LATE TERTIARY MAPLES FROM NORTHEASTERN HOKKAIDO, JAPAN.

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Introduction

The living species of *Acer* are common in the temperate vegetation of the world, and the fossils have been also commonly found from the Tertiary of the world; about 60 species have been reported from the Tertiary of North America, more than 40 species from Europe, and about 35 species from Japan. The genus *Acer* is one of the most familiar trees to us in the temperate floras of the modern and past. From the Tertiary of Hokkaido 9 species of *Acer* were described by OISHI and HUZIOKA (1942), and lately 4 new species and 16 species from the Middle Miocene floras of southwestern Hokkaido were described by TANAI and N. SUZUKI (1960).

Since 1960 the author has investigated on the Late Tertiary floras of northeastern Hokkaido, with a guidance by TANAI, and lately reported the outline of their floral composition (TANAI and N. SUZUKI, 1961). These floras consist largely of typical temperate plants, and contain abundant well-preserved fossils of *Acer*. He was able to determine 9 species of *Acer*, including 2 new species, through a careful comparison of fossil leaves and samaras with those of the modern species of the world. They are described in the following paragraph.

Geologic Occurrence

In northeastern Hokkaido the Neogene are distributed unconformably upon Mesozoic sediments, locally on Palaeogene sediments; lately the Tertiary stratigraphy of this region has been considerably progressed by the Hokkaido Branch of the Geological Survey of Japan. It has been known that Neogene lacustrine sediments bearing plant fossils cover the lowest Tertiary sediments, the Middle Miocene Konomai formation in Kitami-Engaru area by several author (URASHIMA et al., 1953), but nearly no detailed information on this fossil flora has been known up to the present. Recently, several new fossil localities were found by geologists

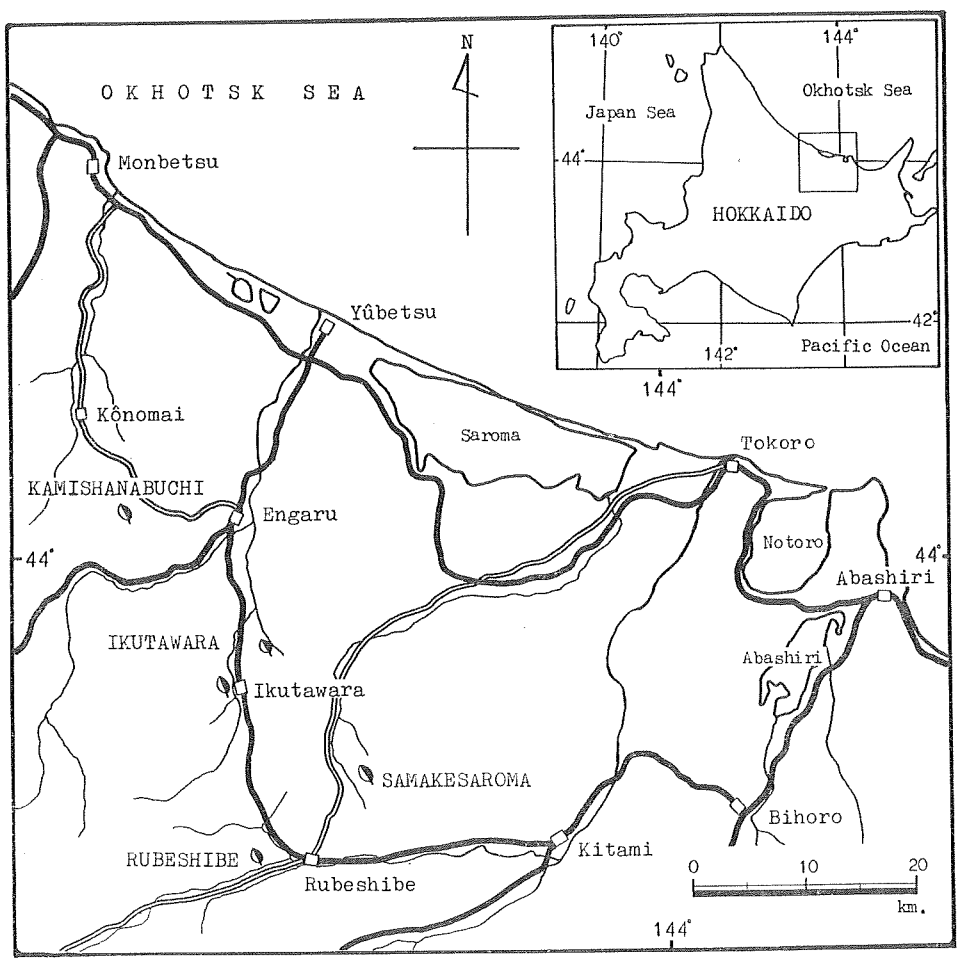
of the Geological Survey, and the author collected a number of plant fossils at many localities in the regions. These four main localities and formations containing fossils are shown as follows:

Shanabuchi flora: Kamishanabuchi, Engaru-machi, Monbetsu-gun. Shanabuchi formation (Late Miocene).

Ikutawara flora: Ikutawara, and Sakinzawa, Ikutawara-machi, Monbetsu-gun. Yahagi formation (Early Pliocene).

Samakesaroma flora: Samakesaroma, Rubeshibe-machi, Tokoro-gun. Toyohara formation (Late Miocene).

Rubeshibe flora: Yongosen, Rubeshibe-machi, Tokoro-gun. Komatsuzawa formation (Early Pliocene).



Text-fig. 1. Localities of Mio-Pliocene floras in Northeastern Hokkaido.

The Shanabuchi formation consists mainly of tuffaceous siltstone, and sandstone, locally interbedding conglomerate and tuff; tuffaceous siltstone contained a number of well-preserved fossil leaves and seeds. The Komatsuzawa formation distributed in Rubeshibe-Ikutawara area overlies post-Shanabuchi liparite, basalt, and two-pyroxene andesite with an unconformity; it is composed mainly of diatomaceous siltstone and tuff, rarely intercalating by tuffaceous sandstone. The diatomaceous siltstone contains numerous excellently-preserved leaves, seeds and cone scales.

Outline of Floral Composition

The Shanabuchi flora consists mainly of typically temperate families such as Pinaceae, Salicaceae, Betulaceae, Fagaceae, Ulmaceae, Rosaceae, and Aceraceae; of Shanabuchi 71 species *Fagus protojaponica, Cladrastis chaneyi, Ulmus protojaponica, Betula protoermani, Cercidiphyllum crenatum, Juglans japonica, Carpinus subcordata, Magnolia elliptica, Acer protojaponicum, Picea kaneharai, Salix lanceolata, Celtis miobungeana,* and *C. nordenskioldii,* make up about 77 per cent of the total 993 specimens collected. This flora is composed largely of temperate broad-leafed trees, accompanying with several southern or exotic elements such as *Taiwania, Liquidambar, Cinnamomum, Ziziphus, Ailanthus,* and *Forsythia*; it belongs surely to the so-called Mitoku-type flora of Late Miocene time (TANAI, 1961, p. 169-184). The Samakesaroma flora consists of 14 genera and 19 species, and is closely similar to the Shanabuchi in its floral composition and components.

The Rubeshibe flora contains 20 families, 31 genera, and 49 species; it is composed largely of Pinaceae, Salicaceae, Betulaceae, Fagaceae, Ulmaceae, Rosaceae, Leguminosae, and Aceraceae. Of 49 species *Fagus protojaponica* is most abundant, and makes up more than 38 per cent of the total 4,510 specimens collected. The following 9 species are also common members, having more than 50 specimens; they are *Populus ezoana, P. protomaximowiczii, Alnus protohirsuta, Betula miomaximowicziana, B. onbaraensis, Carpinus subcordata, Cladrastis chaneyi, Acer protojaponicum,* and *A. subpictum,* and these nine occupy about 42 per cent of the totals. This flora is composed largely of cool-temperate deciduous broad-leafed trees, and contains no exotic elements which are contained in the Shanabuchi flora. It is closely similar to the so-called Shinjo-type flora (TANAI, 1961. pp. 185-190), and is probably of Early Pliocene age. The Ikutawara flora consists of only 11 species, but it seems similar to the

Rubeshibe, considering from its geologic occurrence.

Occurrence of Maples

These 4 floras contains a number of fossil maples representing by leaves and samaras, most of which are excellently preserved. The author could identify the following 9 species of *Acer*:

Acer palaeodiabolicum ENDO
Acer palaeorufinerve TANAI et ONOE
Acer protojaponicum TANAI et ONOE
Acer pseudocarpinifolium ENDO
Acer pseudoginnala TANAI et ONOE
Acer subpictum SAPORTA
Acer subukurunduense sp. nov.
Acer yabei ENDO
Acer sp.

Of these 9 species *Acer subpictum* is most abundant is number of specimens, followed by *A. protojaponicum, A. palaeodiabolicum, A. yabei,* and *A. pseudocarpinufolium.* The remaining 4 species are represented by less than 3 specimens. *A. subpictum* and *A. protojaponicum* are found from all 4 localities. Such occurrence and organs represented are shown in Table 1. From the Middle Miocene floras of southwestern Hokkaido 16 species of Maples was already reported (TANAI and N. SUZUKI, 1960).

Table 1. Occurrence of Late Tertiary Maples in Northeastern Hokkaido.

locality / fossil species	Shanabuchi	Samake-saroma	Ikutawara	Rubeshibe	Total in each species
Acer palaeodiabolicum				29 {26(L), 2(S)}	28
Acer palaeorufinerve		1(L)		1(L)	2
Acer protojaponicum	35(L)	4(L)	5(L)	83(L)	127
Acer pseudocarpinifolium	2 {1(L), 1(S)}			3(L)	5
Acer pseudoginnala				1(S)	1
Acer subpictum	4 {3(L), 1(S)}	18(L)	8(L)	448 {440(L), 8(S)}	478
Acer subukurunduense				3(L)	3
Acer yabei	3(S)			4 {2(L), 2(S)}	7
Acer sp.				1(L)	1
Total in each locality	44	23	13	572	

L: Leaf. S: Samara.

There are the following 5 common species between northeastern and southwestern Hokkaido; they are *A. palaeodiabolicum, A. palaeorufinerve, A. protojaponicum, A. pseudoginnala,* and *A. subpictum,* all of which are most common and widely distributed maples in the Neogene of Japan.

Acknowledgements

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Description of species

Acer palaeodiabolicum ENDO

(Pl. II, figs. 1, 2.)

1950. *Acer palaeodiabolicum* ENDO: Short Papers I.G.P.S., No. 1, p. 12, pl. 3, fig. 3.
1961. *Acer palaeodiabolicum* ENDO, TANAI et ONOE: Geol. Surv. Jap. Rep. No. 187, pp. 48–49. pl. 15, figs. 2, 4; pl. 16, fig. 1; pl. 17, figs. 1–4.
1961. *Acer palaeodiabolicum* ENDO, TANAI: Jour. Fac. Sci. Hokkaido Univ., Ser. 4, vol. 11, p. 359, pl. 28, fig. 5.
1961. *Acer protodiabolicum* SUZUKI: Sci. Rep. Fukushima Univ., No. 10, p. 82, pl. 17, fig. 9.

Remarks: *Acer palaeodiabolicum* is represented by a number of well-preserved impressions of leaves and samaras from the Rubeshibe flora. These leaf specimens are variable in size; they are 10 to 20 cm. (estimated) long and 9 to 20 cm. (estimated) wide. These leaves and samaras well match those produced by the modern *A. diabolicum* BLUME of Honshu, Shikoku, and Kyushu.

A. protodiabolicum SUZUKI established on the basis of a single leaf from the Upper Miocene Shiotsubo flora of northern Honshu, is essentially indistinguishable from *A. palaeodiabolicum.*

Occurrence: Rubeshibe.

Collection: Hypotypes, H.U.M.P. Reg. Nos. 25895, 25986 (Rubeshibe).

Acer palaeorufinerve TANAI et ONOE

(Pl. III, fig. 5.)

1961. *Acer palaeorufinerve* TANAI et ONOE: Geol. Surve. Jap. Rep. No. 187, p. 49, pl. 16, figs. 2, 3.

1951. *Acer trilobatum* var. *tricuspidatum* HEER, ENDO: Short Papers I.G.P.S., No. 3, p. 56, pl. 8, fig. 1.

1959. *Acer akagawaensis* SUZUKI: Monog. Assoc. Geol. Collab. Jap., No. 9, p. 41, pl. 5, fig. 2.

Remarks: This species is represented by a nearly complete leaf impression and a fragmentary specimen from Rubeshibe flora, which well match those produced by the modern *Acer rufinerve* SIEB. et ZUCC.. This living species is commonly growing in Honshu, Shikoku, and Kyushu. A single leaf figured by ENDO (1951) as *A. trilobatum* var. *tricuspidatum* HEER from the Miocene Kanchindo flora of northern Korea is indistinguishable in all foliage character from *A. palaeorufinerve,* though it is very small. *A. akagawaensis* SUZUKI from the Upper Miocene Tennoji flora of northern Honshu is essentially similar to *A. palaeorufinerve,* and it represents merely a large leaf of our species. *A. ryozenensis* SUZUKI lately established on the basis of a single leaf from the Middle Miocene Ryozen flora of northern Honshu, is somewhat similar to *A. palaeorufinerve* in foliage shape, but it is distinguishable by more deeply serrate margin and longer petiole.

Occurrence: Rubeshibe and Samakesaroma.

Collection: Hypotype, H.U.M.P. Reg. No. 25901 (Rubeshibe).

Acer protojaponicum TANAI et ONOE

(Pl. IV, fig. 5; pl. V, fig. 4.)

1959. *Acer protojaponicum* TANAI et ONOE: Bull. Geol. Surv. Jap., vol. 10, No. 4, p. 281, pl. 6, figs. 5–7.

1961. *Acer protojaponicum* TANAI et ONOE, TANAI: Jour. Fac. Sci. Hokkaido Univ., Ser. 4, vol. 11, p. 362, pl. 26, fig. 4; pl. 27, fig. 8.

Remarks: This species is represented by very abundant leaf impressions, including many complete specimens, from the Rubeshibe, Samakesaroma, Ikutawara, and Shanabuchi floras. These leaves are very variable in shape and size; they are from 7 to 11 lobed, and are 4 to 13 cm. long and 6 to 17 cm. wide. These specimens well match leaves produced by the modern *Acer japonicum* THUNB. of Honshu and Hokkaido.

Occurrence: Shanabuchi, Rubeshibe, Ikutawara, and Samakesaroma.
Collection: Hypotypes, H.U.M.P. Reg. Nos. 25763 (Shanabuchi), 25902 (Rubeshibe).

Acer pseudoginnala TANAI et ONOE

(Pl. III, fig. 4.)

1959. *Acer pseudoginnala* TANAI et ONOE: Bull. Geol. Surv. Jap., vol. 10. No. 4, p. 282, pl. 6, fig. 2.
1961. *Acer pseudoginnala* TANAI et ONOE, TANAI: Jour. Fac. Sci. Hokkaido Univ., Ser. 4, vol. 11, p. 365, pl. 26, fig. 3.

Remarks: Only one samara from the Rubeshibe flora is referred to *Acer pseudoginnala,* which is closely similar to the modern *A. ginnala* widely distributed in northeastern Asia. This specimen is somewhat similar to samara of *A. palaeodiabolicum* ENDO (ENDO, 1950: pl. 3, fig. 3; TANAI, 1961: pl. 28, fig. 5), but is distinguishable in having a constricted lower wing.

Occurrence: Rubeshibe.
Collection: Hypotype, H.U.M.P. Reg. No. 25908.

Acer pseudocarpinifolium ENDO

(Pl. III, figs. 2, 3.)

1950. *Acer pseudocarpinifolium* ENDO: Short Papers I.G.P.S., No. 1, p. 14, pl. 3, fig. 6.
1930. *Acer carpinifolium* SIEB. et ZUCC., KONNO: Geol. Central Shinano. pl. 13, fig. 6.
1961. *Acer* cf. *pseudocarpinifolium* ENDO, TANAI et ONOE: Geol. Surv. Jap. Rep. No. 187, p. 51, pl. 15, fig. 3.

Supplementary description: Leaves single in form, lanceolate to ovate-lanceolate in general outline, 9 to 16 cm. (estimated) long and 4 to 9 cm. wide; apex missing; base rounded, somewhat slightly cordate; midrib stout and straight; secondary nerves rather thin but distinct, more than 15 pairs, opposite to subalternata, regularly spaced, leaving midrib at angles of about 35 degrees, nearly straight, ending in large marginal teeth; two pairs of basal secondaries leaving base, lowest pair running down along basal margin; lower third pair of secondaries arriving at about quater part of margin; a few branches from secondaries ending in small marginal teeth; tertiaries thin, regularly percurrent; nervilles finely reticulate; margin duplicately serrate, with acute teeth; texture thin; petiole missing.

Remarks: Our several well-preserved leaves and a samara in our

collection well match those of the modern *Acer carpinifolium* SIEB. et ZUCC. widely distributed in Honshu, Shikoku, and Kyushu, and they are referable to *A. pseudocarpinifolium* ENDO. This species is represented by both leaves and samaras, though it was originally established on the basis of only a single samara from a Upper Miocene flora near Sendai, northern Honshu. In contrast with most labate leaves of the living maples, this species is characteristic to have leaves of single form.

A single leaf figured as *A. carpinifolium* SIEB. et ZUCC. from Upper Miocene flora of central Honshu by KONNO (1930) is referable to *A. pseudocarpinifolium*. Leaves of this species are somewhat similar to slender leaves of *Carpinus subcordata* NATHORST in general appearance, but are distinguishable in mode of lower secondary nervation and marginal serration.

Occurrence: Shanabuchi and Rubeshibe.

Collection: Paratype, H.U.M.P. Reg. No. 25909 (Rubeshibe), Hypotype, H.U.M.P. Reg. No. 25765 (Shanabuchi).

Acer subpictum SAPORTA

(Pl. V, figs. 1, 2, 3.)

1873. *Acer subpictum* SAPORTA: Bull. Soc. Geol. France, Ser. 3, vol. 1.
1943. *Acer subpictum* SAPORTA OISHI et HUZIOKA: Jour. Fac. Sci. Hokkaido Imp. Univ., Ser. 4, vol. 7, p. 93, pl. 13, figs. 1–4; pl. 14, figs. 1–4.

Remarks: These specimens represented by both leaves and samaras from the Shanabuchi and Rubeshibe floras are referred to *Acer subpictum* SAPORTA, which is one of the most common maples in the Neogene flora of Japan. These leaves are very variable in shape and size; they are rounded to cuneate at base, shallow to deep in sinus, and 5 to 7 lobate in form. They well match leaves produced by the modern *A. mono* MAXIM. widely distributed in northeastern Asia.

Occurrence: Shanabuchi, Rubeshibe, Ikutawara and Samakesaroma.

Collection: Hypotypes, H.U.M.P. Reg. Nos. 25912, 25913 (Rubeshibe), 25776a (Shanabuchi).

Acer subukurunduense sp. nov.

(Pl. I, fig. 1.)

Description: Leaves heptagonal-oval in shape, 7-lobed, 5 to 10 cm. long and 6 to 10 cm. wide; base deeply cordate; lobes oblongly trigonal, acute to acuminate at apex, central lobe largest, and a pair of basal lobes smallest, sinuses rather shallow; margin coarsely and duplicately serrate, with deltoid teeth; primary nerves 7 in number, stout, radiating from

base, slightly waved or arcuate; secondary nerves 8 pairs, alternate to opposite, irregularly spaced, leaving primaries at angles of 40 to 60 degrees, gently curving upward, entering marginal teeth; a pair of lowest secondaries in each lobe arriving at bottom of sinus; tertiaries branching from secondaries ending in marginal teeth; tertiaries in intersecondary spaces thin but destinct, percurrent; texture thin, probably pubescent beneath blade; petiole stout, more than 2 cm. long.

Remarks: This new species is based on a well-preserved impression of a incomplete leaf and two fragmentary specimens from the Rubeshibe flora. They are closely similar to leaves produced by the modern *Acer ukurunduense* TRAUTVETTER et MEYER, which is growing on the coniferous or shrub zones of high altitudes in Hokkaido, central and northern Honshu, and Shikoku, extending into Saghalien, Korea, Manchuria, and eastern Siberia. No fossil leaves of *Acer* in Japan is comparable to this new species.

Occurrence: Rubeshibe.

Collection: Holotype, H.U.M.P. Reg. No. 25918.

Acer yabei ENDO

(Pl. IV, figs. 3, 4, 6.)

1950. *Acer yabei* ENDO: Short Papers I.G.P.S., No. 1, p. 13, pl. 3, fig. 7.
1959. *Acer kokangenense* ENDO, TANAI et ONOE: Bull. Geol. Surv. Jap., vol. 10, No. 4, pl. 6, fig. 9.

Supplementary description: Leaves pentagonal in shape, 5.8 to 8 cm. long and 6.5 to 9 cm. wide; palmately five-lobed, middle lobe largest and basal lobes smallest; base nearly truncate; middle and lateral lobes oblong, acuminate at apex, provided with a pair of prominent dents with an acute tip and several smaller teeth in margin; primary nerves five, stout radiating from base, ending straightly in tip of each lobe, prominent beneath blade, upper lateral primaries leaving medial primaries at angles of 40 to 50 degrees, and basal primaries at angles of 90 to 100 degrees; secondaries in each lobes about 8 pairs, opposite to subalternate, divering from midrib at angles of 35 to 40 degrees, gently curving upward, entering marginal teeth; tertiaries thin but distinct, irregularly percurrent; nervilles thin, forming fine polygonal networks; texture thin; petiole missing.

Samaras 5 to 5.5 cm. long, 1.5 to 1.7 cm. in the widest part of wing; wing gradually narrowed to base, rounded at apex; outer margin nearly straight, inner margin convex; veins fine, 18 to 20 in number at base of wing, curving inwards and irregularly dichotomously branching; seed elliptical, 6 to 8 mm. in short diameter and 1.5 to 1.8 cm. in long diameter;

contact line of seed 3 to 5 mm. long; angles between outer margin to contact line of seed about 10 degrees to parallel.

Remarks: Three excellently preserved impressions of samara from the Shanabuchi and Rubeshibe floras are referred to *Acer yabei* ENDO, which was originally established on the basis of only a single samara from the Upper Miocene Nenoshiroishi flora of northern Honshu (ENDO, 1950). They are closely similar to samaras of the modern *A. saccharinum* LINNE, which is distributed in eastern and central United States. In our collection there are two well-preserved impressions of nearly complete leaves closely similar to those of the modern *A. saccharinum*. Accordingly, *A. yabei* is surely redesignated by both leaves and samaras closely similar to those produced by the *A. saccharinum*. Our leaves closely resemble those of modern *A. rubrum* LINNE of eastern United States, but their lateral lobes extend at wider angles than those of *A. rubrum*. Furthermore, our samaras are quite different in shape from those of *A. rubrum*.

A single samara figured as *A. kokangenense* ENDO from the Middle Miocene Shichiku flora of the Joban coal field, Fukushina Prefecture (TANAI et ONOE, 1959), though its seed was missing, is closely similar to *A. yabei* in general outline of wing, and is included in this species.

Occurrence: Shanabuchi and Rubeshibe.

Collection: Paratype, H.U.M.P. Reg. No. 25906 (Rubeshibe); Hypotypes, Nos. 25916, 25917 (Rubeshibe).

Acer sp.

(Pl. II, fig. 4.)

Description: Leaf large, 20 cm. (estimated) high, 20 cm. wide, palmate, probably 5 lobed; lobes oblong in shape, acuminate at apex; margin duplicately serrate, with 3 to 4 small lobes in each side; sinus deeply narrowly incised; central lobe largest; primary nerves stout; secondary nerves stout and distinct, 5 pairs (estimated), leaving primaries at angles of 60 to 80 degrees, entering marginal teeth; tertiaries obscure, making irregular and coarse networks; nervilles thin, finely reticulate; texture firm; petiole missing.

Remarks: An incomplete leaf impression from the Rubeshibe flora resembles leaves of the modern *Acer tschonoskii* MAXIM. growing in Honshu, Shikoku and Kyushu, extending into China. This specimen is far larger than leaves of modern equivalent, but is closely similar in shape and marginal serration. No fossil leaves of maple in Japan are comparable to this species.

Occurrence: Rubeshibe.

Collection: Holotype, H.U.M.P. Reg. No. 25920.

Reference

CHEN Y. (1937): Illustrated manual of Chinese Trees and Shrubs. *Agricultural Association of China Series.* (in Chinese)

ENDO, S. (1950): On the fossil *Acer* from Japan, Korea and South Manchuria I. *Short Papers I.G.P.S., No. 1, pp. 11-17.*

——— (1951): On the fossil *Acer* from Japan, Korea and Manchuria II. *Scort Papers I.G.P.S., No. 3, pp. 52-58.*

——— (1955): Icones of fossil plants from Japanese Islands. (in Japanese). *Tokyo.*

FUJIE, T. et al. (1957): The correlative table of stratigraphic distribution in Neogene of Hokkaido. (in Japanese). *The Cenozoic Research No. 24-25. pp. 51-58.*

KONNO, E. (1930): Cenozoic flora in Central of Shinano, Japan, (in Japanese). *Geology of Central Shinano. (edited by* HOMMA).

MAKINO, T. (1961): MAKINO's new Illustrated Flora of Japan. (in Japanese). *Hokuryukan, Tokyo.*

OHWI, J. (1961): Flora of Japan. (in Japanese). *Shibundo, Tokyo.*

OISHI, S. & HUZIOKA, K. (1943): Studies on the Cenozoic Plants of Hokkaido and Karahuto V. Tertiary *Acer* from Hokkaido and Karahuto. *Jour. Fac. Sci. Hokkaido Imp. Univ., Ser. 4, vol. 7, No. 1, pp. 81-101.*

SUZUKI, K. (1959): On the flora of the upper Miocene Tennoji Formation in Fukushima Basin, Japan, and its palaeoecological aspect, (in Japanese, with English abstract). *Monog. Assoc. Geol. Collab. Japan. No. 9.*

——— (1961): The important and characteristic Pliocene and Miocene species of plants from the southern part of the Tohoku district, Japan. *Sci. Rep. Fac. of Art. & Sci. Fukushima Univ., No. 10.*

TANAI, T. (1961): Neogene Floral Change in Japan. *Jour. Fac. Sci. Hokkaido Univ., Ser. 4, vol. 11, No. 2. pp. 120-398.*

TANAI, T. & SUZUKI, N. (1960): Miocene Maples from Southwestern Hokkaido, Japan. *Jour. Fac. Sci. Hokkaido Univ., Ser. 4, vol. 10, No. 3, pp. 551-570.*

——— (1961): On the Shanabuchi and Rubeshibe floras in northeastern Hokkaido, Japan (Preliminary report). *Abstract of lecture, Hokkaido Branch, Geol. Surv. Jap. No. 13, pp. 59-62,* (in Japanese).

TANAI, T. & ONOE, T. (1959): A Miocene Flora from the Northern Part of the Joban Coal Field. *Bull. Geol. Surv. Japan. vol. 10, No. 4, pp. 261-286.*

——— (1961): A Mio-Pliocene Flora from the Ningyo-toge area on the Border between Tottori and Okayama Prefecture, Japan. *Geol. Surv. Japan. Rep. No. 187.*

URASHIMA, Y. et al. (1953): On the age of igneous activity and mineralization in central Kitami province. *Bull. Geol. Comitt. Hokkaido, vol. 21. pp. 1-14.* (in Japanese).

Explanation of Plate I

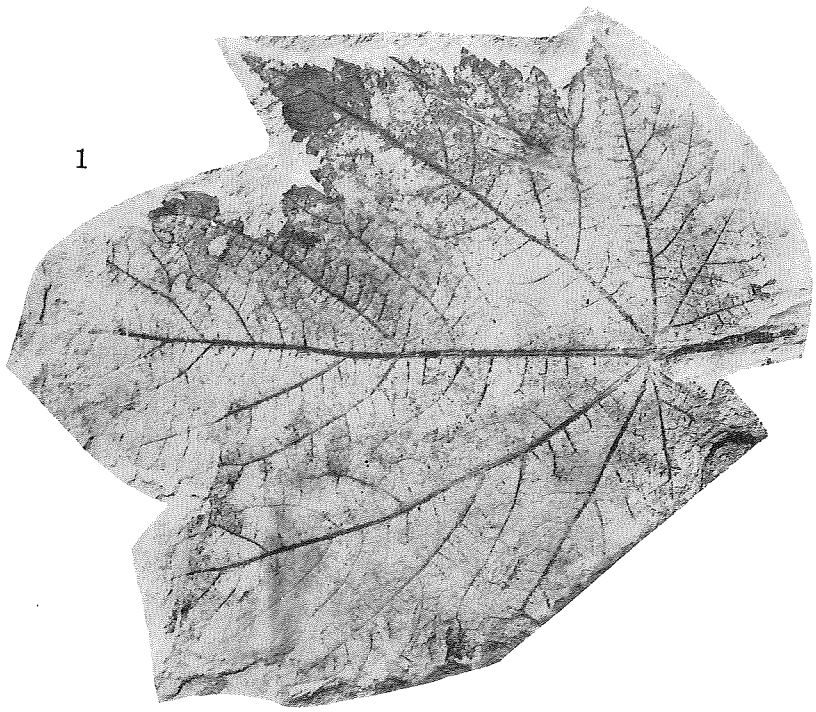
Explanation of plate I

(All natural size)

Fig. 1. *Acer subukurunduense* sp. nov.; (Rubeshibe)
Holotype H. U. M. P. Reg. No. 25918.

Fig. 2. *Acer ukurunduense* TRAUTT. et MEY.;
The living leaf for comparison with figure 1.

1



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N. SUZUKI; Late Tertiary Maples.

Photo. N. Suzuki

Explanation of Plate II

Explanation of plate II

(All natural size)

Figs. 1, 2. *Acer palaeodiabolicum* ENDO; (Rubeshibe)
Hypotypes H. U. M. P. Reg. Nos. 25895, 25896.

Fig. 3. *Acer tschonoskii* MAXIM.;
The living leaf for comparison with figure 4.

Fig. 4. *Acer* sp.; (Rubeshibe) Hypotype H. U. M. P. Reg. No. 25920.

N. SUZUKI; Late Tertiary Maples. *Photo. N. Suzuki*

Explanation of Plate III

Explanation of plate III

(All natural size)

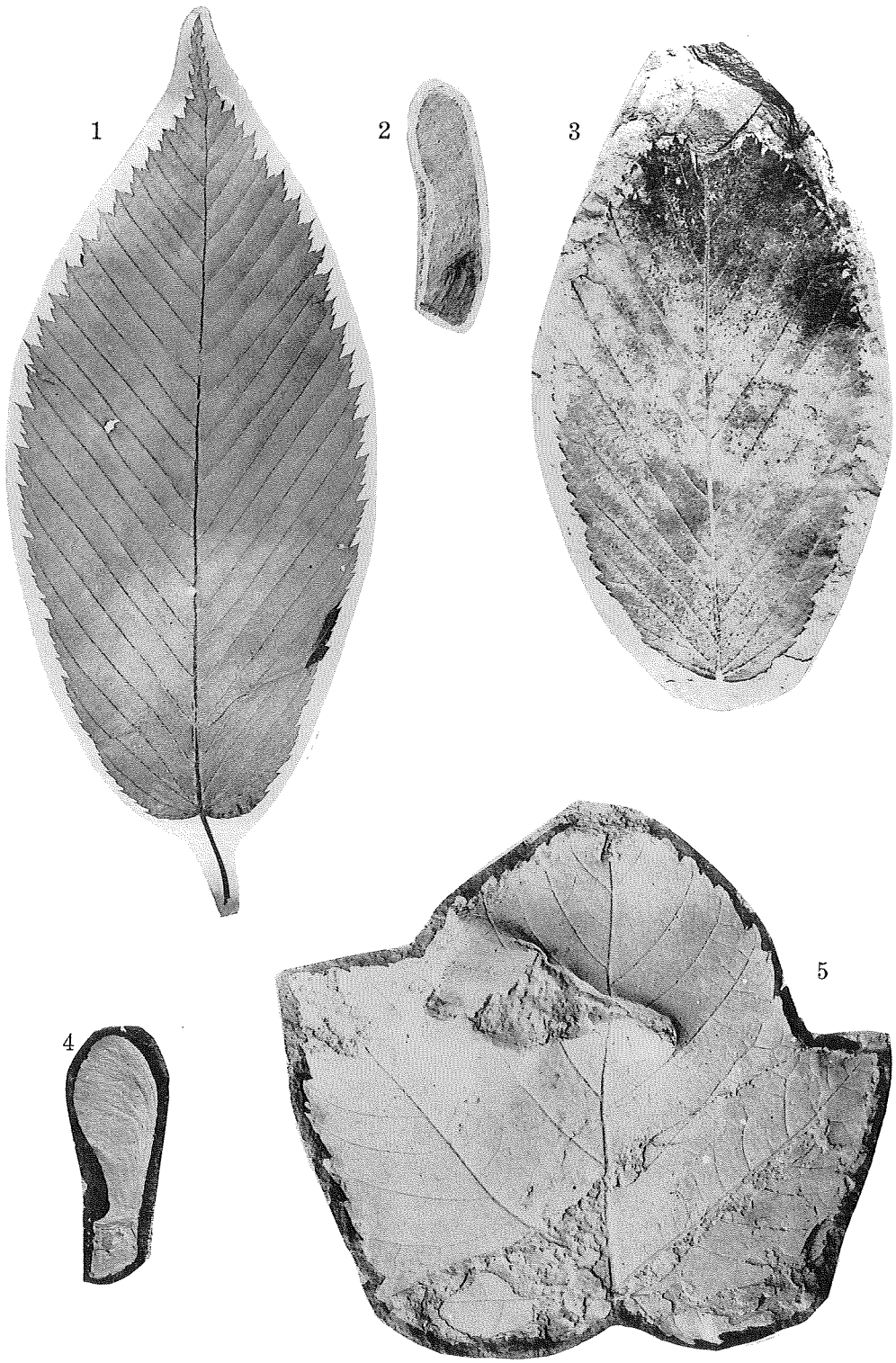
Fig. 1. *Acer carpinifolium* SIEB. et ZUCC.;
The living leaf for comparison with figure 3.

Fig. 2. *Acer pseudocarpinifolium* ENDO; (Shanabuchi)
Hypotype H. U. M. P. Reg. No. 25765.

Fig. 3. *Acer psedocarpinifoliun* ENDO; (Rubeshibe)
Paratype P. U. M. P. Reg. No. 25909.

Fig. 4. *Acer pseudoginnala* TANAI et ONOE; (Rubeshibe)
Hypotype H. U. M. P. Reg. No. 25908.

Fig. 5. *Acer palaceorufinerve* TANAI et ONOE; (Rubeshibe)
Hypotype H. U. M. P. Reg. No. 25901.



N. SUZUKI ; Late Tertiary Maples. *Photo. N. Suzuki*

Explanation of Plate IV

Explanation of plate IV

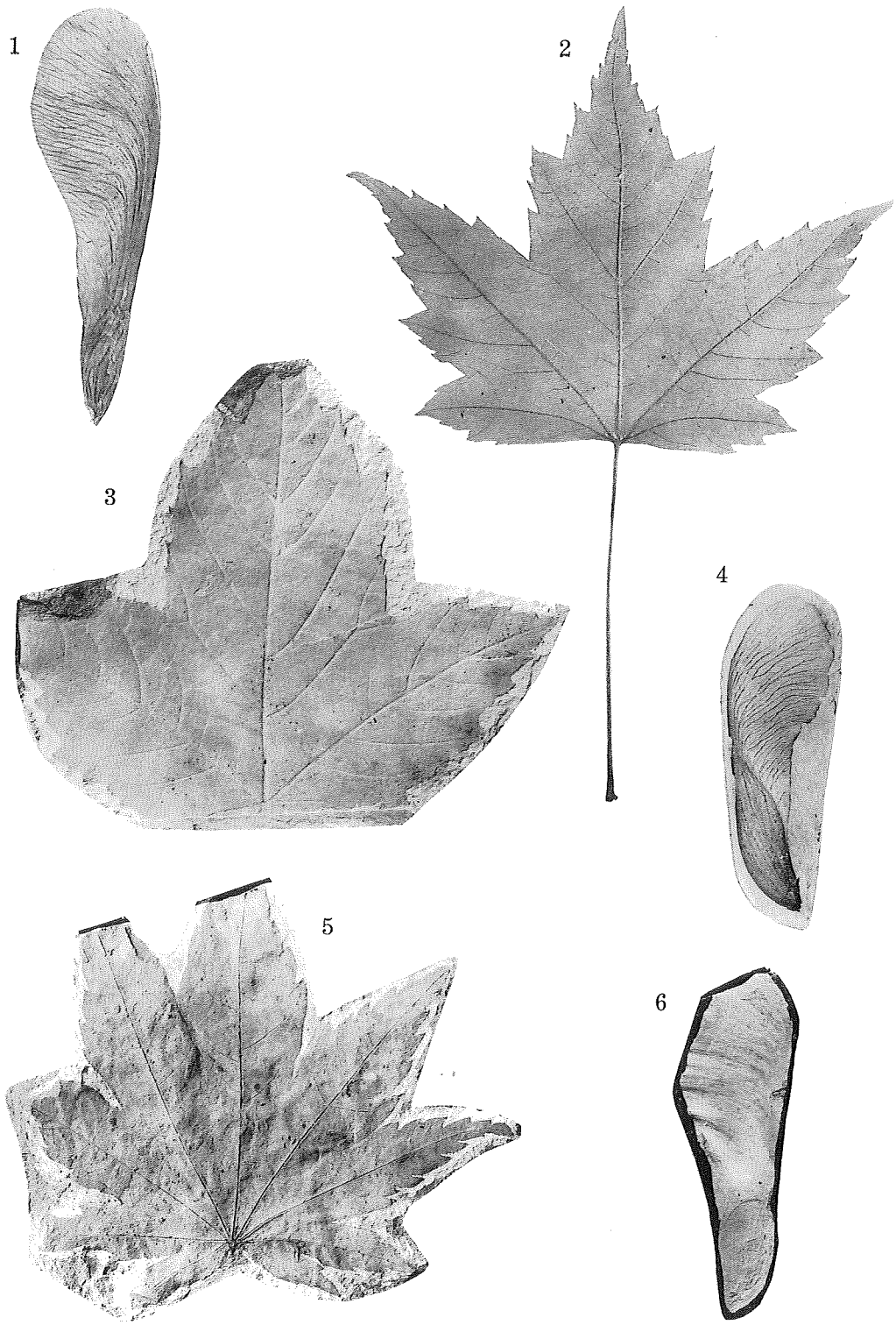
(All natural size)

Figs. 1, 2. *Acer saccharinum* LINNE;
The living leaf for comparison with figures 4, 6.

Fig. 3. *Acer yabei* ENDO; (Rubeshibe)
Paratype H. U. M. P. Reg. No. 25906.

Figs. 4, 6. *Acer yabei* ENDO; (Rubeshibe)
Hypotypes H. U. M. P. Reg. Nos. 25916, 25917.

Fig. 5. *Acer protojaponicum* TANAI et ONOE; (Shanabuchi)
Hypotype H. U. M. P. Reg. No. 25763.



N. SUZUKI ; Late Tertiary Maples. *Photo. N. Suzuki*

Explanation of Plate V

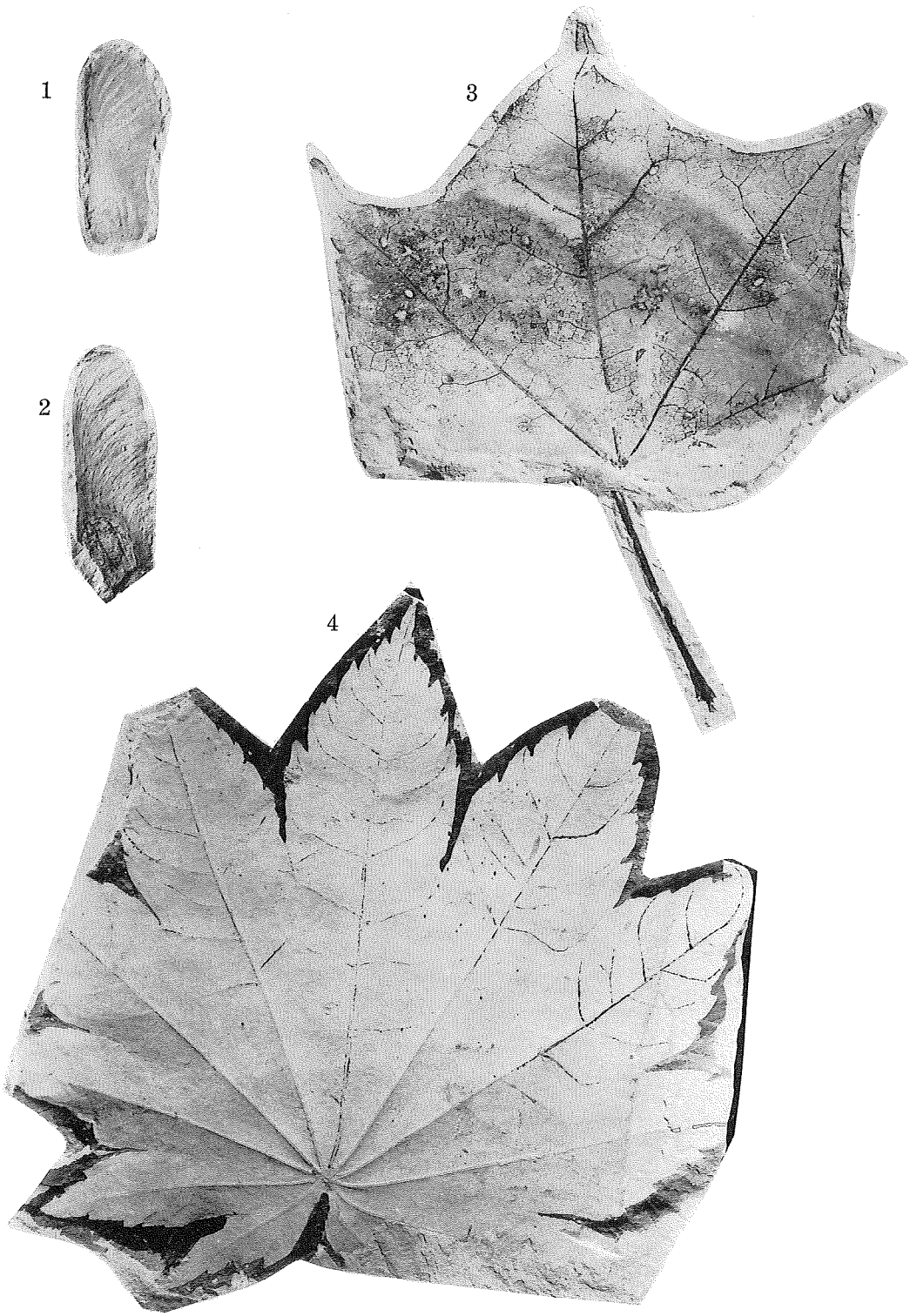
Explanation of plate V

(All natural size)

Figs. 1, 3. *Acer subpictum* SAPORTA; (Rubeshibe)
Hypotypes H. U. M. P. Reg. Nos. 25912, 25913.

Fig. 2. *Acer subpictum* SAPORTA; (Shanabuchi)
Hypotype H. U. M. P. Reg. No. 25776a.

Fig. 4. *Acer protojaponicum* TANAI et ONOE; (Rubeshibe)
Hypotype H. U. M. P. Reg. No. 25902.



N. SUZUKI; Late Tertiary Maples. *Photo. N. Suzuki*