although megafossil records of *Sciadopitys* are not numerous, especially those in continental part of East Asia, the hitherto known occurrence is briefly given below.

Megafossils of *Sciadopitys* from the East Asian Tertiary are known from Korea and Japan (Text-fig. 1). HUZIOKA (1972) reported the leaves of *S. shiragica* HUZIOKA from four localities in North and South Korea: Kungshim and Kogeonweon (both probably Upper Oligocene; TANAI and UEMURA, 1983), Hamg'yeong-bukudo, North Korea; and Keumkwandong (Lower Miocene) and Pohang (Middle Miocene), Kyongsang-bukdo, South Korea.

From the Tertiary of Japan, megafossils of *Sciadopitys* are recorded from the following localities except for those from Miyata:



Text-fig. 1. Distribution of megafossil and modern *Sciadopitys* in East Asia. Modern species distribution simplified from HAYASHI (1960).
1-Yubari; 2-Kungshim; 3-Kogeonweon; 4-Keumkwandong; 5-Pohang; 6-Miyata; 7-Tatsumitoge; 8-Daimanji; 9-Kowa.

Sciadopitys sp. (cone-scales): Tatsumi-toge, Tottori Pref., Upper Miocene (OZAKI, 1979).

"*Sciadopityoxylon verticillatoides* SHIMAKURA", nom. nud., (woods): Daimanji in Nenoshiroishi, Miyagi Pref., Pliocene (SHIMAKURA, 1939). =*S. verticillata*, SHIMAKURA (1933).

Sciadopitys verticillata SIEB. et ZUCC. (leaves): Kowa, Aichi Pref., Pliocene (MIKI, 1950, 1955).

Two other "Pliocene" findings by MIKI (1955), Makiochi in Osaka-fu and Koshihata in Kyoto-fu, are erroneous in their age assignment (=Pleistocene; cf. MIKI, 1948). Pleistocene megafossil records (*S. verticillata*) are much common, as reported by MIKI (1948, 1950, 1955, 1958), MIKI and KOKAWA (1962) and others.

Beside these megafossil records, *Sciadopitys* pollen has been detected from many Tertiary and Quaternary sediments. The genus *Sciadopitys* is evidently a common member in the Tertiary floras of Japan, taking pollen analytical results into consideration, such as YAMANOI (1978) and SHIMAZAKI *et al.* (1972) for Miocene beds, and SOHMA (1956), TAKEUCHI (1974) and YAMANOI (1983) for Pliocene beds. Furthermore, TSUKADA (1963) has provided the pollen and megafossil records known at that time, and demonstrated the Holocene history of the genus.

Description of Miyata Specimen

Family Sciadopityaceae

Sciadopitys sp.

(Pl. 1, Figs. 1–7)

Sciadopitys shiragica HUZIOKA, HUZIOKA & UEMURA, 1973, Bull. Natn. Sci. Mus. Tokyo 16: 701, pl. 2, figs. 9–12.

Material: Following description is based on the leaves (2 leaves fused) illustrated on pl. 2, fig. 12 by HUZIOKA & UEMURA (1973). Loc. Hinokinaimatazawa-2, Nishikimura, Senboku-gun, Akita Pref., Miyata Formation (Late Miocene). For microscopic investigation the material was treated with dilute hydroperoxide solution. Because of the delicate nature for chemical reaction of fossil, usual maceration technique (concentrated nitric acid followed by dilute alkali) has been unapplicable for the examination of the stomatal region.

Description: Cuticles thick and strong except in the median groove on the lower surface where it is thin and often destroyed through the maceration.

Stomata confined only in the single median groove on the lower surface, markedly papillose, forming a stomatal band whose width is 130–150 μm and about 15 rows of stomata, crowded in the stomatal band and regularly oriented in longitudinal direction. Subsidiary cells 10–12 in number (2 polar and 8–10 lateral ones); subsidiary cells of neighbouring stomata lying in contact or seperated by small epidermal cells, very rarely two stomata sharing a subsidiary cells. Papillae mostly cylindrical or

conical with rounded or pointed tips, greatly varying in shape and size, up to 40 μm in length. Guard cells thin, fragile, or delicate, mostly fusi-form in shape, sometimes crescent-shaped, not sunken below the surrounding subsidiary cells. Pore slit-like or narrowly elliptical. Along the margins of the stomatal band, 3–4 continuous longitudinal rows of cells papillose, followed by rows of flat, non-papillose, approximately rectangular cells with straight or occasionally pited anticlinal walls.

Epidermal cells in non-stomatal region on both sides uniform in shape, serially arranged, narrow rectangular in outline, 40–70 μm and more in length and 10–15 μm in width. Cell wall nearly smooth. Ordinary epidermal cells in the groove irregular in shape, possessing papillae. Leaf margin entire.

Comparison and remarks: From the above described peculiar cuticular characters, single stomatal band and papillae on the subsidiarry cells, this Miyata specimen is confirmed to be the genus *Sciadopitys*. This Miyata specimen is similar to the living *S. verticillata* (THUNB.) SIEB. et ZUCC. and fossil *S. tertiaria* MENZEL from the European Miocene in both the external and cuticular structures. *S. tertiaria* was established by MENZEL (1913) on the basis of the leaves, young strobili and isolated strobili from Herzogenrath in the Lower Rhine area (W. Germany). JÄHNICHEN (1969) studied the cuticular structures of the originals of MENZEL (1913), and concluded that all the features of leaf cuticles coincide with those of *S. marcodurensis* WEYLAND, KILPPER et BERENDT (1967), hence designated as *S. tertiaria* MENZEL emend. WEYLAND *et al.* In the Miyata specimen, papillose cells along the margins of the stomatal band are prominent in having three to four rows of cells. In this respect, the Miyata specimen is more similar to *S. tertiaria* than the Japanese living species.

HUZIOKA and UEMURA (1973) found five needle leaves from the Miyata Formation, and referred to the Korean species *S. shiragica* HUZIOKA which shows the resemblance to the living *S. verticillata*. Since cuticular structures of this Korean species have been unknown, the further comparison with the Miyata specimen is impossible. Although the Miyata specimen is closely comparable with *S. tertiaria*, it is better to treat it as *S.* sp. Namely, the examination of cuticles is based on only one specimen (4 remaining specimens are impressions), whose cuticular structures are still insufficiently known in details of guard cells and of ordinary cell surface, as well as their range of variation.

It is noteworthy that the European Miocene form (*S. tertiaria* MENZEL emend. WEYLAND *et al.*) is distinguished from a Pliocene form "*S. tertiaria*" which has characters almost same as the living *S. verticillata* in its leaf cuticle structure (WEYLAND *et al.*, 1967). The example of this Japanese Miocene also shows a similar difference from the living Japanese species.

Sciadopitys verticillata (THUNB.) SIEB. et ZUCC. is now sporadically distributed in Kyushu, and southwestern and central Honshu, disjunctly extending north to southern Northeast Honshu. (HAYASHI, 1960). The species inhabits in forests of temperate and cool-temperate zones (mostly at altitudes between 300–1500 m) under ample rainfalls in summer, mingled with many conifers such as *Chamaecyparis*, *Pinus*,

Abies and *Tsuga* (HAYASHI, 1960; TSUKADA, 1963). As indicated by the composition of the Miyata flora (HUZIOKA and UEMURA, 1973) and general floristic trends in Tertiary floras of Japan (TANAI and HUZIOKA, 1967), fossil *Sciadopitys* might have inhabited in Japan, at least since Late Miocene age, in forests under similar climatic conditions represented by the modern relative.

References

BOULTER, M. C., & W. G. CHALONER, 1970. Neogene fossil plants from Derbyshire, England. *Rev. Palaeobot. Palynol.*, **10**: 61–76.

FERGUSON, D. K., 1967. On the phytogeography of Coniferales in the European Cenozoic. *Palaeogeogr., Palaeoclim., Palaeoecol.*, **3**: 73–110.

FLORIN, R., 1922. On the geological history of the Sciadopitiae. *Svensk Bot. Tidskr.*, **16**: 260–270.

——— 1963. The distribution of conifer and taxad genera in time and space. *Acta Horti Bergiani*, **20**: 121–312.

HAMMEN, T., van der, T. A. WIJMSTRA & W. H. ZAGWIJN, 1971. The floral record of the Late Cenozoic of Europe. *In* K. K. TUREKIAN ed.: Late Cenozoic Glacial Ages. Yale Univ. Press, New Haven, pp. 391–424.

HAYASHI, Y., 1960. Taxonomical and Phytogeographical Study of Japanese Conifers. Norinshuppan, Tokyo. 246+12+202 pp., 64 pls. (In Japanese with English summary.)

HUZIOKA, K., 1972. The Tertiary floras of Korea. *J. Mining Coll., Akita Univ.*, ser. A, **5**: 1–83, pls. 1–14.

——— & K. UEMURA, 1973. The Late Miocene Miyata flora of Akita Prefecture, Northeast Honshu, Japan. *Bull. Natn. Sci. Mus.*, Tokyo, **16**: 661–738, pls. 1–18.

JÄHNICHEN, H., 1969. Revision zu originalen strukturbietender Blätter aus der lausitzer und niederrheinischen Braunkohle: P. MENZEL 1906–1913. *Geologie*, Berlin, **18**: 77–93, pls. 1–9.

MENZEL, P., 1913. Betrag zur Flora der niederrheinischen Braunkohlenformation. *Jahrb. Kgl. Preuß. Landsanstalt.*, **37**: 1–98, pls. 1–7.

MIKI, S., 1948. Floral remains in Kinki and adjacent districts since the Pliocene with description 8 new species. *Sci. Rep. Osaka Second Teachers Coll.*, (2): 105–144, pls. 1–5. (In Japanese with English abstract.)

——— 1950. Taxodiaceae of Japan, with special reference to its remains. *J. Inst. Polytech., Osaka City Univ.*, ser. D, **1**: 63–77.

——— 1955. Successions of Five Native Species in Kiso Based on the Plant Remains. Nagano Forest Bureau, Nagano, 17 pp., 2 pls., 4 figs. (In Japanese.)

——— 1958. Gymnosperms in Japan, with special reference to the remains. *J. Inst. Polytech., Osaka City Univ.*, ser. D, **9**: 125–150, pls. 1–3.

——— & S. Kokawa, 1962. Late Cenozoic floras of Kyushu, Japan. *J. Biol., Osaka City Univ.*, **13**: 65–85, pls. 1–12.

OZAKI, K., 1979. Late Miocene Tatsumitoge flora of Tottori Prefecture, Southwest Honshu, Japan (1). *Sci. Rep. Yokohama Natn. Univ.*, sec. 2, (26): 31–56, pls. 1–7.

OGURA, Y., 1932. On the structure and affinities of some Cretaceous plants from Hokkaido. Second contribution. *J. Fac. Sci., Imp. Univ. Tokyo*, sec. 3, **2**: 455–483, pls. 22–24.

SHIMAKURA, M., 1933. Notes on fossil woods, part 1. Fossil wood of *Sciadopitys*. *J. Geol. Soc. Japan*, **40**: 473–479. (In Japanese.)

——— 1939. The past distribution and origin of coniferous plants in Japan. *Jubl. Publ. Commem. Prof. H. YABE 60th Birthday.*, **1**: 233–253, pls. 16–17.

SHIMAZAKI, T., S. TOKUNAGA & T. ONOE, 1972. Some stratigraphic considerations concerning the

fossil pollen and spores in the oil bearing regions of Honshu, Japan. *J. Japan. Assoc. Petroleum Tech.*, **37**: 391–398. (In Japanese.)

SOHMA, K., 1956. Pollenanalytische Untersuchungen der pliozänen Braunkohlen der Sendai-Gruppe. I. Ubersichtliches. *Ecol. Rev.*, **14**: 121–132.

TANAI, T., & K. HUZIOKA, 1967. Climatic implication of Tertiary floras of Japan. *In* K. HATAI ed.: Tertiary Correlations and Climatic Changes in the Pacific (11th Pacific Sci. Congr., Tokyo, 1966), pp. 89–94.

——— & K. UEMURA, 1983. *Engelhardia* fruits from the Tertiary of Japan. *J. Fac. Sci., Hokkaido Univ.*, ser. 4, **20**: 249–260.

TAKEUCHI, S., 1974. Geology and palynology of the hilly area southeast of Ichinoseki City, Iwate Prefecture, Japan. *Sci. Rep. Tohoku Univ.*, 2nd ser., **44**: 65–119, pls. 1–5.

TSUKADA, M., 1963. Umbrella pine, *Sciadopitys verticillata*: past and present distribution in Japan. *Science*, **142**: 1680–1681.

WEYLAND, H., K. KILPPER & K. BERENDT, 1967. Kritische Untersuchungen zur tertiär Blätter, VII. Nachträge zu frühren Arbeiten über Epidermen aus der niederrheinischen Braunkohle und neue Arten. *Palaeontographica*, B, **120**: 151–168, pls. 26–33.

YAMANOI, T., 1978. Neogene pollen stratigraphy of the Oga Peninsula, Northeast Honshu, Japan. *J. Geol. Soc. Japan*, **84**: 69–86, pl. 1. (In Japanese with English abstract.)

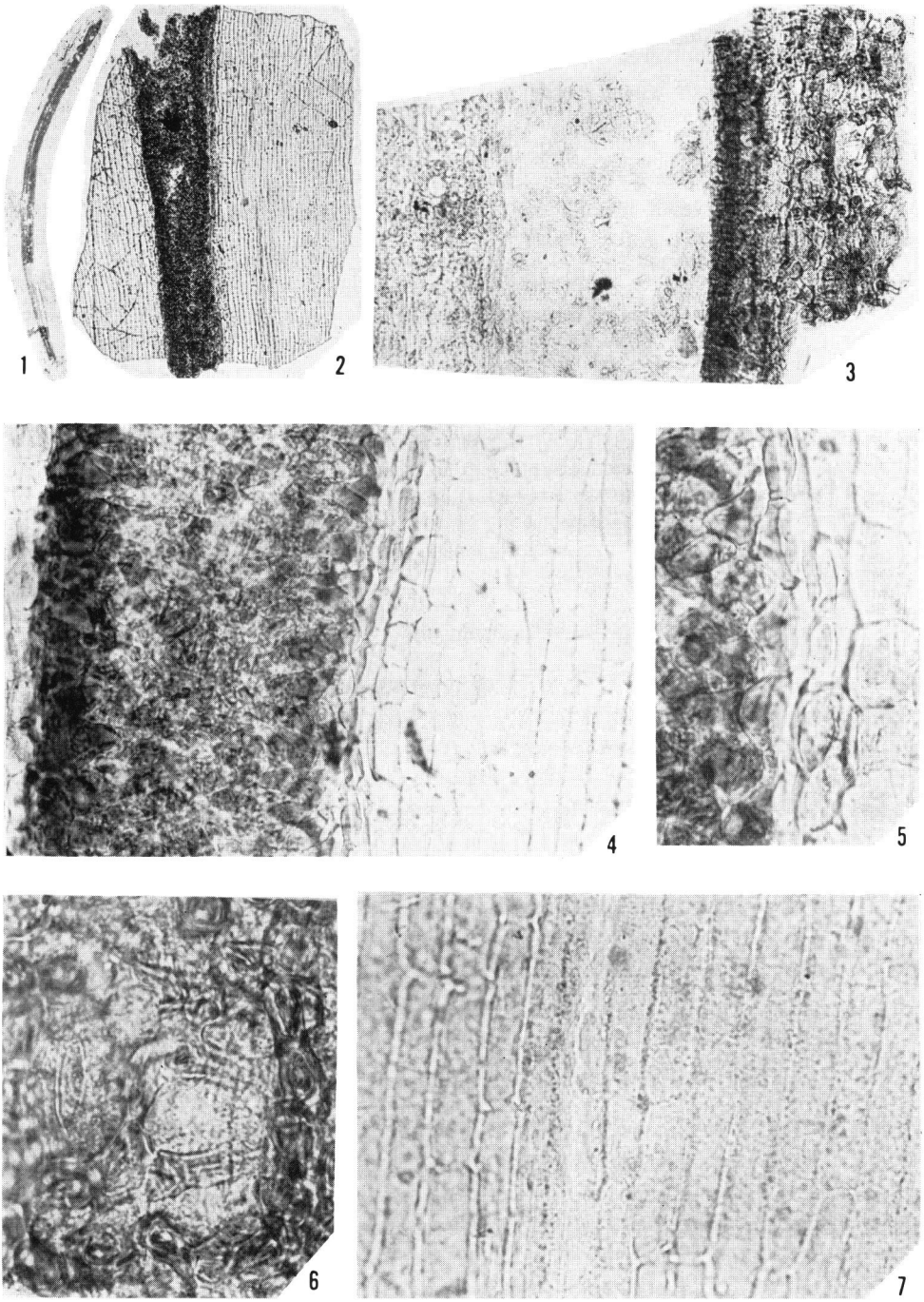
——— 1983. Pollen stratigraphy of the Shinjyo Group, Northeast Honshu, Japan. *Mem. Natn. Sci. Mus.*, Tokyo, (16): 37–52, pls. 3, 4. (In Japanese with English summary.)

Explanation of Plate 1

Figs. 1–7. *Sciadopitys* sp.

Loc. Hinokinaimatazawa-2, Nishiki-mura, Senboku-gun, Akita Prefecture; Miyata Formation (Late Miocene). NSM-PP-6244.

1. The needle leaves, ×1.
2–4. Lower cuticles with single median stomatal band, ×60, ×375, ×375. Fungal hypae intrudes ordinary cell surface (fig. 2).
5. Cells between ordinary cells and stomatal band, ×600.
6. Stomata surrounded by papillae, ×600.
7. Ordinary cells in the upper cuticle, ×600.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