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Late Cretaceous platanoids from the Mifune Group of Kyushu, Southwest Japan —Revisiting the early paleobotanical collection in the National Museum of Nature and Science

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Abstract One of the earliest plant fossil specimens in the National Museum of Nature and Science collection was systematically studied, and its history was reviewed. The specimen is a sandstone block from Mifune in Kumamoto Prefecture, Southwest Japan, yielding five "platanoid" leaves scattered on the mudstone cap. Variably oriented leaves from the same species suggest that they were deposited par-autochthonously. The leaves were identified as *Ettingshausenia cuneifolia* (Bronn) Stiehler, which were common on the Eurasian continent during the Cenomanian–Turonian age of the Late Cretaceous. To our knowledge, this is the southernmost record of this species in Far East Asia. The lithological features of the specimen and age range of the fossil species are concordant with those of the Upper Formation of the Mifune Group (Turonian–Coniacian). We confirmed the occurrence of this species in several localities. Although the timing of collection and collector(s) remains unclear, we assumed that the specimen was collected after the initial paleobotanical work by a Swedish paleobotanist A. G. Nathorst in 1888, who first reported the fragmentary specimens of the Mifune Group sent by E. Naumann and M. Yokoyama of the Geological Survey of Japan in 1884.
Key words: platanoids, Cretaceous, Mifune Group, Japan, collection history

Introduction

The National Museum of Nature and Science (NMNS) was officially established as an educational museum in 1877 (Meiji 10) and is the oldest museum in Japan focusing on natural science and technology. The paleobotanical collection of the NMNS began to grow during this establishment period, with the earliest collections dating to 1872 (Meiji 10) and continuing to be developed until the 1910s. In the early days, there were no paleobotanists in Japan, with the first paleobotanical study by a Japanese scientist being conducted by Matajiro Yokoyama of the Imperial University of Tokyo, who described Mesozoic plant fossils from the Tetori Group in Central Japan (Yokoyama, 1889). Despite these circumstances, the number of collections grew. Understanding the background, as well as the scientific recognition of geology and paleontology in Japan, is of particular interest in this study. However, to date, no other researchers have attempted to examine this ancient collection in light of the history of science in Japan.

In this study, we focused on a specimen designated as NSM PP-0001, which contains Cretaceous plants collected from Kamimashiki (the area that includes current area of the Mifune Town) in Kumamoto Prefecture, southwestern Japan. We describe its morphological characteristics and discuss its habitat and phytogeographical implications. We have also commented on the time and procedure of collection, which were realized during our study.

Materials and Methods

The specimen is a slab of rock, approximately 34.0 cm wide, 18.7 cm long, and 5.0 cm thick, deposited at the NMNS, Japan (NSM PP; Fig. 1) and has been on permanent display for over 30 years.

The rock consists of pale green fine sandstone

Fig. 1. The upper surface of NSM PP-0001 with its sketch. Five platanoid and two other leaves are scattered on the same bedding plain.

with climbing ripple laminations (Fig. 2) interbedded with thin dark gray mudstone (bottom) or reddish mudstone (top). The isolated angiosperm leaves were scattered over the reddish mudstone. The unclear handwriting at the bottom indicates the site area (Kamimashiki), objectives (leaf fossils), and time of collection (Meiji period, date and month not shown; Fig. 3). Leaf shape and venation characteristics of each specimen were examined for accurate identification. The specimens were photographed using a Pentax K3 camera with a Pentax HD DA macro 35 mm lens. In addition to the laboratory work, we conducted a literature survey to better understand the origins and collection histories of the specimens.

Geologic Outline of the Mifune Area

The Mifune area is located in the west-central part of Kyushu Island, north of the Usuki–Yatsushiro tectonic line. The Upper Cretaceous Mifune Group is widely distributed in the area, with its depocenter located around Iida-san (= Mt. Iida; Fig. 4). It forms a gentle syncline with its axis oriented

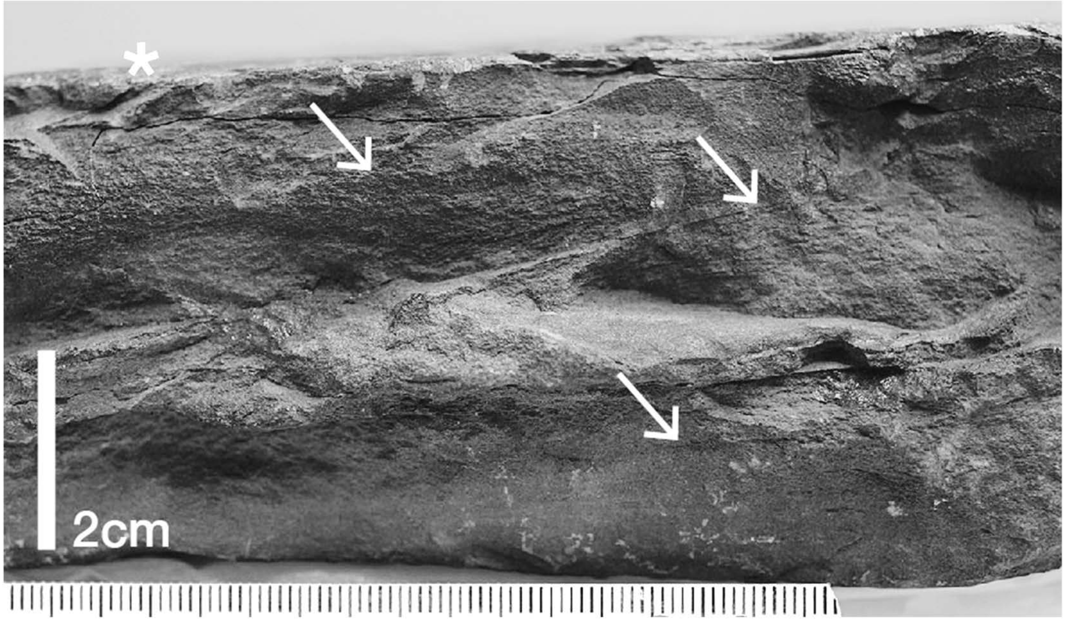

Fig. 2. Lithology of NMS PP-0001. The specimen consists of fine greenish sandstone showing climbing-ripple lamination (arrow), with black and reddish mudstones either on the bottom or top of the specimen.

northeast–southwest. The Mifune Group is informally divided into Basal, Lower, and Upper formations (Matsumoto, 1939). The Basal Formation, approximately 50–300 m thick, consists mainly of conglomerates deposited in an alluvial fan environment (Kuroki *et al.*, 1995), and yields freshwater bivalve assemblages (Tamura, 1970) and turtle fossils (Hirayama, 1994). The Lower Formation consists of alternating beds of sandstone and mudstone with an abundance of blackish and shallow marine mollusks. The thickness of this section is approximately 1000 m. The depositional environment of the formation was assumed to be estuarine or shallow marine. The Upper Formation, over 1000 m thick, is characterized by reddish mudstone deposited in a fluvial environment, often interbedded with paleosol and tuff deposits. The formation yields freshwater mollusks, plants, and terrestrial vertebrates (Tamura, 1990; Tamura *et al.*, 1991; Iwasaki, 1994; Matsuo, 1994; Ikegami *et al.*, 2000; Kusuhashi *et al.*, 2008; Ikegami, 2015). The red bed of the floodplain deposit includes caliches (pedogenic carbonates) and reveals a paleosol structure that can be classified as Calcic Vertisol. These features strongly indicate semi-arid, subtropical to warm-temperate climatic conditions (Lee *et al.*, 2003). Some fission-track ages were reported for the tuffaceous deposits of the Lower and Upper formations: 91.4 ± 3.0 Ma and 83.6 ± 3.1 Ma, respectively (Ikegami *et al.*, 2007). More recently, Tsutsumi *et al.* (2018) reported U–Pb ages for the Lower and Upper formations of the Mifune Group as 94 Ma and 93.3 ± 2.1 Ma, respectively. These ages are concordant to the age of the Gankaisan Formation (Lower Santonian), which unconformably overlies the Mifune Group (Tanaka *et al.*, 2022). Based on these absolute ages and on the biostratigraphy, the Mifune Group is considered to be Upper Cenomanian–Coniacian and the Upper Formation is mostly restricted to the Turonian–Coniacian.

To confirm the localities of the specimens, we visited four fossil sites in the Upper Formation of the Mifune Group (Fig. 4).

Locality 1 (Nakano): Gray to greenish fine sandstones intercalated with thin mudstones containing leaves.

Locality 2 (Zameki Bridge): Outcrops along the Iwatogawa River of fine sandstones with black mudstone interbeds. “Platanoid” leaves are often found in mudstones containing compressed wood.

Locality 3 (Shimoyama): Brown sandy mudstone that often yields carbonaceous seeds and conifer leaves.

Locality 4 (Koganosako): White fine sandstone intercalated with grey mudstone containing leaves.

Based on the lithologic similarities and plant fossil content, we concluded that the specimen most likely originated from Nakano (Loc. 1) or from

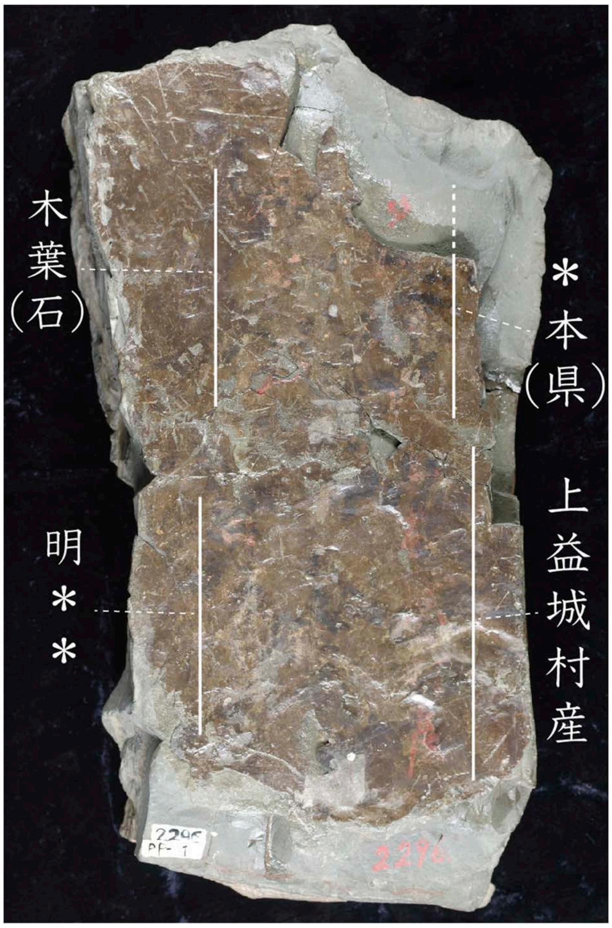

Fig. 3. View of bottom surface of specimen. Unclear handwriting can be seen. Letters beside the rock are translations of the writing. Right side (from top to the bottom) shows location (Kamimashiki, Kumamoto Prefecture); left side, shows objectives (Konoha-ishi = leaf fossil) and time of collection (Mei, probably indicates the Meiji Period). Letters in brackets indicate presumed part; * denotes illegible words.

nearby sites.

Systematic Paleontology

The specimen is described in this section. The terminology for dicotyledonous leaves is based on Hickey (1973, 1979) and Ellis *et al.* (2009).

Genus *Ettingshausenia* Stiehler, 1857
Ettingshausenia cuneifolia (Bronn) Stiehler

(Fig. 5)

Credneria cuneifolia Bronn, 1837, Lethaea geognostica, vol. 1, nos. 6–8, p. 583.

Ettingshausenia cuneifolia (Bronn) Stiehler, 1857, Palaeontographica, vol. 5, no. 2, p. 67.

Platanus cuneifolia (Bronn) Krysht., 1914, Izvestiya Imperatorskoi Akademii Nauk, St. Petersburg, Ser. 6, vol. 8, no. 9, p. 607.

Description: Leaves simple or very shallowly three lobed; laminae symmetrical, rhomboid shape; apex of central lobe acute, straight or short acuminate; apex of lateral lobe, acute and straight-sided; base acute to obtuse, cuneate, often decurrent along the petiole; length ca. 70 to 110 mm, width ca. 76 to 130 mm; length to width ratio 0.85 to 0.95; petiole thin, at least 32 mm long; margin serrate, basal fourth entire; teeth simple, regularly spaced, distant, concave on both sides, tooth apex acutely pointed, principle vein enters tooth slightly basally; sinuses round, obtuse; venation suprabasal actinodromous with three primary veins, divergent point ca. 5 mm above the leaf base, moderate, straight or spread; secondary veins thick, craspedodromous, rarely semi-craspedodromous, 5 to 6 subopposite to opposite pairs, divergent angle 40° to 60°, curved, straight or sinuous, branched near the margin, sending thick sub-secondaries toward both sides, distance between two secondaries increasing basally; lateral primary vein sends thick secondaries exmedially and admedially at acute angle; basalmost exmedial secondary veins looped; intercostal tertiaries diverged in wide-acute angle, thick, often forked, percurrent (scalariform), convex outward, thick sub-tertiaries common, parallel to the tertiaries; quaternary veins thin, oblique to the tertiary, forming a large network; veinlets unclear; cuticle not preserved.

Material examined: NSM PP-0001a, PP-0001b, PP-0001c, PP-0001d, and PP-0001e (original collection number: NSM-2296).

Horizon: the Upper Formation of the Mifune Group (late Cenomanian–Coniacian)

Locality: Mifune Town, Kamimashiki-gun, Kumamoto Prefecture, Japan (exact location unknown).

Comparison: Fossilized leaves similar to those of modern plane trees, were common in the Late Cretaceous in the Northern Hemisphere, especially at mid- and high-latitudes. Despite their similarities, it has been suggested that most of them are not exactly related to the plane family but rather to other families because of the presence of distinct reproductive organs (Maslova *et al.*, 2011; Kodrul *et al.*, 2013), cuticular characteristics (Maslova *et*

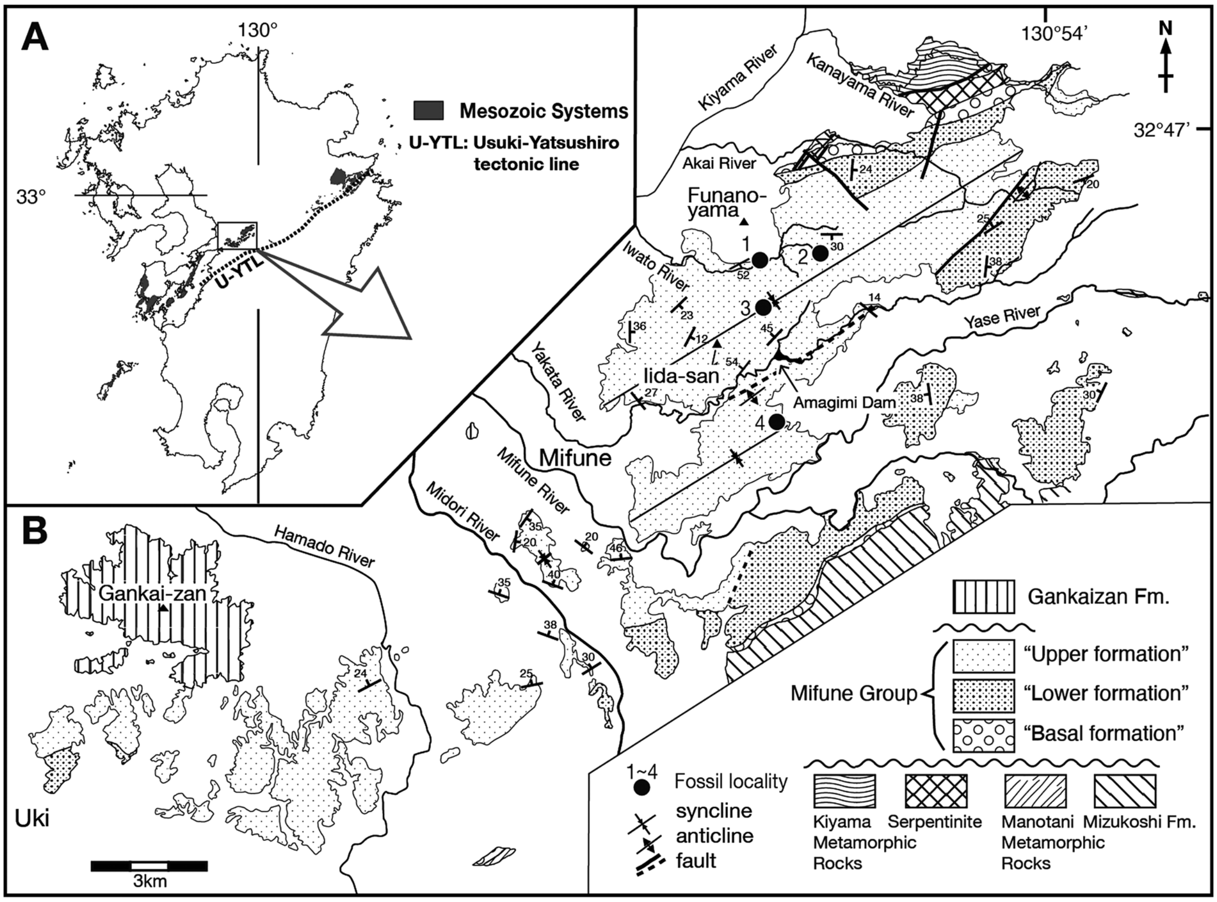

Fig. 4. Location (A) and geologic map of the Mifune area (B), with plant fossil localities indicated (Locs. 1–4). Geologic map based on Ikegami (2010).

al., 2005), and the absence of pollen grains that are consistent with the plane family (Denk and Tekleva, 2006; Legrand *et al.*, 2022). Maslova *et al.* (2005) proposed the use of the genus *Ettingshausenia* Stiehler instead of *Platanus* L. to accommodate *Platanus*-like leaves that yield a range of characteristics. Herman and Kvaček (2010), and Halamski and Kvaček (2015) applied this interpretation. Although some objections have been voiced (Tschan *et al.*, 2008), we followed Maslova *et al.* (2005) because of the lack of information regarding cuticular features.

The genus *Ettingshausenia* was established by Stiehler (1857) with the type species *E. cuneifolia*, which was originally described as *Credneria cuneifolia* from the Cenomanian of Niederschön, Germany (Bronn, 1837). According to Maslova *et al.* (2005), the genus yields a wide range of morphological variations, namely: *Leaf blades vary from entire triangular and pentagonal hexangular, rhomboidal or triangular and pentagonal hexangular, rhomboidal or oval rhomboidal, without lobes or with vestigial lobes to leaf blades with two to six lateral lobes. Leaf blades often asymmetric. Leaf base usually cuneate and decurrent on the petiole. If leaf base truncate or cordate, region of leaf base that is adjacent to petiole forms at least small wedge. Peltate base occasionally present. Leaf apex pointed or, more rarely, obtuse. Margin dentate-incised; more rarely, leaf entire-margined. Leaf venation craspedodromous or palinactinodromous, with developed lateral basal veins. Tertiary venation scalariform or branchy-scalariform.*

More than ten species of the genus *Ettingshausenia* have been accepted from the Upper Cretaceous of Eurasia, eight of which have a rhomboid shape with a serrated margin (Table 1). Our specimens are most similar to *E. cuneifolia* in general shape, characteristics of the lateral lobe, marginal teeth, and venation, especially its prominent intercostal tertiaries, often described as "scalariform." *Ettingshausenia sarbaensis* from the Cenomanian–Turonian of western Kazakhstan (Maslova and Shilin, 2011) is similar to this species but differs in its orthogonal

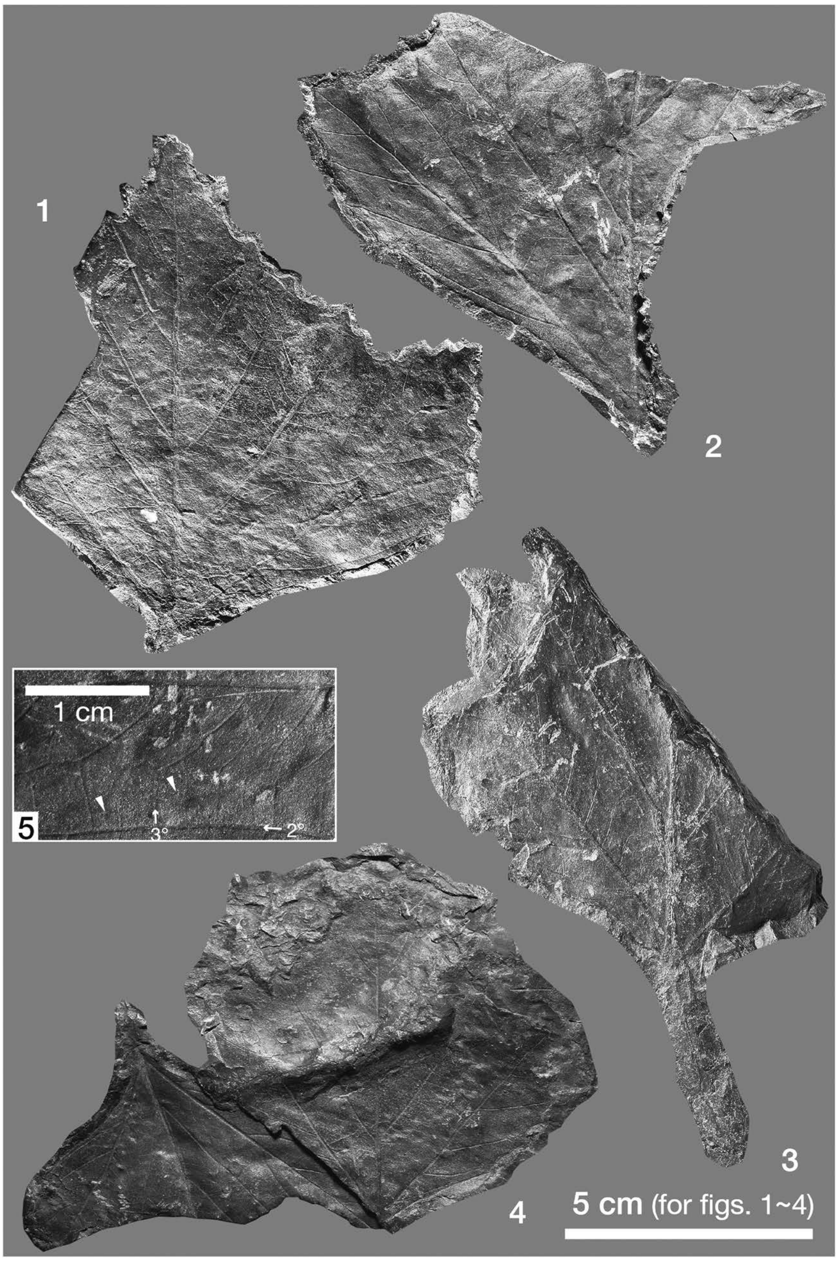

Fig. 5. *Ettingshausenia cuneifolia* (Bronn) Stiehler from Mifune, Kumamoto Prefecture. 1, NSM PP-0001a; 2, NSM PP-0001b; 3, NSM PP-0001c; 4, NSM PP-0001d (right) & e (left); 5, detail of intercostal area, NSM PP-0001b.

reticulate tertiary veins and the presence of short intercalary secondaries. *Ettingshausenia kubaensis* from the Albian–Cenomanian of western Siberia (Maslova *et al.*, 2011) is similar to this species, although it differs in the presence of typical glandular teeth. Our specimens can be distinguished from *E. geinitziana* from Germany (Stiehler, 1857) and *E. vetviensis* from northeastern Russia (Herman and Sokolova, 2016), which are typically transversely elliptical and nearly truncated at the base, respectively. *Ettingshausenia laevis* from the Cenomanian of the Czech Republic (Kvacek and Váchová, 2006) also differed from our specimens, with indistinct tertiary veins in the intercostal area. In contrast, *E. grandidentata*, from the same locality as the type species of *E. cuneifolia* (Stiehler, 1857), does not have prominent lateral primary veins, but does have secondaries. *Ettingshausenia bohemica* (Kvaček and Váchová, 2006) also differs in the presence of rhombic laminae and peltate, pseudopeltate, or rounded base.

Ettingshausenia cuneifolia was common on the Eurasian continent during the Cenomanian–Turonian or later (Maslova *et al.*, 2005; Golovneva, 2011). It has also been reported in the Twb unit of the Mikasa Formation (late Cenomanian–early

Table 1. Comparison of selected *Ettingshausenia* species. Late Cretaceous species with lobed serrate margins are selected.

	1	2	3	4
Species	*E. cuneifolia* (Bronn) Stiehler	*E. bohemica* (Valenovsky) J. Kvaček et Váchová	*E. geinitziana* (Unger) Stiehler	*E. grandidentata* (Unger) Stiehler
Type locality	Niederschöna, Freiberg, Sachsen, Germany	Vyšehořovice, Czech Republic *Lectotype designoted by Knobloch (1997) as Velenovský (1882, pl. 3, fig. 1)	Niederschöna, Freiberg, Sachsen, Germany	Niederschöna, Freiberg, Sachsen, Germany
Horizon & age	Peruc-Korycany Formation, Cenomanian, Late Cretaceous	Peruc-Korycany Formation, Cenomanian, Late Cretaceous	Peruc-Korycany Formation, Cenomanian, Late Cretaceous	Peruc-Korycany Formation, Cenomanian, Late Cretaceous
Characteristics	see text	Diamond-shaped laminae and peltate, pseudopeltate or rounded bases	Serrate margin, transversely elliptic shape	Basal shape narrow acute, serrate margin, prominent teeth. Basal lateral secondaries not prominent
Reference	Stiehler (1857)	Kvacek & Vachova (2006)	Stiehler (1857)	Stiehler (1857)
	5	6	7	8
Species	*E. kubaensis* Maslova *et* Sokolova	*E. laevis* (Velen.) J. Kvaček *et* Váchová	*E. sarvaensis* Maslova *et* Shilin	*E. vetviensis* A.B. Herman
Type locality	near the village of Kuvaebo, Kiya River, western Siberia	Mělník, Czech Republic *Lectotype designated by Kvaček et Váchová (2006) as Velenovský (1882, pl. 4, fig. 2)	Sarbai locality, western Kazakhsta	Upper reaches of the Vetvistyi Stream, locality no. 17, Penzhina and Okian rivers interfluve, Northeastern Russia
Horizon & age	Kiya and Simonovo Formations, Albian–Cenomanian, Late Cretaceous	Peruc-Korycany Formation, Cenomanian, Late Cretaceous	Zhirkindek Formation, Cenomanian–Turonian	Lower part of the Vetvinskaya Member, Chaibugchan Group, Turonian–Coniacian, Late Cretaceous
Characteristics	Rhomboid shape, serrate margin, glandular teeth	Indistinct tertiary veins. Sometimes entire margined leaves	Domination of orthogonally reticulate tertiary venation and the presence of short intercalary secondary veins	A broad transversely-elliptical leaf lamina with a broadly cuneate, nearly truncate base
Reference	Maslova *et al.* (2011)	Kvaček & Váchová (2006)	Maslova & Shilin (2011)	Herman & Sokolova (2015)

Turonian) of the Upper Yezo Group in Hokkaido, northern Japan (Narita *et al.*, 2008) and the Santonian–Lower Campanian Kuji Group (Tanai, 1979). The latter occurrence should be omitted because the specimens yielded much more prominent lateral lobes and indistinct intercostal tertiaries, similar to those of *E. laevis* (Velen.) Kvaček et Váchová.

Discussion

Remarks on the age and habitat of fossil species

Golovneva (2011) compiled the occurrence of *Ettingshausenia cuneifolia* from the Turonian–Coniacian on the Eurasian continent. Our specimens from the Mifune Group are concordant with the general age range of this species and further represent the southernmost occurrence of this species in Far East Asia because there is no concrete evidence of this species in China.

Narita *et al.* (2008) recorded the parautochthonous nature of this species in fluvial deposits of the Mikasa Formation of the Upper Yezo Group in Hokkaido, Japan, based on a detailed examination of its occurrence and lithological features. Our specimens also showed a similar characteristic; a few *Ettingshausenia* leaves were predominant and scattered on the same bedding plane with different leaf apex orientations. If we consider the Upper Formation of the Mifune Group to be fluviatile, it can also be said that it exhibits a parautochthonous nature. In Locality 1 in Nakano, platanoid leaves were found in thin mudstone immediately below the sandstone that had accumulated in the natural levee setting. We do not yet have sufficient data on its habitat; however, this is in good agreement with that reported by Narita *et al.* (2008) for the Mikasa Formation.

Collection history of the specimen, NSM PP-0001

Letters on the underside of NSM PP-0001 indicate that it was collected during the Meiji period (1868–1912) but was not properly identified at that time (Fig. 3). The first paleobotanical study of the Mifune group was carried out by Swedish paleobotanist A. G. Nathorst as part of his comprehensive study of Japanese flora (Nathorst, 1888; Endo, 1963). Nathorst reported 32 fossil localities, including the Mifune Group, as Cenozoic. The specimens and their geological information were provided in 1884 by E. Naumann and Matajiro Yokoyama of the

Geological Survey of Japan (Nathorst, 1888: p. 3), who visited the locality (Nanataki-Nakano, Mifune, equivalent to Nakano district of Mifune in current usage; Endo, 1963) in early 1884 (Naumann, 1887; Yajima, personal communication with AY). Unfortunately, at that time, the specimens from the Mifune Group were fragmentary and only the basal part was preserved. Therefore, Nathorst hesitated to assign them to a natural genus but instead assigned them to *Phyllites* sp., which implies that the specimens were angiosperm leaves of unknown affinity. Since then, this group has been neglected in paleobotanical studies (although some research have addressed this issue, such as Matsuo, 1994).

There is no concrete information regarding when, how, or by whom the specimen was collected from the Mifune Group. However, our specimen contains five "platanoid" leaves in good condition. Therefore, if examined by a paleobotanist, it would be possible to identify it as a Cretaceous platanoid, even if its familial affinities and generic assignment were controversial. Based on this assumption, we deduced that the specimen was collected after Nathorst reported fossils from the Mifune Group in 1888 (Nathorst, 1888).

The first geological map of Kumamoto Prefecture was published in 1890 (Suzuki, 1890), when the Mifune Group was assigned to the Cenozoic system on the basis of fossil plants. This view was adopted in subsequent studies in this area (Yamashita, 1896). The age of the Mifune Group was finally revised when Matsumoto (1939) published a complete revision of the geology of the area, based mainly on invertebrate fossils from the Lower and Upper formations. This view agrees with our conclusions based on paleobotany, as shown above, and was corroborated after 130 years of discussion.

Perspective on the history of the early paleobotanical collection of the NMNS

Some of the early paleobotanical collections of the NMNS were known to have been collected in 1872, when the first National Museum was established in Tokyo (National Science Museum, 1977). This study clearly showed that the collection time of early specimens can be divided into several stages. The cause of this difference and its implications for paleobotanical and geological studies in Japan are debatable.

Acknowledgements

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References

Bronn, H. G. (1837) *Lethaea geognostica oder Abbildungen und Beschreibungen der für die Gebirgsformationen bezeichnendsten Versteinerungen.* I., p. 481–768, pls. 31–47, E. Schweizerbart'sche Verlagsbuchhandlung u. Druckerei, Stuttgart.

Denk, T. and Tekleva, M. V. (2006) Comparative pollen morphology and ultrastructure of *Platanus*: Implications for phylogeny and evaluation of the fossil record. *Grana*, **45**: 195–221.

Ellis, B., Daly, D. C., Hickey, L. J., Johnson, K. R., Mitchell, J. D., Wilf, P. and Wing, S. L. (2009) *Manual of Leaf Architecture*. 190 pp. Cornell University Press, Ithaca, New York.

Endo, S. (1963) A survey of the fossils from Japan illustrated in classical monographs, Part V. In: Matsumoto, T. (Ed.), *A Survey of the Fossils from Japan*, *Illustrated in Classical Monographs*, Palaeontological Society of Japan, Tokyo, p. 13–19, 21–34 pls.

Golovneva, L. B. (2011) Genus *Ettingshausenia* (Platanaceae) in the Cenomanian–Turonian Floras of Eurasia. In: *Paleobotany*, Russian Academy of Sciences, Komarov Botanical Institute, p. 127–163. (in Russian with English abstract)

Halamski, A. T. and Kvaček, J. (2015) The Late Cretaceous (Coniacian) leaf and cone flora from the Sudetes. *Palaeontographica*, *Abteilung B: Palaeobotany-Palaeophytologie*, **292**, no. 4–6: 95–171.

Herman, A. B. and Kvaček, J. (2010) *Late Cretaceous Günbach Flora of Austria*. 224 pp. Naturhistorisches Museum Wien, Vienna.

Herman, A. B. and Sokolova, A. B. (2016) Late Cretaceous Kholokhovchan Flora of Northeastern Asia: Composition, age and fossil plant descriptions. *Cretaceous Research*, **59**: 249–271.

Hickey, L. J. (1973) Classification of the architecture of

Dicotyledonous leaves. *American Journal of Botany*, **60**, no. 1: 17–33.

Hickey, L. J. (1979) A revised classification of the architecture of dicotyledonous leaves. In: Metcalfe, C. R. and Chalk, L. (Eds.), *Anatomy of Dicotyledons*, Clarendon Press, Oxford, p. 25–39.

Hirayama, R. (1994) Turtle fossils from the Mifune Group. In: Scientific Expedition Group of the Mifune Group (Ed.), "*Dinosaurs in the Mifune Group*"—*Reports of the Scientific Expedition at the Mifune Group*, Reports of the Scientific Expedition at the Mifune Group, Kumamoto, p. 32–39. (in Japanese)

Ikegami, N. (2010) Bonebeds in the Upper Cretaceous Mifune Group, Kumamoto Prefecture, Japan. *Journal of Fossil Research*, **42**, no. 2: 66–73. (in Japanese with English abstract)

Ikegami, N. (2015) The first record of an ornithomimosaurian dinosaur from the Upper Cretaceous of Japan. *Historical Biology*, **28**, nos. 1–2: 264–269.

Ikegami, N., Kellner, A. W. A. and Tomida, Y. (2000) The presence of an azhdarchid pterosaur in the Cretaceous of Japan. *Paleontological Research*, **4**, no. 3: 165–170.

Ikegami, N., Iwano, H., Danhara, T. and Sakai, H. (2007) Fission-track ages of tuff beds from the Upper Cretaceous Mifune Group in Kyushu, Japan. *The Journal of the Geological Society of Japan*, **113**, no. 3: 127–130.

Iwasaki, Y. (1994) Gastropod fossils from the Mifune Group. In: Scientific Expedition Group of the Mifune Group (Ed.), "*Dinosaurs in the Mifune Group*"—*Reports of the Scientific Expedition at the Mifune Group*, Reports of the Scientific Expedition at the Mifune Group, Kumamoto, p. 59–62. (in Japanese)

Knobloch, E. (1997) "*Credneria*" *bohemica* Velenovský—einer altertümliche Platane. *Palaeontographica*, *Abteilung B*, **242**, no. 4–6: 127–148.

Kodrul, T. M., Maslova, N. P., Tekleva, M. V. and Golovneva, L. B. (2013) Platanaceous reproductive structures and leaves from the Cretaceous of Kundur, Amur Region, Russia. *The Palaeobotanist*, **62**: 123–148.

Kryshtofovich, A. N., 1914. *Discovery of angiosperm floral remains from the Cretaceous of Ural region*. Izvestiya Imperatorskoi Akademii Nauk, Petersburg, pp. 603–612. (in Russian)

Kuroki, S., Okada, H. and Sakai, T. (1995) Sedimentary facies and environments of the Upper Cretaceous Mifune Group in the Axial Zone of Kyushu, Japan. *Journal of the Sedimentological Society of Japan*, no. 41: 65–83. (in Japanese with English abstract)

Kusuhashi, N., Ikegami, N. and Matsuoka, H. (2008) Additional mammalian fossils from the Upper Cretaceous Mifune Group, Kumamoto, western Japan. *Paleontological Research*, **12**, no. 2: 199–203.

Kvaček, J. and Váchová, Z. (2006) Revision of platanoid foliage from the Cretaceous of the Czech Republic. *Journal of the National Museum*, *Natural history Series*, **175**, nos. 3–4: 77–89.

Lee, Y. W., Lee, Y. I. and Hisada, K.-I. (2003) Paleosols in the Cretaceous Goshoura and Mifune groups, SW Japan and their paleoclimate implications. *Palaeogeography*, *Palaeoclimatology*, *Palaeoecology*, **199**, no. 3–4: 265–282.

Legrand, J., Yamada, T. and Nishida, H. (2022) *Yezopollis mikasaensis* gen. et sp. nov., a new Normapolles-type angiosperm pollen from the Upper Cretaceous of Hokkaido, Japan. *Cretaceous Research*, **136**, DOI: 10.1016/j.cretres.2022.105216.

Maslova, N. P. and Shilin, P. V. (2011) The new species *Ettingshausenia sarbaensis* (Angiospermae) from the Cenomanian–Turonian of western Kazakhstan in Light of the Problem of Classification of Dispersed Cretaceous *Platanus*-like leaves. *Paleontological Journal*, **45**, no. 4: 459–473.

Maslova, N. P., Moiseeva, M. G., Herman, A. B. and Kvaček, J. (2005) Did plane trees exist in the Cretaceous? *Paleontological Journal*, **39**, no. 4: 440–453.

Maslova, N. P., Tekleva, M. V., Sokolova, A. B., Broushkin, A. B. and Gordenko, N. V. (2011) Platanoid infructescences *Friiscarpus kubaensis* sp. nov. and leaves *Ettingshausenia kubaensis* sp. nov. from the Albian–Cenomanian of Chulym–Yenisei depression, Russia. *The Palaeobotanist*, **60**: 209–236.

Matsumoto, T. (1939) Geology of Mifune District, Kumamoto Prefecture, Kyushu (with special reference to the Cretaceous System). *The Journal of the Geological Society of Japan*, **46**, no. 544: 1–12. (in Japanese with English abstract)

Matsuo, H. (1994) Plant fossils from the Mifune Group. In: Scientific Expedition Group of the Mifune Group (Ed.), "*Dinosaurs in the Mifune Group*"—*Reports of the Scientific Expedition at the Mifune Group*, Reports of the Scientific Expedition at the Mifune Group, Kumamoto, p. 63–67. (in Japanese)

Narita, A., Yamada, T. and Matsumoto, M. (2008) Platanoid leaves from Cenomanian to Turonian Mikasa Formation, northern Japan and their mode of occurrence. *Paleontological Research*, **12**, no. 10: 81–88.

Nathorst, A. G. (1888) Zur Fossilen Flora Japan's. *Paläontologische Abhandlungen*, **4**, no. 3: 197–250, pls. 17–30.

National Science Museum (1977) *A Hundred Year of the National Science Museum*. 898 pp. National Science Museum, Tokyo.

Naumann, E. (1887) The Physical Geography of Japan, with Remarks on the People. *Proceedings of the Royal Geographical Society and Monthly Record of Geography*, **9**, no. 2: 86–102.

Stiehler, A. W. (1857) Beiträge zur Kenntnis der vorweltlichen Flora des Kreidegebirges im Harze. *Palaeontographica*, *Abteilung B*, **5**: 47–70.

Suzuki, T. (1890) Preliminary report on the geology of Kumamoto District. *Geological Abstract*, no. 1: 1–142. (in Japanese)

Tamura, M. (1970) The hinge structure of *Trigonioides*, with description of *Trigonioides mifunensis* sp. nov. from Upper Cretaceous Mifune Group. *Memoirs of the Faculty of Education*, *Kumamoto University. Natural Science*, **18**: 47–57.

Tamura, M. (1990) Stratigraphic and palaeontologic studies on non-marine Cretaceous bivalve faunas in southwest Japan. *Memoirs of the Faculty of Education*, *Kumamoto University*, *Natural Science*, no. 39 supplement: 1–47. (in

Japanese with English abstract)

Tamura, M., Okazaki, Y. and Ikegami, N. (1991) Occurrence of Carnosaurian and Herbivorous dinosaurs from Upper Formation of Mifune Group, Japan. *Memoirs of the Faculty of Education*, *Kumamoto University. Natural Science*, no. 40: 31–45. (in Japanese with English abstract)

Tanai, T. (1979) Late Cretaceous floras from the Kuji District, Northeastern Honshu, Japan. *Journal of the Faculty of Science*, *Hokkaido University*, *ser. 4*, **19**: 75–136.

Tanaka, H., Hirota, S., Uetsuka, J., Tsuruda, K., Tsuruda, R. and Honda, E. (2022) Geotectonic movement and molluscan fossils from the Upper Cretaceous Gankaisan Formation, south of Kumamoto. *Bulletin of the Kumamoto Prefecture Museum Network Center*, no. 2: 1–13. (in Japanese with English abstract)

Tschan, G. F., Denk, T. and Von Balthazar, M. (2008) *Credneria* and *Platanus* (Platanaceae) from the Late Cretaceous (Santonian) of Quedlinburg, Germany. *Review of Palaeobotany and Palynology*, **152**, nos. 3–4: 211–236.

Tsutsumi, Y., Isozaki, Y., Kani, T. and Nakahata, H. (2018) Detrital Zircon U–Pb Dating of Cretaceous Sandstones from Amakusa–Mifune District, Central Kyushu, Japan: Provenance and Transition of Fore-arc Clastic Rocks in Cretaceous Japan. *Journal of Geography (Chigaku Zasshi)*, **127**, no. 1: 21–51. (in Japanese with English abstract)

Velenovský, J. (1882) Die Flora der Böhmischen Kreideformation. *Beiträge zur Paläontologie Österreich*, *Ungarns und des Orientes*, **2**, no. 1–2: 8–32.

Yamashita, D. (1896) *Explanation text of the Geological Map, 1 : 200,000, Kumamoto*. 97 pp. Geological Survey of Japan, Tokyo. (in Japanese)

Yokoyama, M. (1889) Jurassic plants from Kaga, Hida, and Echizen. *Journal of College of Science*, *Imperial University*, *Japan*, **3**, no. 1: 1–66, pls. 1–14.