

On Urticales, Ranales and Rosales of the Late Miocene Tatsumitoge Flora*

By

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Introduction

From the central part of Tottori Prefecture to the border area between Tottori and Okayama Prefectures of the western Honshu develop volcanics frequently intercalating terrestrial sedimentary rocks of Late Miocene to Pliocene age. These rocks are the members of the Misasa Group in which the presence of four volcanic cycles are confirmed by FUKUOKA & KUBO (1969). Many plant fossils are found in the sediments intercalated in products of the second to third cycles of volcanism. Some of those fossils were described by TANAI & ONOE (1961) as Hoki flora (the Mitoku, the Onbara and the Ningyotoge florules). According to FUKUOKA & KUBO (1969), the Tatsumitoge flora is included in the uppermost mudstone of the Tochiwara Formation, varying from pschite to pelite, which approximately corresponds to the products of the second cycle of volcanism in the Misasa Group.

The Tatsumitoge flora is of palaeontological importance with respect to the abundant occurrence of well-preserved specimens including many uninvestigated ones.

Coniferales, Juglandales, Salicales, Fagales, and Aceraceae of the Tatsumitoge flora have been reported by OZAKI (1979) and TANAI & OZAKI (1977). Urticales, Ranales, and Rosales of the Tatsumitoge flora are described in this paper. These taxa contain 9 families, 27 genera, and 41 species, 18 of which being new. The remaining taxa of the Tatsumitoge flora will be described separately.

Description

Family Ulmaceae

***Celtis angusta* TAO**

Pl. 1, fig. 4

Celtis angusta TAO, ACADEMIA SINICA, PEKING INST. & NANKING INST. GEOL. & PALAEONT. (Compiled), 1978, p. 36, pl. 26, fig. 1, text-fig. 18.

Discussion: Three leaves are referable to *Celtis angusta* TAO in the lanceolate-

* Late Miocene Tatsumitoge Flora in Tottori Prefecture, Southwest Honshu, Japan (II).

oblong foliar shape, small number of the secondary veins, and the marginal serration that surrounds the whole margin except the basal part. This species is distinguished from *C. hokiensis* n. sp. by the slender foliar shape. *C. angusta* is similar to the extant *C. australis* LINN. growing in southern area of Europe.

Collections: NSM PP 16018; TPM 164, 458.

***Celtis hokiensis* OZAKI, new species**

Pl. 1, figs. 3, 9; Fig. 1A

Celtis occidentalis LINN.: OKUTSU, 1955, p. 94, pl. 1, fig. 5.

Celtis nordenskioldii auct. non NATHORST: TANAI, 1961, p. 316, pl. 17, fig. 1.

Holotype: TPM 498. Upper Tochiwara Formation (Late Miocene). Sajimura, Tottori Prefecture.

Description: Leaves ovate to oval, 6.5 to 10 cm long and 5 to 7 cm wide, base inequilateral and obliquely round to slightly cordate, apex acute to acuminate, margin serrate with densely arranged teeth except the basal part; marginal teeth triangular, concave on the apical side and convex on the basal side with incurved acute tips; venation brochidodromous with a pair of strong secondaries which extend from the base of the lamina; midvein stout weakly curved and sometimes slightly sinuous in the middle to the upper part, sending off two to three alternate secondary veins; basal secondary veins making an angle of 25° to 30° with the midvein, curving up, reaching upper one-third of the leaf length and joining tertiary veins or branches from the superadjacent secondaries to form the marginal loops, sending off five to seven strong tertiaries to the abaxial side which join the superadjacent one to form marginal loops; secondaries in the middle to the upper part of the midvein making an angle of about 30° to the midvein, gently curving up and joining the superadjacent secondaries or branches from the secondaries to form marginal loops; tertiary veins in the intercostal area weakly percurrent, while the tertiaries in the marginal area extending from the marginal loops of the secondaries and entering the marginal teeth; quaternary veins making mainly pentagonal meshes; ultimate veinlets twice to thrice branching; petiole

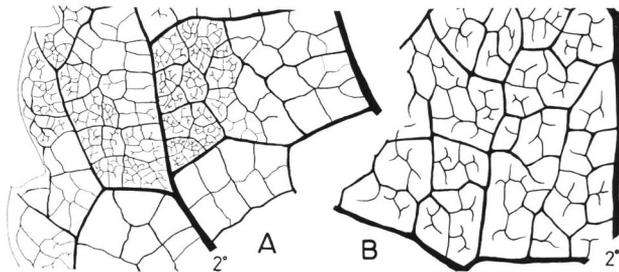


Fig. 1. Venation characters of fossils.

A. *Celtis hokiensis* n. sp. NSM PP 16018. ($\times 3.5$).

B. *Lindera hokiana* n. sp. GSJ 4804. ($\times 12$).

thick, about 1.5 cm long.

Discussion: There have been reported about 10 fossil species of *Celtis* from the Neogene of East Asia. Among them, *C. nordenskiöldii* NATHORST (1883), *C. miobungeana* HU et CHANEY (1938), *C. nathorstii* TANAI et ONOE (1961), *C. aizuensis* K. SUZUKI (1961), and *C. angusta* TAO (1978) are similar to this new species, but they differ from this new one in the situation and shape of the marginal teeth, the basal shape, and width of the lamina. New leaves closely resemble those of *C. jessoensis* KOIDZ. growing in Japan and Korea and somewhat resemble *C. vendervetiana* SCHNEID. growing in central to southern China.

Collections: NSM PP 16019, 16020; GSJ 4783–4785; TPM 105, 123, 330, 498.

***Ulmus protojaponica* TANAI et ONOE**

Pl. 1, fig. 1

Ulmus protojaponica TANAI et ONOE, 1961, p. 38, pl. 10, figs. 2, 5.

Discussion: Some leaves are identified to *Ulmus protojaponica* TANAI et ONOE in the asymmetrical foliar shape, sometimes bifurcating secondary veins, percurrent tertiary veins, and compoundly serrate margin. This species is similar to the extant *U. davidiana* PLANCH. growing in northern China and is closely similar to *U. davidiana* PLANCH. var. *japonica* NAKAI growing in Japan, Korea, and China.

Collections: NSM PP 16050; TPM 232.

***Ulmus subparvifolia* NATHORST**

Pl. 1, fig. 8

Ulmus subparvifolia NATHORST, 1883, p. 77, pl. 15, figs. 5a–c. TANAI, 1961, p. 321, pl. 17, fig. 9.

Ulmus protoparvifolia HU et CHANEY, 1938, p. 40, pl. 14, fig. 4 (only).

Discussion: Two specimens are identified to *Ulmus subparvifolia* NATHORST in small foliar size, singularly serrated blunt marginal teeth, and thick tertiary veins that are nearly percurrent. This species is closely similar to the extant *U. parvifolia* JACQ. growing in central to southern Japan, Korea, and China.

Collection: NSM PP 16041, 16042.

***Zelkova ungeri* KOVATS**

Pl. 1, fig. 7

Zelkova ungeri KOVATS, 1851, p. 187. MIKI, 1937, p. 312, pl. 3, figs. D, E.

Discussion: This species is widely reported from the Neogene floras in various localities of Japan. This species is closely related to the extant *Zelkova serrata* MAKINO growing in Japan except Hokkaido, and China, and is similar to *Z. schneideriana* HAND.-MEZZ. growing in China.

Collections: NSM PP 16002, 16013–16015, 16043, 16084; TPM 128, 503.

Family Eucommiaceae

Eucommia japonica TANAI

Pl. 1, fig. 2

Eucommia japonica TANAI, 1961, p. 329, pl. 31, fig. 3.

Discussion: This nearly complete winged-seed is identical to *Eucommia japonica* TANAI reported from the Middle Miocene Kamigo Formation of Yamagata Prefecture, Japan. This seed is closely similar to the extant *E. ulmoides* OLIVER growing in central China.

Collection: TPM 490.

Family Magnoliaceae

Liriodendron honsyuensis ENDO

Pl. 2, figs. 2, 5

Liriodendron honsyuensis ENDO, 1934, p. 591, figs. 1, 2.

Discussion: Many well-preserved leaves are identified to the genus *Liriodendron* in their characteristic features, and are referable to *L. honsyuensis* ENDO. This species has shallowly cordate to obtuse base and this character resembles the two extant species, *L. chinense* (HEMSL.) SARG. of central to southern China and *L. tulipifera* LINN. of the eastern United States; the former has mainly cordate base, whereas the latter has widely cordate to decurrent base on the petiole as far as the author's investigation is concerned.

Collections: NSM PP 6430, 16055–16058, 16064, 16065; GSJ 4790, 4791; TPM 241.

Magnolia elliptica TANAI et ONOE

Pl. 2, fig. 1

Magnolia elliptica TANAI et ONOE, 1961, p. 40, pl. 12, figs. 1, 5.

Discussion: This specimen, though incomplete, is referred to *Magnolia elliptica* TANAI et ONOE by its entire elliptical shape, large foliar size and the brochidodromous venation. This species is similar to the living *M. kobus* DC. growing in Japan.

Collection: GSJ 4795.

Family Lauraceae

Lindera paraobtusiloba HU et CHANEY

Pl. 3, figs. 8, 9

Lindera paraobtusiloba HU et CHANEY, 1938, p. 43, pl. 8, figs. 1–3, pl. 20, fig. 4. TANAI, 1955, pl. 12, fig. 4.

Sassafras yabei auct. non ENDO et OKUTSU: TANAI, 1961, p. 340, pl. 23, fig. 1.

Discussion: Several leaves are referred to *Lindera paraobtusiloba* HU et CHANEY by the infrabasal imperfect acrodromous venation and characteristic foliar shape, and are closely similar to the living *L. obtusiloba* BLUME growing in central to southern Japan, Korea, and China and somewhat similar to *L. cercidifolia* HEMSL. growing in China.

Collections: NSM PP 16004; GSJ 4768A.

***Lindera hokiana* OZAKI, new species**

Pl. 3, fig. 7; Fig. 1B

Holotype: GSJ 4804. Upper Tochiwara Formation (Late Miocene). Sajimura, Tottori Prefecture.

Description: Leaf elliptical, cuspidate at apex, cuneate and slightly decurrent at base, 7.5 cm long and 5 cm (estimated) wide; margin entire; midvein slightly sinuous on its upper part; secondary veins alternate to subopposite, about 5 pairs, irregularly spaced, making an angle of 65° to 70° with the midvein except basal pair which diverges about 45° from the midvein, turns up and runs slightly zigzag in some case; intersecondary veins composite; tertiary veins random reticulate in intercostal area, making angular loops in marginal area; quaternary veins random reticulate; ultimate veinlets none or once branched; petiole more than 5 mm long.

Discussion: This leaf is somewhat similar to those of *Lindera miyataensis* HUZIOKA et UEMURA (1973) in foliar shape, but is separable from the latter by larger and elliptical foliar shape, and by the character of the secondary veins. This new species is similar to the extant *L. umbellata* THUNB. var. *membranacea* (MAXIM.) MOMIYAMA growing in Honshu to Hokkaido, but is different in the less secondary veins and high angle of secondary departure from the midvein.

Collection: GSJ 4804.

***Parabenzoin* sp.**

Pl. 3, fig. 5; Fig. 2A, B

Discussion: A single leaf, though lacking in its distal ends, is closely similar to the extant *Parabenzoin trilobum* (SIEB. et ZUCC.) NAKAI growing in central to southern Japan.

Leaves of the extant *P. trilobum* are separable from those of *Sassafras* by the following points: secondary and tertiary veins in the lower region of the separating point of the primaries are parallel or decurrent to the midvein; apices of lateral lobes are attenuate-acuminate and generally markedly outcurved; not having strong secondary veins around separating point of the primaries; generally having short distance between the base and the separating point of the primaries; generally smaller foliar size compared to those of *Sassafras*.

On the other hand, the leaves of *Sassafras* have following characters: sometimes strong secondaries develop around or in the lower part of the separating point of the

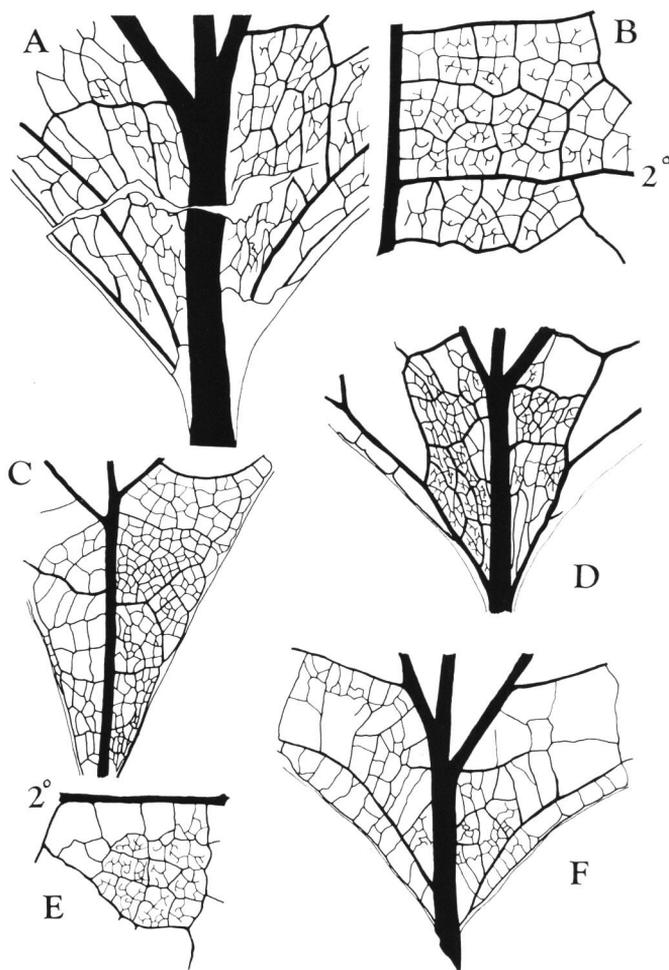


Fig. 2. Venation characters of fossils and related extant species.

A, B. *Parabenzoin* sp. NSM PP 16002. ($\times 6$).

D. *Parabenzoin trilobum* (SIEB. et ZUCC.) NAKAI, HUPB 307. ($\times 3.5$).

C. *Sassafras albidum* NEES, HUPB 642. ($\times 1.5$).

E, F. *Sassafras yabei* ENDO et OKUTSU, NSM PP 16003. E ($\times 8$), F ($\times 1.5$).

primaries; in the lower region of the separating point of the primaries secondaries are generally perpendicular to the midvein and tertiaries are random reticulate; apices of lobes are round to acute; foliar size is large; and distance between the base and the separating point of the primaries is longer than those of *Parabenzoin*.

Parabenzoin eotrilobatum reported from the Eocene Takashiam flora in Kyushu by MATSUO (1967) is distinguishable from my specimen by longer foliar shape and narrower basal angle.

Collection: NSM PP 16002.

***Sassafras yabei* ENDO et OKUTSU**

Pl. 3, figs. 1, 2, 6; Fig. 2E, F

Sassafras yabei ENDO et OKUTSU, 1936, p. 47, figs. 2–4.

Sassafras oishii OKUTSU, 1953, p. 9, pl. 1, fig. 2.

Discussion: Many leaves are identifiable as *Sassafras* by the foliar shape and venation characters as noted in the discussion of the *Parabenzoin*, and are referable to *S. yabei* ENDO et OKUTSU in foliar shape and venation characters.

Among other similar fossil species of *Sassafras* reported from Japan, *S. oishii* OKUTSU (1953) can not be separated from *S. yabei* ENDO et OKUTSU in foliar shape and the venation. *S. endoi* HUZIOKA (1938) seems to be close to *Parabenzoin trilobum* NAKAI by the short distance between the base and the separating point of the primary veins and slender shape of the lobes though it lacks their apices. *S. subtriloba* (KONNO) TANAI et ONOE (1961) is illegitimate on the Code: (1) *Lindera subtriloba* KONNO (1931) is nomen nudum, (2) the syntypes are missing but TANAI and ONOE (1961) selected two holotypes from the leaves of the Hoki flora. *Lindera subtriloba* KONNO is closely similar to the extant *Parabenzoin trilobum* NAKAI as same as *S. Fujiokae* MURAI (1963) in the attenuate-acuminate apices of the lobes.

Collections: NSM PP 6433, 16003, 16239, 16300; GSJ 4767, 4769, 4770, 4781; TPM 132, 296, 379, 380.

Family Cercidiphyllaceae

***Cercidiphyllum crenatum* (UNGER) BROWN**

Pl. 3, figs. 3, 4

Cercidiphyllum crenatum (UNGER) BROWN, 1935, p. 488, pl. 68, figs. 1, 6, 8–10. HUZIOKA et NISHIDA, 1960, p. 16, pl. 4, figs. 5, 6.

Discussion: Very small two winged-seeds are referable to *Cercidiphyllum crenatum* by the parallelogram shape of wing and seed. This species closely resembles the modern *C. japonicum* SIEB. et ZUCC. growing in Japan and China.

Collection: NSM PP 16144, 16230.

Family Hamamelidaceae

***Hamamelis protojaponica* TANAI et N. SUZUKI**

Pl. 1, figs. 5, 6

Hamamelis protojaponica TANAI et N. SUZUKI, 1965, p. 27, pl. 5, fig. 3b, pl. 17, fig. 4.

Hamamelis sp., TANAI et ONOE, 1961, p. 43, pl. 12, fig. 3.

Discussion: The leaves have several characteristics that indicate a close relationship to *Hamamelis*: oval to rhombate foliar shape, imperfect basal and infrabasal

acrodromous venation, repand to crenate margin in the upper half of the lamina, secondary veins extend to the crest of the marginal teeth, and complicated ultimate veinlets. These leaves are referable to *H. protopaponica* TANAI et N. SUZUKI. This species is most similar to the extant *H. japonica* SIEB. et ZUCC. growing in Honshu to Kyushu, Japan.

Collection: NSM PP 6432, 16162.

Family Saxifragaceae

Philadelphus hokiensis OZAKI, new species

Pl. 2, fig. 4, Fig. 3B, C

Holotype: NSM PP 16228. Upper Tochiwara Formation (Late Miocene). Saji-mura, Tottori Prefecture.

Description: Leaf elliptical with suprabasal imperfect acrodromous venation, 5.5 cm long (estimated) and 2.4 cm wide (estimated), apex acuminate, base missing but apparently acute, margin having sporadic minute teeth; primary vein nearly straight; one pair of secondary veins leaving from the primary vein at an angle of 30° near the base, extending in the middle course of lateral half of the lamina till a half of the leaf length then running to the apex along the margin with sinuous course; from basal part of the primary vein weak one pair of secondaries extending along the margin till about three-fifths of the leaf length from the base and making a series of loops with joining tertiary veins; weak secondaries diverging from the middle to upper part of the midvein with random acute angles and with irregular space, forking and sometimes

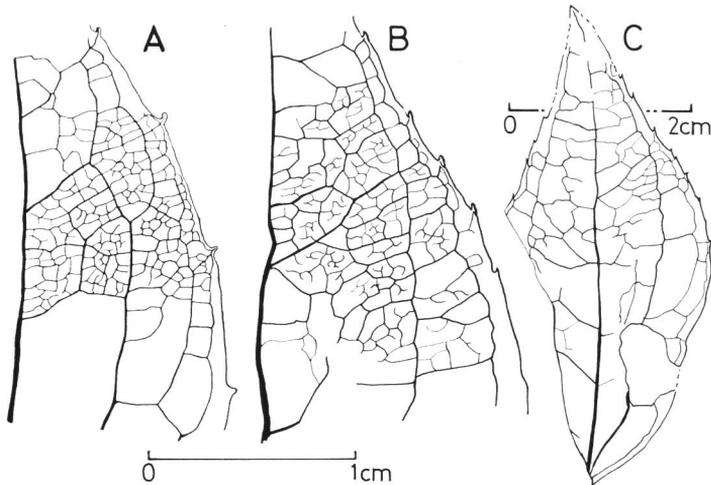


Fig. 3. Venation characters of *Philadelphus hokiensis* n. sp. and related extant species.

A. *Philadelphus satsumi* SIEB. YNUPB 503.

B, C. *Philadelphus hokiensis* n. sp. NSM PP 16228.

connecting with each other then reaching the lateral pair of secondaries; tertiary veins among the secondaries random reticulate, in the marginal area entering marginal teeth or making loops; ultimate veinlets mainly once branching.

Discussion: This imperfect leaf is characterized by elliptical shape, acuminate apex, acute base, suprabasal acrodromous venation and sporadically spaced minute teeth on the margin. These characters indicate a close relationship to *Philadelphus*. Among the living *Philadelphus*, this leaf is similar to those of *P. sericanthus* KOEHNE growing in central China and somewhat to *P. satsumi* SIEB. ex LINDL. et PAXT. growing in Japan, but is separable from the extant species in the venation in the upper half of the marginal area as shown in text-fig. 3. This leaf is similar to the leaves of some *Pertya*, but is different in suprabasal acrodromous venation.

Collection: NSM PP 16228.

Family Rosaceae

***Crataegus hokiensis* OZAKI, new species**

Pl. 4, figs. 1, 2, 3, 6, 9; Fig. 4D, E

Holotype: NSM PP 16173. Upper Tochiwara Formation (Late Miocene). Saji-mura, Tottori Prefecture.

Description: Leaves oval to rhombate, 4 to 7 cm (estimated) long and 3.7 to 6 cm (estimated) wide, base widely cuneate and slightly decurrent to petiole, separated into two pairs of oblong lateral lobes and ovate apical lobe by acuminate sinuses, each apex acute, sinuses reaching the middle of lateral half of lamina, marginal teeth acuminate with 1 to 3 attenuate-acuminate subsidiary teeth on the basal side, petiole more than 2 cm long, rather thin, straight or slightly curving; midvein slightly curving; secondary veins generally subopposite, 4 to 5 pairs, diverging from the midvein at an angle of about 30° to 45°, lower two pairs extending to the apices of the lateral lobes and the upper two or more pairs extending in the principal teeth of the apical lobe, the basal pair of the secondaries extending straight or curving down, the secondary pair almost straight and the upper pairs gently curving up; basal intersecondary veins extending to the sinuses and forking near the bottom of sinuses: basal branch discordantly running along the margin and joining tertiary veins and another branch entering teeth; upper intersecondary veins forking near the margin: basal branch reaching the sinus bottom and the other entering the marginal tooth; tertiary veins random reticulate in intercostal area and entering marginal teeth in marginal area; fourth and fifth order veins orthogonal reticulate; ultimate veinlets once to thrice branched.

Discussion: The foliar shape, doubly serrate margin and intersecondary veins represent a species of *Crataegus*. These leaves most resemble those of the living *C. maximowiczii* SCHNIED. growing in Hokkaido, Korea and northern China and are also similar to *C. wilsonii* SARG, growing in central to western China. This fossil species is distinguishable from *C. sugiyamae* HUZIOKA (1964) in the deeply lobated

foliar shape and the intersecondary veins, and from *C. miocuneata* HU et CHANEY (1938) in the foliar shape.

Collections: NSM PP 16172–16174; TPM 130, 264, 475.

***Crataegus tatsumitogensis* OZAKI, new species**

Pl. 5, fig. 9, Fig. 4C

Holotype: TPM 251. Upper Tochiwara Formation (Late Miocene). Sajimura, Tottori Prefecture.

Description: Leaf small, triangular, 6 cm long (estimated) and 4 cm wide (estimated), dissected by deep attenuate sinuses, apices of lateral lobes attenuate-acuminate, apex of terminal lobe missing, margin serrulate with fine acute teeth, base cordate but decurrent to the petiole, petiole 2.2 cm long; midvein rather thick weakly curving; secondary veins diverging at an angle of about 50° from the midvein, the lower pair gently curving down and reaching the apices, upper pair extending almost straight; intersecondary veins short, extending to the sinus then bifurcating just near the bottom with almost right angles, the basal branch extending almost straight along the margin and connecting with tertiaries, the other branch extending with sinuous course and

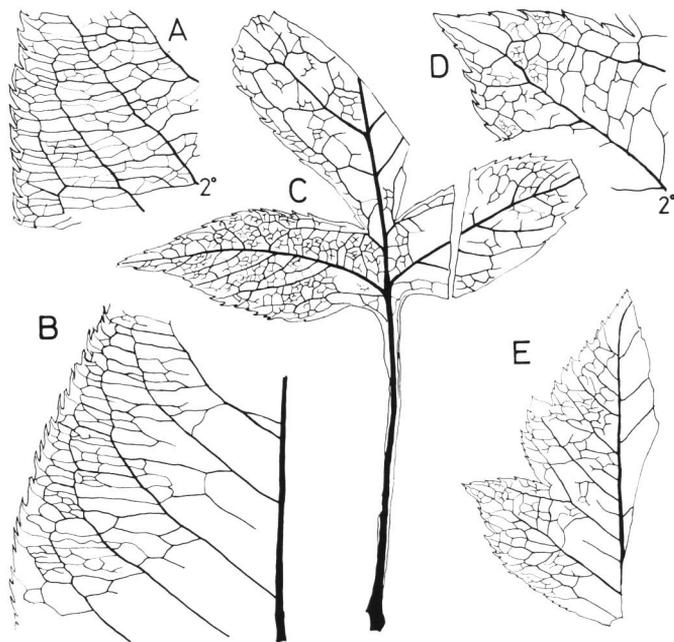


Fig. 4. Venation characters of fossils and its related some extant species.

- A. *Pyrus calleryana* DECNE. YNUPB 251. ($\times 2.2$).
- B. *Pyrus hokiensis* n. sp. TPM 245. ($\times 2.2$).
- C. *Crataegus tatsumitogensis* n. sp. TPM 251. ($\times 1.8$).
- D, E. *Crataegus hokiensis* n. sp. TPM 475. D ($\times 2.2$), E ($\times 7/8$).

connecting with tertiaries; tertiaries in basal side of lateral lobes diverging from the secondaries at an angle of about 40° to 50° , weakly curving toward apex and reaching marginal teeth, tertiaries in the basal side of the apical lobe connecting with the upper branch of the intersecondary veins, tertiaries in the apical side of the lobes orthogonal reticulate and some of them curving toward apex and forking in the apical part; quaternaries between the tertiaries orthogonal reticulate, in marginal area entering marginal teeth; finer veins not well preserved; petiole thick, slightly curving, having very narrow wings from the base of the lamina till near the proximal end of the petiole.

Discussion: One small leaf is referred to the genus *Crataegus* by the foliar shape and the intersecondary veins. The apical lobe is fragmentary and there is possibility of existence of one pair of sinuses in the lacking part. This specimen is slightly similar to small leaves of the extant *Crataegus pinnatifida* BUNGE growing in northern Korea, northeastern China and southern Siberia.

This new species is separable from the known fossil species of *Crataegus* by the small leaf size and the deep sinuses.

Collection: TPM 251.

Malus sp.

Pl. 2, fig. 6, Fig. 5C, D

Discussion: A single incomplete leaf has widely elliptical foliar shape, round base, four or five pairs of brochidodromous secondary veins that form angular marginal loops, closely arranged tertiary veins that are nearly perpendicular to midvein, and densely arranged fine marginal acute teeth. The leaf appears, therefore, to represent a species of *Malus*. Among the extant species of *Malus*, this fossil leaf is similar to those of *M. baccata* (LINN.) BORKH. and *M. hupehensis* (PAMP.) REHD. in the fine marginal teeth and the number of the secondary veins.

Collection: GSJ 4842.

Prunus protossiori TANAI et ONOE

Pl. 4, figs. 11, 12

Prunus protossiori TANAI et ONOE, 1961, p. 44, pl. 13, figs. 6, 7. TANAI et N. SUZUKI, 1965, p. 29, pl. 12, fig. 8 (only). TANAI, 1971, p. 161, pl. 10, fig. 5.

Discussion: There have been reported several fossil species of cherry in Neogene floras of eastern Asia, among which these specimens are referred to *P. protossiori* TANAI et ONOE in foliar shape, marginal almost single serration and secondary veins that do not form double loops in the marginal area. My leaves also resemble those of *P. florinii* TANAI reported from the Mogi flora (TANAI, 1976), but are distinguishable in large attenuate marginal teeth. *P. protossiori* is similar to the living *P. sargentii* REHD. and *P. jamasakura* SIEB. and its varieties. Several leaves were reported under the name of *P. protossiori* from the Neogene of Japan by some authors. Among them, the above-noted leaves are fairly identical to the original leaves. The others reported as *P. protossiori* should be excluded from this species, because those leaves

have different foliar shape, marginal serration and venation.

Collections: NSM PP 16009, 16072; TPM 295, 376.

***Prunus tanaii* OZAKI, new species**

Pl. 5, figs. 1, 2, 4; Fig. 5A, B

Holotype: TPM 323. Upper Tochiwara Formation (Late Miocene). Sajimura, Tottori Prefecture.

Description: Leaves oblong in general shape, apex acute, base cuneate, about 5 cm long and 2.5 cm wide; margin serrulate with basilaminar glandular teeth; marginal teeth concave to sometimes sigmoidal on apical side and sigmoidal to convex on basal side, often accompanied by one subsidiary tooth on the basal side, tooth apex acute; midvein stout, slightly arched; secondary veins irregularly spaced, about 12 pairs diverging from the midvein at an angle of 50° to 60° , extending slightly sinuous, generally forking two times on the way and making angular large loops with joining adjacent veins; intersecondary veins simple to composite; tertiary veins in intercostal area random reticulate, in marginal area extending from the corner of the secondary's angular loops and entering marginal teeth or forming angular loops; fourth and fifth

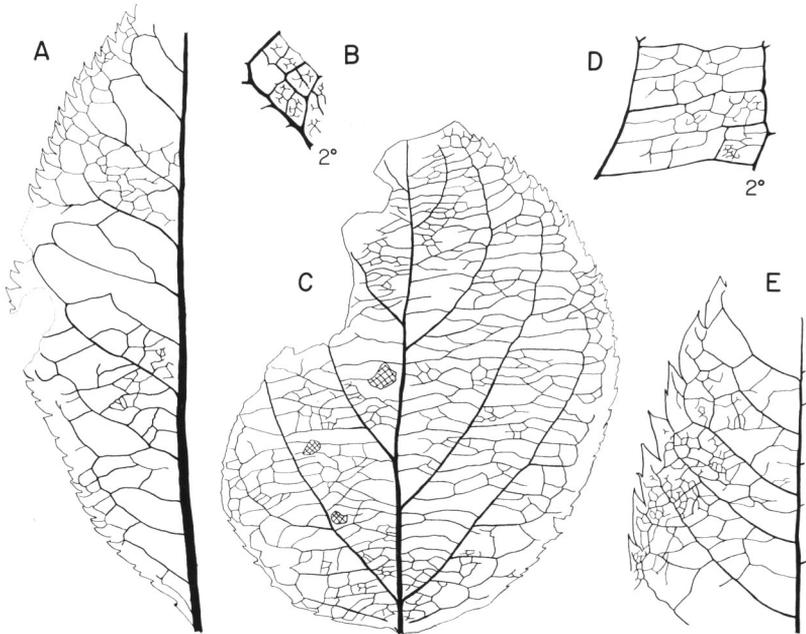


Fig. 5. Venation characters of fossils.

A, B. *Prunus tanaii* n. sp. TPM 323. A ($\times 1.75$), B ($\times 8.75$).

C, D. *Malus* sp. GSJ 4842. C ($\times 2$), D ($\times 5$).

E. *Prunus* sp. NSM PP 16085. ($\times 2$).

order veins making polygonal meshes; ultimate veinlets once to twice branched; petiole stout, almost straight but curving and fattening on the proximal end, about 1.4 cm long.

Discussion: These nearly complete specimens are referred to the genus *Prunus* by a pair of basal glandular teeth, marginal serration and secondary veins. Among the fossil species of *Prunus*, *P. ishidae* TANAI et SUZUKI (1965) and *P. rubeshibensis* TANAI et SUZUKI (1965) have similar marginal serration, but are different in the secondary and tertiary veins. This new species most resembles the extant *P. cerasifera* EHRH. growing in western Asia in foliar shape, marginal serration and the position of the glandular teeth, but is somewhat different in the secondary and tertiary veins.

Collection: TPM 323, 481, 482.

***Prunus* sp.**

Pl. 2, fig. 3; Fig. 5E

Discussion: Several features of the two incomplete leaves indicate that they represent a species of *Prunus*: lanceolate-oblong foliar shape, attenuate apex, round base, brochidromous secondary veins that form angular marginal loops near the margin, weakly precurrent tertiary veins, and attenuate-acuminate marginal teeth that are generally of single serration but sometimes have a minute subsideary tooth on the basal side.

These leaves are somewhat similar to those of the extant *Prunus grayana* MAXIM. growing in Japan and China.

Collection: NSM PP 16095, 16136.

***Pyrus hokiensis* OZAKI, new species**

Pl. 4, figs. 4, 5, 7, 8, 10, pl. 5, fig. 10; Fig. 4B

Holotype: GSJ 4820, Upper Tochiwara Formation (Late Miocene). Saji-mura, Tottori Prefecture.

Description: Leaves oval, 2.5 to 7.0 cm long and 2.1 to 4.2 cm wide, apex acuminate, base generally round but sometimes obtuse, margin serrulate with attenuate teeth; marginal teeth small, densely arranged, straight to slightly concave on the apical side and convex on the basal side; primary vein medium, straight; secondary veins rather thin, 8 to 10 subopposite to alternate pairs, diverging from the primary vein at an angle of 60° in the basal part, at 45° to 50° in the middle part and at about 20° in the apical part, extending straight or slightly curving up, joining with the branches of superadjacent secondary veins and making parallelogram-like network in marginal area; intersecondary veins composite; tertiary veins fine, obliquely precurrent, nearly perpendicular to the midvein together with the branches of the secondaries in intercostal area, entering the marginal teeth in marginal area; quaternary veins making mainly pentagonal meshes between the tertiaries; ultimate veinlet not well preserved; petiole 1.3 to 2.6 cm in length, generally oblique to the lamina, curving and slightly thickening at the proximal end.

Discussion: These leaves are characterized by densely arranged fine attenuate marginal teeth and tertiary veins that are almost perpendicular to the midvein. These characters belong to the genus *Pyrus*. The classification of this genus only by leaf is difficult, but these fossil leaves resemble those of *Pyrus callyana* DEC. var *dimorphophylla* (MAKINO) KOIDZ. growing in central Japan and also somewhat resemble *P. ussuriensis* MAXIM. growing in northern China and Korea in the marginal teeth. This fossil species is distinguishable from *P. ussuriensis* by not having hairlike apices at the marginal teeth and from the *P. callyana* by attenuate, more densely arranged marginal teeth.

Collections: NSM PP 16165–16170; GSJ 4820, 4821; TPM 245, 473, 474.

***Sorbus hokiensis* OZAKI, new species**

Pl. 6, figs. 2–6, Fig. 6B, C

Holotype: TPM 409. Upper Tochiwara Formation (Leat Miocene). Saji-mura, Tottori Prefecture.

Description: Leaves oval, 6 to 12 cm (estimated) long and 7 to 12 cm (estimated) wide, 4 pairs of lanceolate lateral lobes and an apical lobe separated by acuminate sinuses, sinuses reaching the middle of lateral half of lamina, apices attenuate-acuminate, base widely cuneate to truncate, margin mainly single serrulate but sometimes doubly serrulate; teeth fine, slightly convex to straight on basal side, short and straight

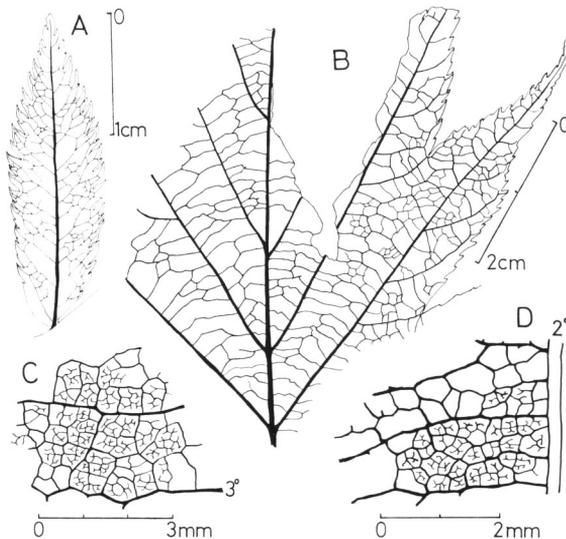


Fig. 6. Venation characters of fossils.

- A. *Sorbus uzenensis* HUZIOKA, TPM 376.
- B, C. *Sorbus hokiensis* n. sp. TPM 319.
- D. *Sorbus palaeojaponica* MURAI, NSM PP 16062.

on apical side with acute apex; midvein running slightly sinuous; secondary veins subopposite, 4 to 5 pairs, basal two pairs making an angle of 60° to 50° with the midvein, the upper pairs gradually decreasing the angle to the apex and the uppermost pair making an angle of about 20° , the basal pairs slightly turning down, while the middle to apical pairs weakly turning up, sending off some branches on the basal side in the upper part of the lobes; branches from the secondary veins gently curving to the apical portion of the lobes and directly entering the marginal teeth or forking just near the margin: one of which entering the teeth and the other joining with tertiary veins; tertiary veins percurrent, forking well and joining each other in intercostal area; fourth and fifth veins orthogonal reticulate; ultimate veinlets once to twice branching; petiole more than 3 cm in length, almost straight.

Discussion: These peculiar-shaped five leaves resemble some leaves of *Sorbus*, *Crataegus*, *Malus* and somewhat resemble *Stephanandra* in their lobated foliar shape. My leaves are different from those of the *Malus* in not having nearly perpendicular tertiary veins to midvein and from those of the *Stephanandra* in not having large marginal teeth. Among the living species of *Crataegus* and *Sorbus*, *C. pinnatifida* BUNGE growing in Korea and northern China, and *S. torminalis* CRANTZ. growing in central to southwestern Europe are similar to my leaves in their characteristic foliar shape, but the former is separable from my leaves by its intersecondary veins. My leaves are most similar to *S. torminalis* in foliar shape, marginal serration and venation, but is separable by the smaller number of the lobes and the widely cuneate basal shape. My leaves are separable from *S. praetorminalis* KRYSST. et BAIK. from the Late Miocene Donetsk area (KRYSHTOFOVICH and BAIKOVSKAYA, 1951) by the number of the lobes and the foliar size.

Collections: NSM PP 16175; GSJ 4822; TPM 318A, 319, 409.

***Sorbus lesquereuxi* NATHORST**

Pl. 5, figs. 3, 5

Sorbus lesquereuxi NATHORST, 1883, p. 57, pl. 3, figs. 7–9, 12–15, pl. 15, fig. 1. TANAI, 1976, p. 326, pl. 4, figs. 5–7, text-fig. 4j.

Discussion: Only 4 leaves are referred to *Sorbus lesquereuxi* NATHORST. This species is closely similar to the extant *S. alnifolia* (SIEB. et ZUCC.) K. KOCH growing in Japan, Korea and central to northern China.

Collections: GSJ 4798; TPM 333.

***Sorbus palaeojaponica* MURAI**

Pl. 5, figs. 6, 7; Fig. 6D

Sorbus palaeojaponica MURAI, 1969, p. 61, pl. 3, fig. 6.

Discussion: Several leaves are identical to *Sorbus palaeojaponica* MURAI in the foliar shape, marginal serration and venation. This species closely resembles the modern *S. japonica* (DECNE.) HEDLUND growing in mountainland of Honshu to Kyu-

shu, Japan and *S. zahlbruckneri* SCHNEID. growing in central western China. Some species of *Crataegus* have similar foliar shape and marginal serration but are distinguishable in the tertiary veins.

Collection: NSM PP 6432, 16062–16064, 16302.

***Sorbus uzenensis* HUZIOKA**

Pl. 5, fig. 8, pl. 6, fig. 1; Fig. 6A

Sorbus uzenensis HUZIOKA, 1964, p. 86, pl. 13, figs. 8, 9.

Discussion: These leaves are identical to *Sorbus uzenensis* HUZIOKA in the marginal teeth and the secondary veins which do not extend straight to the marginal teeth. This species is closely similar to the extant *S. commixta* HEDLUND growing in temperate forest of Japan and *S. amurensis* KOEHNE growing in northern Korea.

Collections: NSM PP 16060, 16061; TPM 376.

Family Legminosae

***Caesalpinia hokiana* OZAKI, new species**

Pl. 7, figs. 2, 2a; Fig. 9C

Holotype: GSJ 4810. Upper Tochiwara Formation (Late Miocene). Sajimura, Tottori Prefecture.

Description: Leaflets small, slightly inequilateral, elliptical to ovate, about 1.8 cm long and 1.0 cm wide, apex round, base asymmetrically round, margin entire; midvein rather thick, straight; secondary veins fine, about 8 alternate pairs, diverging from the midvein at an angle of about 45° in the middle part and 80° to 90° in the basal part, spaced widely in the middle of the lamina, extending rather straight on the way then turning up and joining superadjacent secondary vein or tertiary veins at the margin; intersecondary veins composite; tertiary veins random reticulate, not well preserved; petiolule short, 1.0 to 1.6 mm long; petiole about 1 mm in width and preserved only 1.2 cm long.

Discussion: Three small leaflets attached to petiole, having elliptical to ovate foliar shape and asymmetrical base are referable to the genus *Caesalpinia* with some hesitation. These specimens are similar to the extant *C. japonica* SIEB. et ZUCC. growing in central to southern Japan and also resemble *C. crista* LINN. growing in southern China. This fossil species is distinguishable from similar small fossil leaflets of *C. microphylla* reported by HUZIOKA and TAKAHASHI (1970) from the Eocene Ube coal field in Yamaguchi Prefecture in the apical and basal shape. Another fossil species, *C. ubensis*, also reported by HUZIOKA and TAKAHASHI (1970) is distinguishable from my species by the foliar size and shape.

Collection: GSJ 4810.

Cercis sp.

Pl. 7, fig. 1

Discussion: Only one and fragmentary leaf is most similar to those of the genus *Cercis* in the character of secondary veins in marginal area.

Collection: GSJ 4812.

Cladrastis aniensis HUZIOKA

Fig. 7D

Cladrastis aniensis HUZIOKA, 1963, p. 205, pl. 35, figs. 5, 6. TANAI et N. SUZUKI, 1963, p. 132, pl. 23, figs. 1, 7. ISHIDA, 1970, p. 88, pl. 14, figs. 6, 9, 10, 14, 15. HUZIOKA, 1972, p. 60, pl. 7, fig. 5. *Rhus aniensis* HUZIOKA, 1964, p. 88, pl. 14, figs. 3, 4.

Discussion: My leaflets are referable to *Cladrastis aniensis* HUZIOKA by the foliar shape and the secondary veins, though the type specimens do not preserve well their finer veins. *Rhus aniensis* HUZIOKA (1964) reported from the Early Miocene of Akita Prefecture has brochidodromous venation and is considered to be conspecific with *C. aniensis*. *C. aniensis* is similar to the living *C. platycarpa* (MAXIM.) MAKINO growing in southwestern Japan and China.

Collection: NSM PP 16130–16132.

Cladrastis inouei (HUZIOKA) OZAKI, new combination

Pl. 7, figs. 5–8; Fig. 7A, B

Rhus inouei HUZIOKA, 1963, p. 206, pl. 36, fig. 3.

Cladrastis chaneyi TANAI et N. SUZUKI, 1965, p. 33, pl. 10, fig. 1, pl. 21, fig. 1.

Diospyros sublotus TANAI et N. SUZUKI, 1965, p. 45, pl. 12, fig. 7, pl. 13, fig. 1, pl. 18, fig. 5.

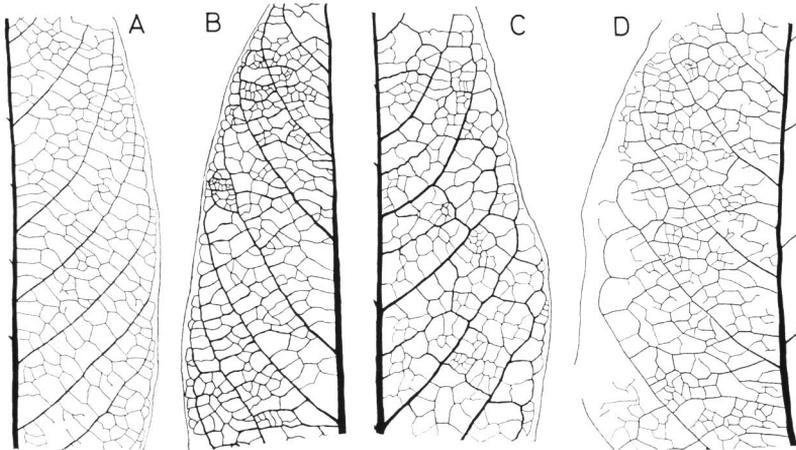


Fig. 7. Venation characters of fossils. (all figures are $\times 1.8$).

A, B. *Cladrastis inouei* (HUZIOKA) n. comb. NSM PP 16121C, TPM 366.

C. *Wisteria fallax* (NATHORST) TANAI, TPM 461.

D. *Cladrastis aniensis* HUZIOKA, NSM PP 16131.

Discussion: Many leaflets which are variable in foliar size and shape are referable to *Rhus inouei* HUZIOKA. The secondary veins of the type specimen of this species make a series of loops at its distal end and the tertiaries are percurrent in the intercostal area. These characters do not belong to the leaves of *Rhus* but belong to the leaflets of *Cladrastis* such as the extant *C. shikokiana* MAKINO of Japan, *C. wilsonii* TAKEDA of China and *C. lutea* (MICHX.) KOCH of North America. *Cladrastis chaneyi* reported by TANAI et N. SUZUKI (1965) has the closely similar venation character to *Cladrastis inouei* (HUZIOKA). *Diospyros sublotus* reported by TANAI et N. SUZUKI (1965) has characteristic petiolule of the Legminosae, and the characters of the foliar shape and the percurrent tertiary veins are referable to *Cladrastis inouei*. Among the above noted extant species of *Cladrastis* there are some differences in the foliar characters between two Asian species and an American species; *C. shikokiana* and *C. wilsonii* have lanceolate-oblong foliar shape, numerous secondary veins and closely spaced percurrent tertiary veins, while *C. lutea* has elliptical foliar shape and rather weakly percurrent tertiary veins. The characters of the leaflets from the Tatsumitoge collection range between the former characters and the latter ones.

Collections: NSM PP 16037, 16118–16122; GSJ 4807–4809; TPM 366, 391.

***Desmodium hokianum* OZAKI, new species**

Pl. 7, figs. 19, 19a; Fig. 9E

Holotype: NSM PP 16126. Upper Tochiwara Formation (Late Miocene). Saji-mura, Tottori Prefecture.

Description: Leaflet small, linear-oblong, inequilateral, 10 mm long and 4 mm wide, apex cuspidate with strong primary vein's awn, base round, margin entire; midvein strong, straight, secondary veins about 9 pairs, alternate to opposite, diverging from the midvein at variable angles but mainly about 60°, turning up on the middle of the way and making a loop with the superadjacent secondaries rather inner side from the margin; higher order veins not preserved; petiolule strong, curving, about 1 mm in length.

Discussion: In the foliar shape and venation, this specimen has a close relationship to the genus *Desmodium*. This leaflet is similar to those of the extant *D. microphylla* DC. growing in central to southern Japan and southeastern Asia in foliar shape and the venation, but is slightly different in the rather regular venation. *D. pulchellum* reported by ACAD. SINICA (1978) is separable from my specimen in the shape and large size of the leaflets.

Collection: NSM PP 16126.

***Desmodium tatsumitogeanum* OZAKI, new species**

Pl. 2, fig. 8; Fig. 8B, E

Holotype: NSM PP 16244. Upper Tochiwara Formation (Late Miocene). Saji-mura, Tottori Prefecture.

Description: Leaflet oblong, slightly inequilateral, 4.7 cm long, 1.9 cm wide

(estimated), apex attenuate, base acute, margin entire; midvein nearly straight; secondary veins 5 to 6 pairs, diverging from the midvein at an angle of 40° to 60° , gently curving up, making angular loops with some branches from the superadjacent secondaries or superadjacent secondaries; intersecondaries composite; tertiaries in intercostal area random reticulate, in marginal area making loops; quaternaries orthogonal reticulate; ultimate veinlets well preserved, more than once branched; petiolule short and fat.

Discussion: This leaflet has oblong foliar shape, acute base and small number of secondary veins that are curving up and making marginal loops. The leaflet appears, therefore, to represent a species of *Desmodium*. This leaflet is similar to the extant *D. caudatum* DC, and *D. oldohami* OLIV. both growing in Japan and China.

Collection: NSM PP 16244.

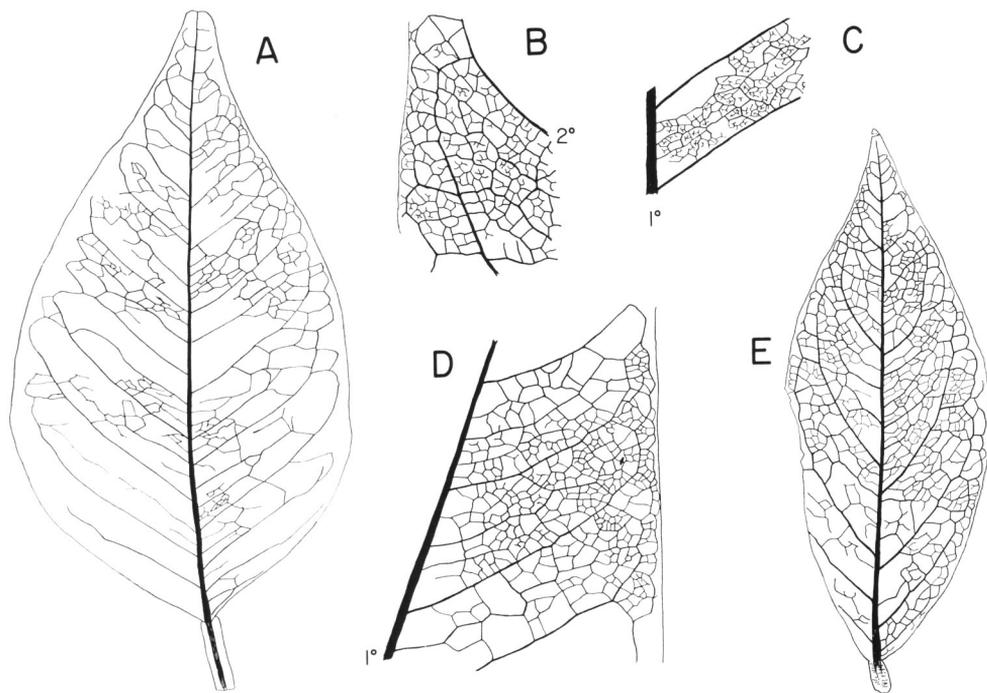


Fig. 8. Venation characters of fossils.

A, C, D. *Erythrophleum* (?) *hokianum* n. sp. A, C, NSM PP 16133A, A ($\times 1.5$), C ($\times 4$); D, NSM PP 16133B ($\times 4$).

B, E. *Desmodium hokianum* n. sp. NSM PP 16244. B ($\times 4$), E ($\times 1.5$).

***Erythrophleum* (?) *hokianum* OZAKI, new species**

Pl. 2, fig. 7, pl. 7, figs. 3, 4; Fig. 8A, C, D

Holotype: NSM PP 16133A. Upper Tochiwara Formation (Late Miocene).

Saji-mura, Tottori Prefecture.

Description: Leaflets ovate, slightly asymmetrical, 5.5 to 6.5 cm long, 2.2 to 2.9 cm wide, apex attenuate to attenuate-acuminate with round tip, base asymmetrical and widely cuneate to obtuse, margin entire, midvein straight to slightly arched; secondary veins about 10 to 12 pairs, extending straight from the midvein at an angle of 45° to 55°, forming angular loops with intersecondary veins or superadjacent secondaries near the margin; intersecondary veins simple, well developed; tertiaries in intercostal area forming orthogonal reticulation, in marginal area forming angular loops; quaternaries orthogonal reticulate among tertiaries; ultimate veinlet once to thrice branched; petiolule 5 to 7 mm in length.

Discussion: In the shape of apex and the character of the secondary and intersecondary veins the fossils are somewhat similar to the genus of *Erythrophleum*. These specimens are somewhat similar to the *Cladrastis aniensis* HUZIOKA in venation character, but are separable in the apical shape and well developed intersecondary veins. This new fossil species is similar to *E. fordii* OLIV. growing in central to southern China, Taiwan and Indochina.

Collection: NSM PP 16133A–E.

Gleditsia miosinensis HU et CHANEY

Pl. 7, fig. 13

Gleditsia miosinensis HU et CHANEY, 1938, p. 52, pl. 26. figs. 6, 7.

Discussion: Rather numerous leaflets are referred to *Gleditsia miosinensis* HU et CHANEY. My specimens have characteristic fine crenate margin, asymmetric base, fine camptodrome secondary veins and short awn on apex, and resemble the extant *G. sinensis* LAM of China, *G. japonica* MIQ. of Japan and *G. aquatica* MARSH. of North America and so on.

Collections: NSM PP 16031–16036, 16038, 16085; GSJ 4781, 4794B.

Indigofera hokiana OZAKI, new species

Pl. 7, figs. 10, 10a; Fig. 9F

Indigofera cf. *pseudotinctoria* MATS., ACADEMIA SINICA, 1978, p. 108, pl. 89, fig. 2.

Holotype: NSM PP 16125. Upper Tochiwara Formation (Late Miocene). Saji-mura, Tottori Prefecture.

Description: Leaflet small, elliptical slightly inequilateral, 10.5 mm long and 8 mm (estimated) wide, apex round with short awn, base round, margin entire; midvein thick, straight; secondary veins 5 to 6 pairs, alternate, diverging from the midvein at an angle of 30° to 45° in the middle to upper part, more widely in the basal part, forking with wide angles near the margin and making loops by joining adjacent secondaries; tertiary veins random reticulate in intercostal area, making an irregular series of angular loops in marginal area; finer veins not preserved; petiolule not preserved.

Discussion: This small specimen is considered to belong to a small leaflet of

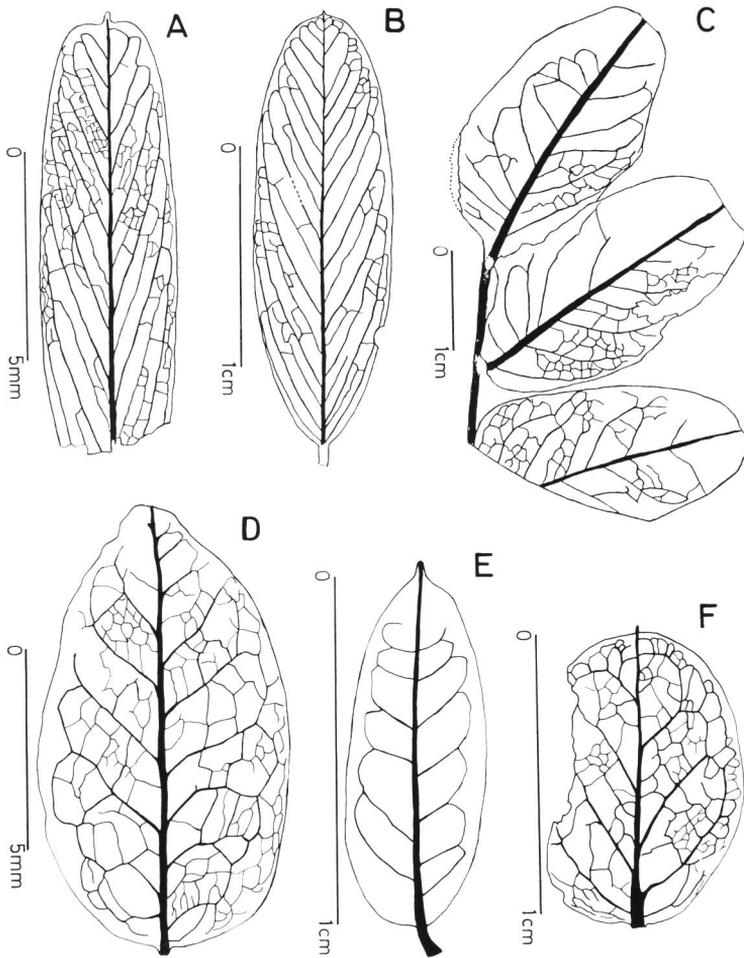


Fig. 9. Venation characters of fossils.

- A. *Lespedeza hokiana* n. sp. NSM PP 16123.
- B. *Lespedeza tatsumitogeana* n. sp. NSM PP 16124.
- C. *Caesalpinia hokiana* n. sp. GSJ 4810.
- D. *Spohora hokiana* n. sp. NSM PP 16129.
- E. *Desmodium hokianum* n. sp. NSM PP 16126.
- F. *Indigofera hokiana* n. sp. NSM PP 16125.

Indigofera by the foliar shape, short awn of the apex and the characteristic marginal series of loops, especially in the apical part. This species is closely similar to the living *I. pseudo-tinctoria* MATS. growing in central to southern Japan and China. This new species is slightly different from the extant species in the basal shape and the basal secondary veins. This fossil leaflet resembles those of *Caesalpinia hokiana* n.

sp., but is separable by the awn on the apex, smaller number of the secondary veins and smaller size of the leaflets.

Collection: NSM PP 16125.

***Lespedeza hokiana* OZAKI, new species**

Pl. 7, figs. 17, 17a; Fig. 9A

Holotype: NSM PP 16123. Upper Tochiwara Formation (Late Miocene). Saji-mura, Tottori Prefecture.

Description: Leaflet small, oblanceolate, 12 mm long (estimated) and 2 mm wide, apex slightly retuse with pointed tip, base missing, margin entire; primary vein straight; secondary veins fine but distinct, about 10 pairs, alternate, diverging from the midvein at an angle of about 20° in the lower to middle part and of about 30° in the apical part, running parallel with each other, joining the superadjacent secondaries near the margin at about right angles; intersecondary veins well developed but thin, simple; tertiary veins orthogonal reticulate; finer veins indistinct.

Discussion: This small leaflet, though only one and is lacking its basal part, has oblong to oblanceolate foliar shape, slightly retuse apex with pointed tip and parallel running secondary veins that extend from the midvein with wider angle in the apical part than in the middle to lower part of the lamina. These characters indicate a close relationship to *Lespedeza*. Small leaflets of *Vicia* have similar characters to this fossil leaflet, but are separable by narrow angle of the apical part of the secondary veins. Among the living species of *Lespedeza* the fossil leaflet is similar to those of *L. cuneata* (DU MONT DE COURS.) G. DON growing in Japan, China to India.

Collection: NSM PP 16123.

***Lespedeza tatsumitogeana* OZAKI, new species**

Pl. 7, figs. 16, 16a; Fig. 9B

Holotype: NSM PP 16124. Upper Tochiwara Formation (Late Miocene). Saji-mura, Tottori Prefecture.

Description: Leaflet small, linear-oblong, 19 mm long and 6 mm wide, apex mucronate, base obtuse, margin entire; midvein straight, rather thick, secondary veins 11 to 12 pairs, alternate, extending from the midvein at an angle of about 30°, running parallel with each other, gently curving up and forming loops by joining superadjacent secondaries; intersecondary veins well developed, simple; finer veinlets not preserved; petiolule 1 mm long, thick.

Discussion: This well-preserved leaflet is also considered to belong to the genus *Lespedeza* by the secondary veins that diverge from the midvein more widely in the apical part than in the lower part. This fossil species is distinguishable from *L. hokiana* n. sp. by the larger size of the leaflet, wider width and the shape of the apex. *L. tatsumitogeana* is similar to the leaflets of the extant *L. virgata* (THUNB.) DC. of Japan and *L. chinensis* G. DON of China.

Collection: NSM PP 16124.

Maackia cf. onoei MATSUO

Pl. 7, fig. 11

Maackia onoei MATSUO, 1963, p. 240, pl. 52, figs. 7, 8.

Discussion: Three leaflets are referable to the genus *Maackia* by barred petiolule, round to slightly cordate base and small number of secondary veins and are similar to *M. onoei* MATSUO. My specimens are akin to the extant *M. amurensis* RUPR. et MAXIM. var. *buergeri* (MAXIM.) C. K. SCHN. and somewhat to *M. floribunda* (MIQ.) TAKEDA growing in Japan.

Collections: NSM PP 16059; GSJ 4823C; TPM 260.

Sophora hokiana OZAKI, new species

Pl. 7, figs. 18, 18a; Fig. 9D

Holotype: NSM PP 16129. Upper Tochiwara Formation (Late Miocene). Saji-mura, Tottori Prefecture.

Description: Leaflet small, ovate, 11 mm long (estimated) and 6 mm wide, apex missing, base round, margin entire; midvein thick, slightly running sinuous; secondary veins 8 to 10, alternate, irregularly spaced, emerging from the midvein at an angle of 45° to 50°, extending rather straight in the middle to the upper part and slightly curving down in the basal part of the lamina, forking with wide angles near the margin and joining the adjacent secondaries; tertiary veins rather random reticulate in intercostal area, making irregular loops in the marginal area; finer veins not preserved well.

Discussion: This small imperfect leaflet has small-sized lamina, ovate foliar shape, and rather irregularly arranged brochidodromous secondary veins, and the apex is estimated to be acute. These characters appear to belong to a species of *Sophora*, and is similar to the extant *S. flavescens* AITON growing in Japan except Hokkaido, Korea and northern China and also similar to *S. subprostrata* CHEM et T. CHEN of southwestern China. This fossil species is distinguishable from *S. miojaponica* HU et CHANEY in the small foliar shape and the marginal state of the secondary veins, and is also separable from *S. spatulata* HUZIKOA et TAKAHASHI in the foliar shape. *S. parafravescens* GENG et LIN is separable from this new species by the foliar size. This new species is somewhat similar to *Indigofera hokiana* n. sp. and *Caesalpinia kohiana* n. sp., but is distinguishable from the former mainly in the apical shape and from the latter in the secondary veins.

Collection: NSM PP 16129.

Sophora miojaponica HU et CHANEY

Pl. 7, figs. 9, 12

Sophora miojaponica HU et CHANEY, 1938, p. 52, pl. 27, figs. 1, 3.

Discussion: My leaflets are referable to *Sophora miojaponica* HU et CHANEY, and are similar to the extant *S. japonica* LINN. in the venation character. These fossil leaflets slightly resemble those of *Robinia nipponica* TANAI in the venation, but are

different in the ovate foliar shape.

Collections: NSM PP 16127, 16128; GSJ 4892, 4793.

***Wisteria fallax* (NATHORST) TANAI et ONOE**

Pl. 7, figs. 14, 15; Fig. 7C

Wisteria fallax (NATHORST) TANAI et ONOE, 1961, p. 45, pl. 10, fig. 6, pl. 14, figs. 2–4.

Sophora (?) *fallax* NATHORST, 1883, p. 58, pl. 10, figs. 11, 12, pl. 11, figs. 1, 2.

Discussion: This species is characterized by ovate foliar shape, slightly caudate apex, secondary veins that run slightly zigzag and make irregular marginal loops in the distal part. This species is similar to the living *W. floribunda* DC. and also to *W. brachybotrys* SIEB. et ZUCC., but is different in the smooth margin.

Collection: TPM 237, 461.

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Explanation of Plates

(All figures in natural size, unless otherwise stated)

NSM PP: National Science Museum, Tokyo, Plant fossils.

GSJ: Geological Survey of Japan, Tsukuba.

TPM: Tottori Prefectural Museum, Tottori.

Plate 1

Fig. 1. *Ulmus protojaponica* TANAI et ONOE, TPM 232.

Fig. 2. *Eucommia japonica* TANAI, TPM 490.

Fig. 3. *Celtis hokiensis* n. sp. Holotype, TPM 498.

Fig. 4. *Celtis angusta* TAO, TPM 458.

Figs. 5, 6. *Hamamelis protojaponica* TANAI et ONOE, NSM PP 6432, 16162.

Fig. 7. *Zelkova ungeri* KOVATS, TPM 503.

Fig. 8. *Ulmus subparvifolia* HU et CHANEY, NSM PP 16042.

Fig. 9. *Celtis hokinsis* n. sp. Paratype, GSJ 4785.

Plate 2

- Fig. 1. *Magnolia elliptica* TANAI et ONOE, ($\times 2/3$). GSJ 4785.
 Figs. 2, 5. *Liriodendron honsyuensis* ENDO, ($\times 2/3$). NSM PP 16065, GSJ 4790.
 Fig. 3. *Prunus* sp. NSM PP 16085.
 Fig. 4. *Phyladelphus hokiensis* n. sp. Holotype, NSM PP 16288.
 Fig. 6. *Malus* sp. GSJ 4842.
 Fig. 7. *Erythrophleum* (?) *hokianum* n. sp. Holotype, NSM PP 16133A.
 Fig. 8. *Desmodium tatsumitogeanum* n. sp. Holotype, NSM PP 16244.

Plate 3

- Figs. 1, 2, 6. *Sassafras yabei* ENDO et OKUTSU, ($\times 2/3$). NSM PP 16003, 16167, 16240.
 Figs. 3, 4. *Cercidiphyllum crenatum* (UNGER) BRAUN, ($\times 2$). NSM PP 16144, 16230.
 Fig. 5. *Parabenzoïn* sp. NSM PP 16002.
 Fig. 7. *Lindera hokiana* n. sp. Holotype, GSJ 4804.
 Figs. 8, 9. *Lindera paraobtusiloba* HU et CHANEY, ($\times 2/3$). NSM PP 16004, GSJ 4768.

Plate 4

- Figs. 1, 3, 6, 9. *Crataegus hokiensis* n. sp. Paratypes, TPM 264, NSM PP 16172, TPM 475, NSM PP 16174.
 Fig. 2. *Crataegus hokiensis* n. sp. Holotype, NSM PP 16173.
 Figs. 4, 7, 8, 10. *Pyrus hokiensis* n. sp. Paratypes, TPM 474, 245, 473, NSM PP 16168.
 Fig. 5. *Pyrus hokiensis* n. sp. Holotype, GSJ 4820.
 Figs. 11, 12. *Prunus protossiori* TANAI et ONOE, TPM 295. NSM PP 16009.

Plate 5

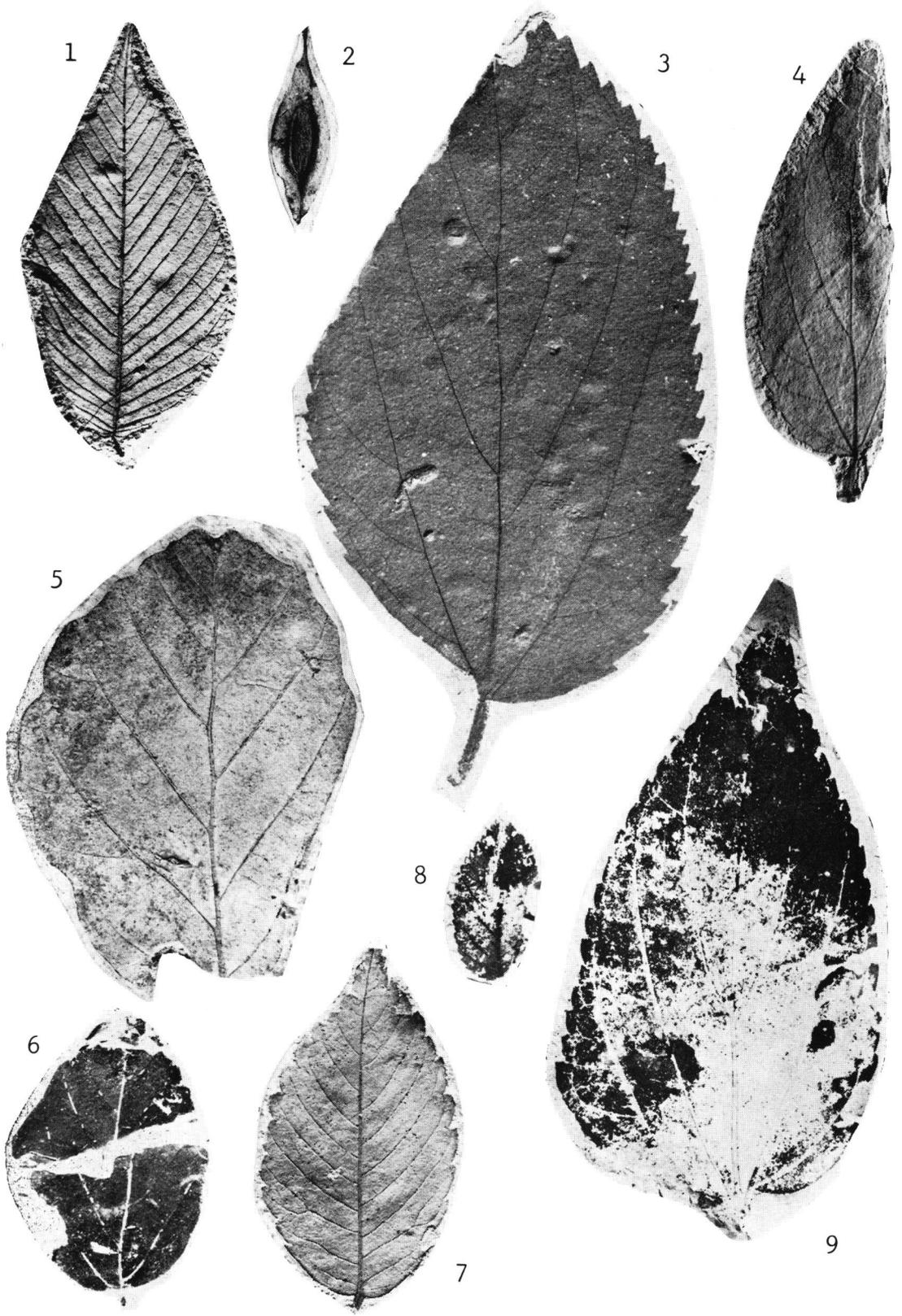
- Fig. 1. *Prunus tanaii* n. sp. Holotype, TPM 323.
 Figs. 2, 4. *Prunus tanaii* n. sp. Paratypes, TPM 482, 481.
 Figs. 3, 5. *Sorbus lesqueleuxi* NATHORST, GSJ 4798, TPM 333.
 Figs. 6, 7. *Sorbus palaeojaponica* MURAI, NSM PP 16302, 16063B.
 Fig. 8. *Sorbus uzenensis* HUZIOKA, NSM PP 16061.
 Fig. 9. *Crataegus tatsumitogensis* n. sp. Holotype, TPM 251.
 Fig. 10. *Pyrus hokiensis* n. sp. Paratypes, NSM PP 16168.

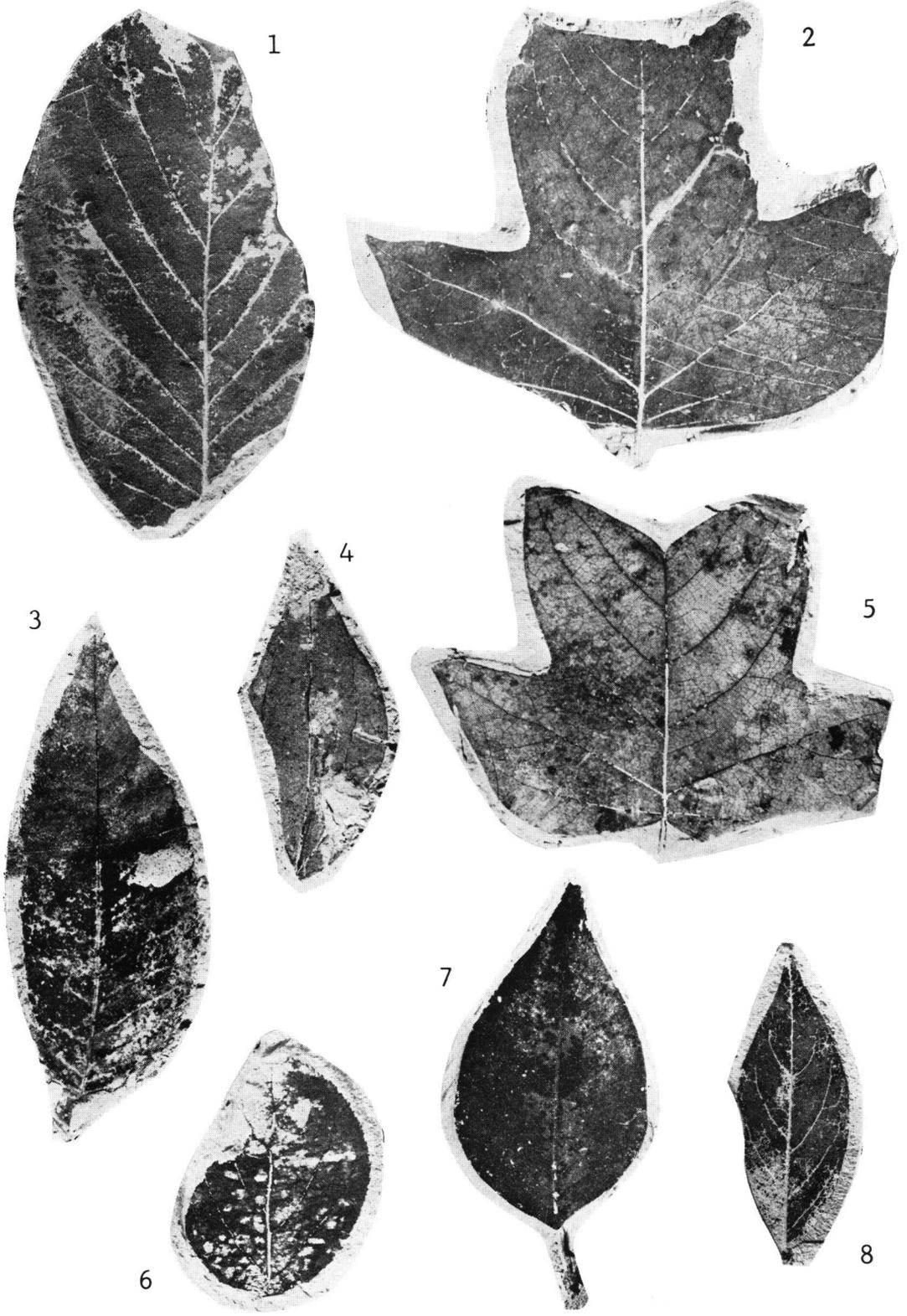
Plate 6

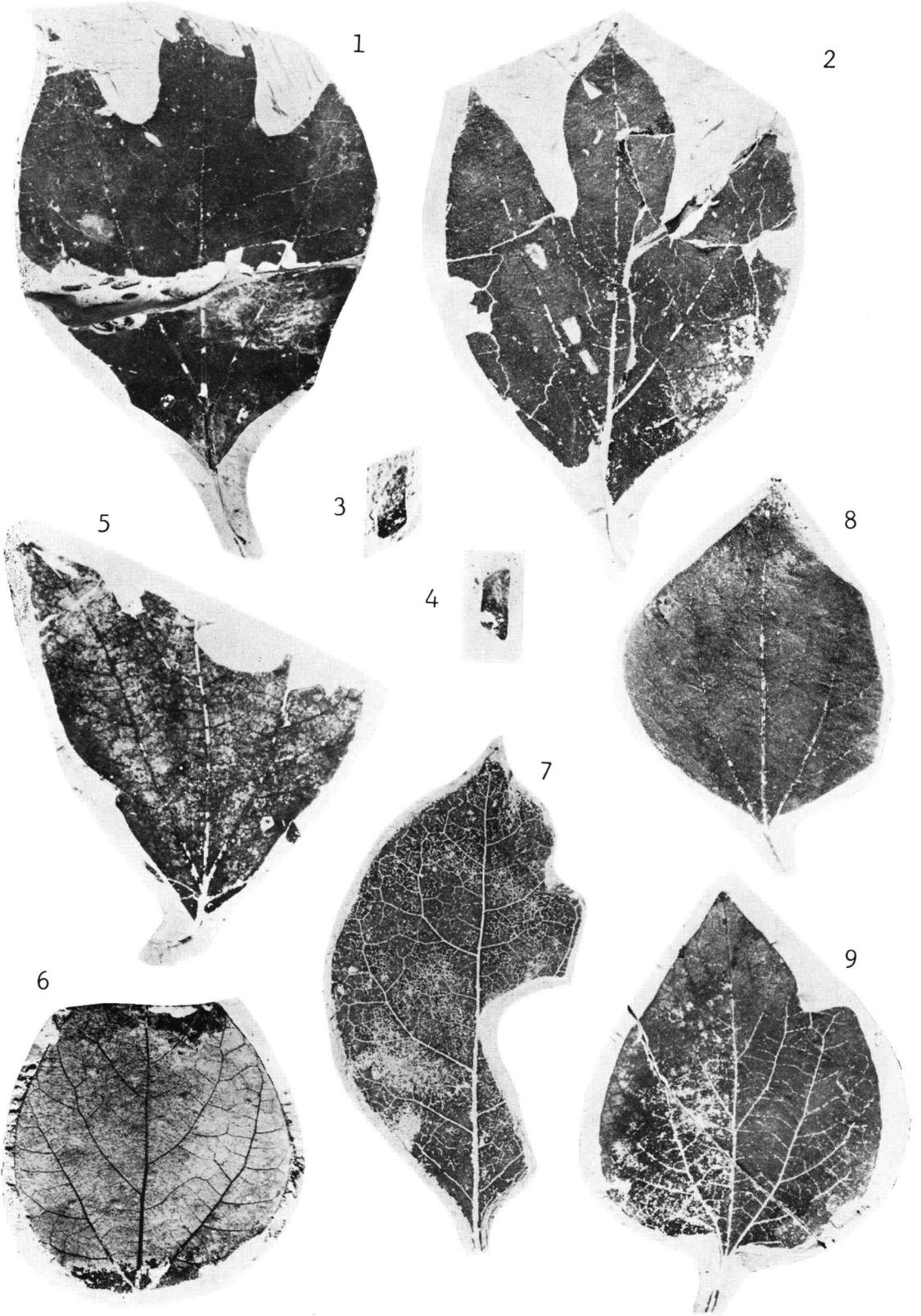
- Fig. 1. *Sorbus uzenensis* HUZIOKA, TPM 376.
 Figs. 2-4, 6. *Sorbus hokiensis* n. sp. Paratypes, TPM 318A, GSJ 4822, TPM 319, NSM PP 16175.
 Fig. 5. *Sorbus hokiensis* n. sp. Holotype, TPM 409.

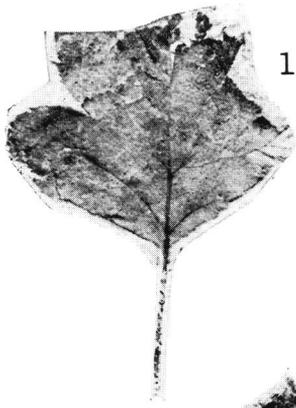
Plate 7

- Fig. 1. *Cercis* sp. GSJ 4812.
 Figs. 2, 2a. *Caesalpinia hokiana* n. sp. Holotype, GSJ 4810. 2a ($\times 2$).
 Figs. 3, 4. *Erythrophleum* (?) *hokianum* n. sp. Paratypes, NSM PP 16133B, C.
 Figs. 5-8. *Cladrastis inouei* (HUZIOKA) n. comb. TPM 391, 366, NSM PP 16121C, GSJ 4788.
 Figs. 9, 12. *Sophora miojaponica* HU et CHANEY, GSJ 4793, NSM PP 16127.
 Figs. 10, 10a. *Indigofera hokiana* n. sp. Holotype, NSM PP 16125. 10a ($\times 2$).
 Fig. 11. *Maackia* cf. *onoei* MATSUO, GSJ 4823.
 Fig. 13. *Gleditsia miosinensis* HU et CHANEY, NSM PP 16038.
 Figs. 14, 15. *Wisteria fallax* (NATHORST) TANAI, TPM 237, 461.
 Figs. 16, 16a. *Lespedeza tatsumitogeana* n. sp. Holotype, NSM PP 16124. 16a ($\times 2$).
 Figs. 17, 17a. *Lespedeza hokiana* n. sp. Holotype, NSM PP 16123. 17a ($\times 2$).
 Figs. 18, 18a. *Sophora hokiana* n. sp. Holotype, NSM PP 16129. 18a ($\times 2$).
 Figs. 19, 19a. *Desmodium hokianum* n. sp. Holotype, NSM PP 16126. 19a ($\times 2$).

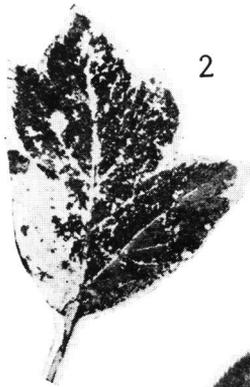




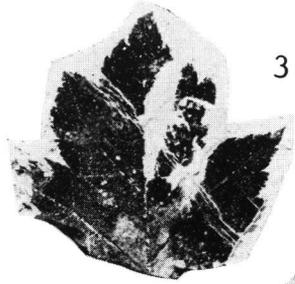




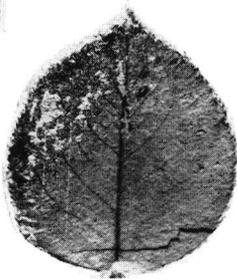
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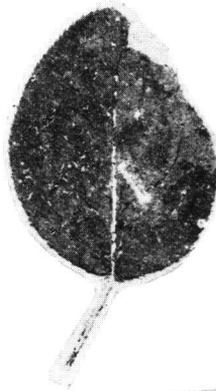
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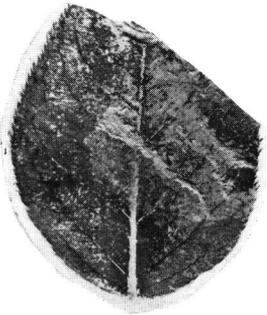
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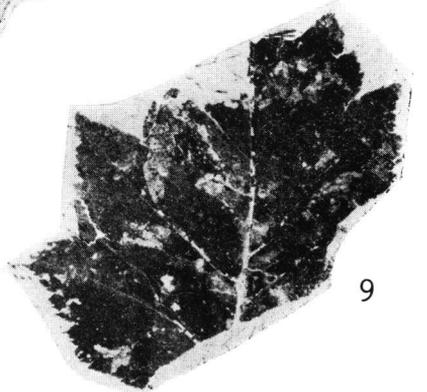
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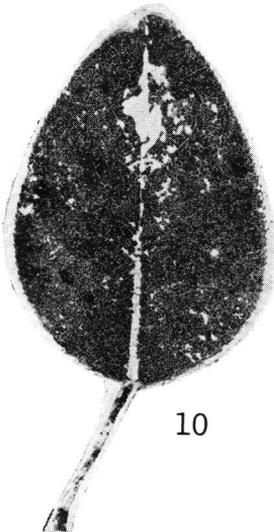
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