

Baiera cf. *furcata* (LINDLEY and HUTTON) BRAUN from
the Carnic Momonoki Formation, Japan*

By

Tatsuaki KIMURA

Department of Astronomy and Earth Sciences, Tokyo Gakugei University,
Koganei, Tokyo 184

Gentaro NAITO

26-9, Higahi-Matsuzaki-machi, Hofu City, Yamaguchi Prefecture 747

and

Tamiko OHANA

Department of Astronomy and Earth Sciences, Tokyo Gakugei University,
Koganei, Tokyo 184

(Communicated by Ikuwo OBATA)

Foreword and acknowledgements

The western part of Yamaguchi Prefecture (formerly Nagato Province) has been known to be one of the classical Mesozoic plant-sites in Japan where the upper part of Middle to Upper Triassic strata of marine and non-marine origins are extensively exposed in the Miné, Atsu and Asa Synclinal Basins north to southwards.

In the northern Miné Basin, the Triassic sediments called the Miné Group is divided into as follows (see TAKAHASI and MIKAMI, 1975) in upward sequence:

Aso Formation: ca. 1500 m thick, brackish to littoral with coal seams.

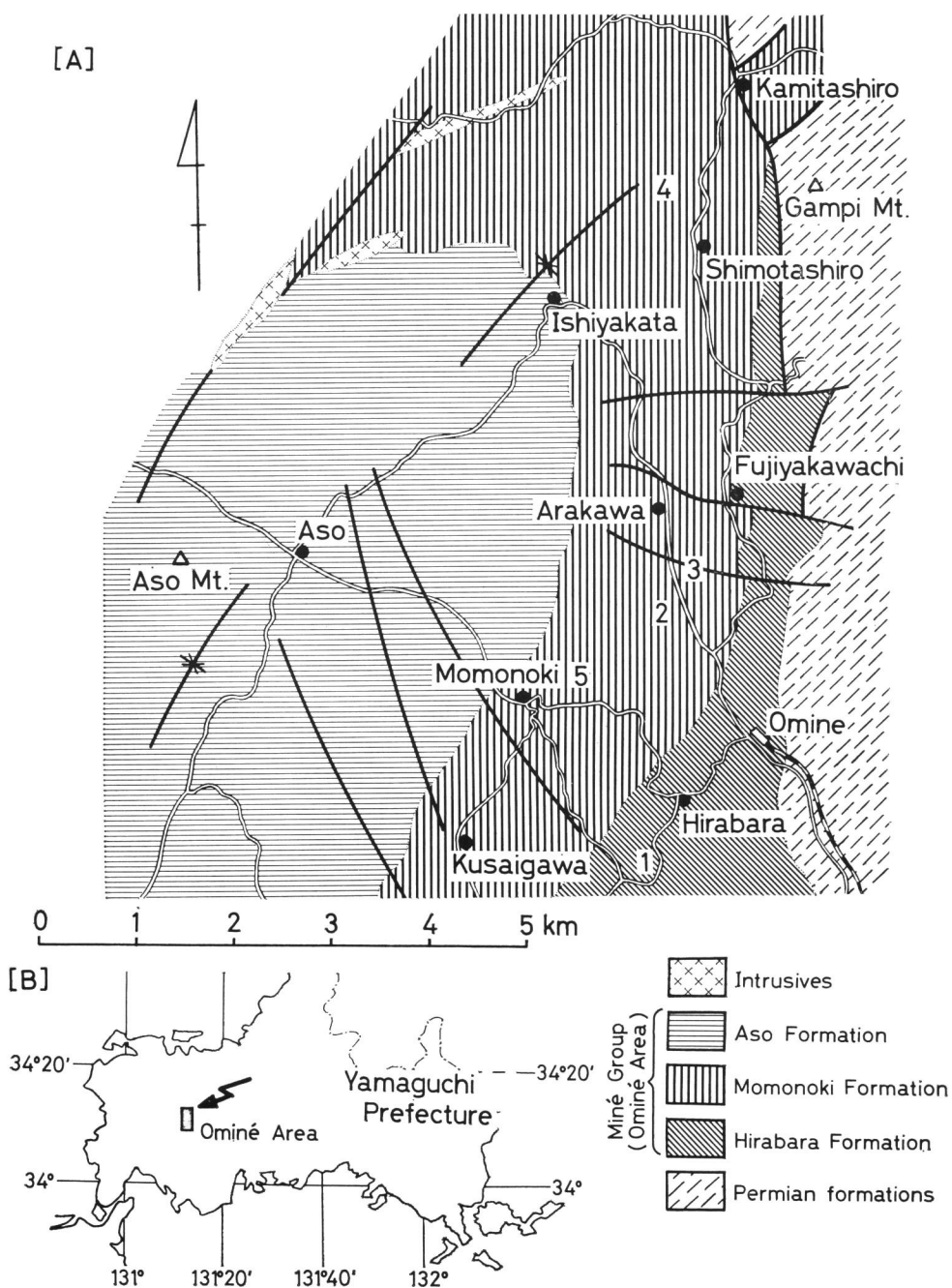
Momonoki Formation: up to 1500 m thick, lacustrine partly deltaic with main coal seams in this area.

Hirabara Formation: ca. 1300 m thick, bay-sediments.

Takiguchi Formation: ca. 300 m thick, brackish lagoon sediments, some authors regard it as the basal member of Hirabara Formation.

The Miné Group rests unconformably on the Permian formations and has been dated as Carnian based on its marine invertebrate fossils (Text-fig. 1). The stratigraphical sequence of the Momonoki Formation in the Miné Basin is shown in the columnar section of Text-fig. 2. It yields abundant fossil plants (YOKOYAMA, 1891, 1905; OISHI, 1932b, 1940; OISHI and TAKAHASI, 1936; KON'NO, 1961, 1962a, b, 1968; KON'NO and NAITO, 1960, 1978; TAKAHASI, 1950, 1959, 1973a, b; TAKAHASI and OKAFUJI

* Supported partly by the Overseas Scientific Research Fund of Ministry of Education, Japan: no. 57043021 (For comparison with ginkgoalean leaves from the Daedong Supergroup, Korea).



Text-fig. 1. The location of the Ominé Area [B] and its brief geological map [A] with main fossil plant-localities (1–5).



Text-fig. 2. The columnar section of the Momonoki Formation and its fossil plants, together with those from the Hirabara and Aso Formations. A; Mugikawa Coal-Bed. B; Fujiyawa-kawachi Coal-Bed. C; Hazegatani Coal-Bed. D; Lower Coal-Bed of the Open-Mine. E; Upper Coal-Bed of the Open-Mine. F; Inoki Coal-Bed.

1963, 1967, 1968, 1970: TAKAHASI *et al.*, 1963a, b, 1965a, b: HUZIOKA and TAKAHASI, 1973: ASAMA and NAITO, 1978: ASAMA and OISHI, T., 1980: KIMURA and OHANA, 1980).

The fossil plants hitherto described are shown in the right-side of Text-fig. 2, contrasting its stratigraphical horizons.

During about 1968–1971, the late Mr. Goro OKAFUJI found and collected abundant ginkgoalean leaves from a single horizon of its Upper Coal Bed (Text-fig. 2). They are mostly thickly massed and appressed as shown in Pls. 1–2. No plant-organs belonging to other taxa have been found in association with these ginkgoalean leaves.

As the result of our detailed examination of these ginkgoalean leaves varied in form and size, we concluded that they belong to a single and the same species. Thus this paper deals with the description of these ginkgoalean leaves together with their variation in leaf-form, and the comparison with similar leaves described from other regions. The material here described is kept at the National Science Museum, Tokyo and the Miné City Museum of History and Folk-Custom (OKAFUJI's Collection).

We express our sincere gratitude to the late Professor Emeritus Thomas M. HARRIS, F. R. S. of the University of Reading for his helpful suggestions and critical reading over the manuscript. We are indebted to Mr. Shiro ANNO, director of the Miné City Museum of History and Folk-Custom for giving us the facilities to study OKAFUJI's Collection.

In this paper, the stratigraphical setting, palaeobotanical description and drawings are liable for the second author NAITO, the first author KIMURA and the third author OHANA respectively.

Description

Baiera cf. furcata (LINDLEY and HUTTON) BRAUN

Pls. 1–6; Text-figs. 3–7

Specimens from Yamaguchi Prefecture:

Baiera? sp.: YOKOYAMA, 1891, p. 246, pl. 34, fig. 6 (Yamanoi).

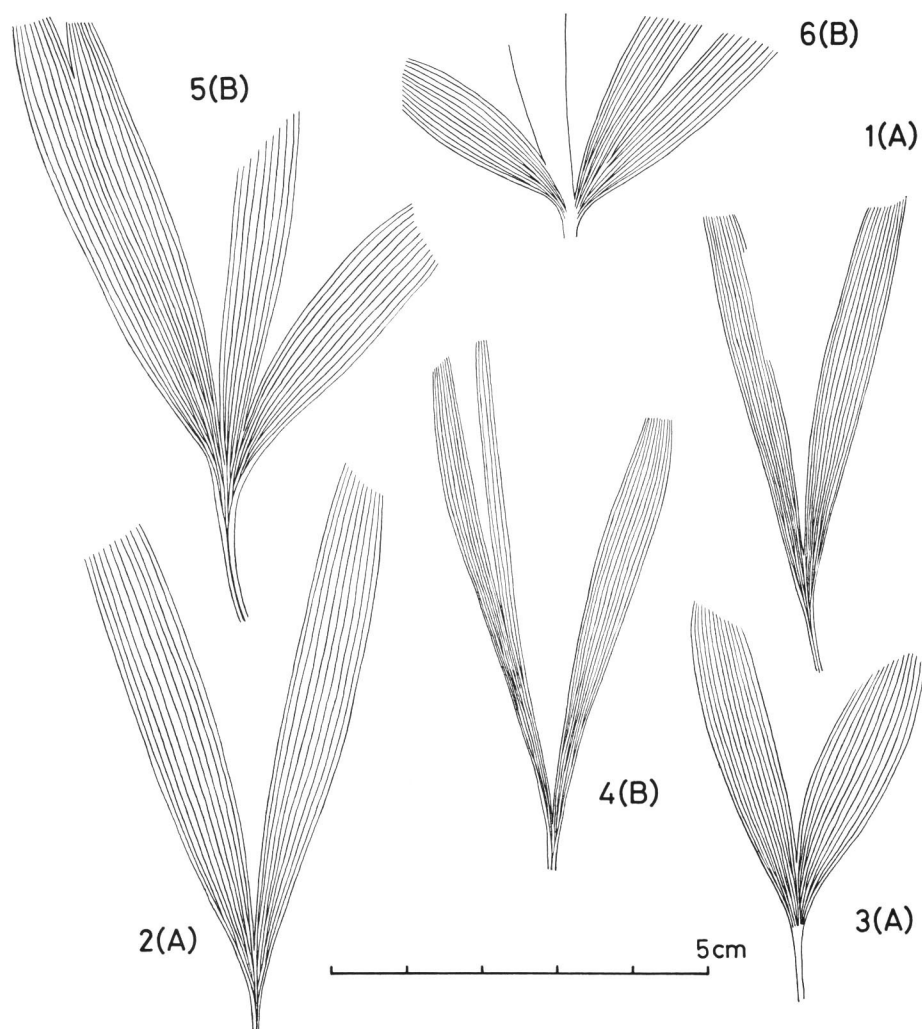
Baiera lindleyana (SCHIMPER) SEWARD: TAKAHASI and KIMURA, H., 1965, pl. 1, fig. 1 (Schimotashiro): TAKAHASI and OKAFUJI, 1968, p. 31, pl. 1, fig. 5; pl. 2, figs. 1–4 (Open Mine).

Baiera paucipartita NATHORST: INOUE, 1896, p. 363, pl. 12, fig. 6 (Yamanoi): YOKOYAMA, 1905, p. 9, pl. 2, fig. 5 (Yamanoi): OISHI, 1932c, p. 65, pl. 9 (1), figs. 10–11 (Yamanoi); 1940, p. 374, pl. 38, fig. 5 (Momonoki, exact horizon uncertain).

Material: F2–31, 33, 35, F3–2, 4, NSM-PP 7662~5 and many other blocks.

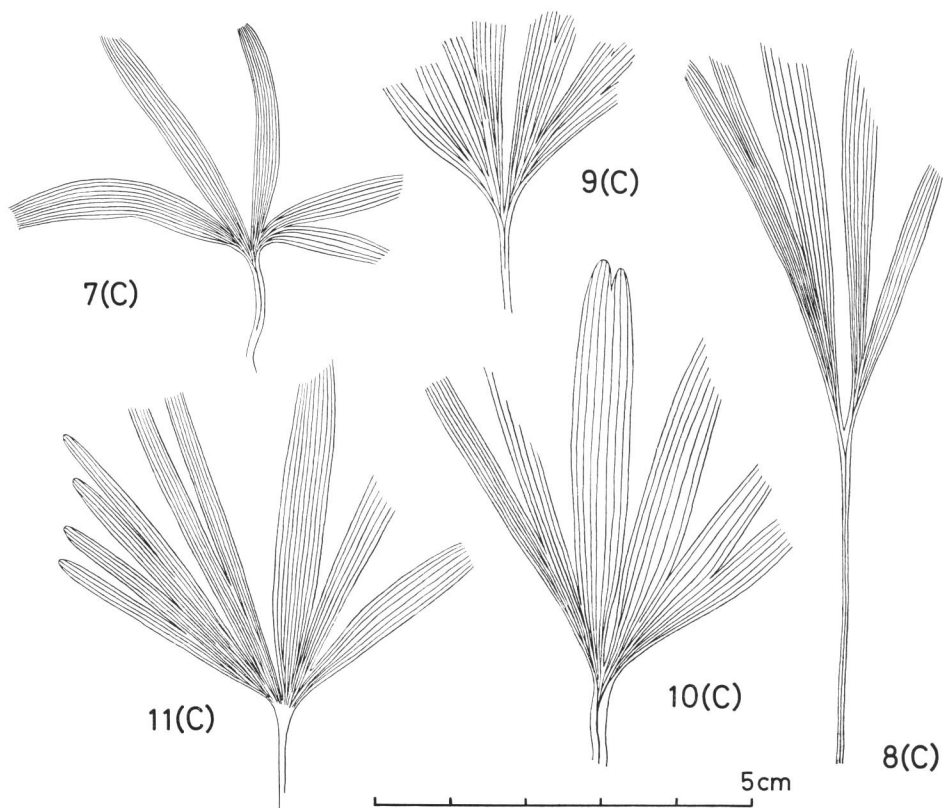
Description: Examined were over 200 detached leaves and three leaves attached to a broken shoot from a single horizon of the Upper Coal Bed of Momonoki Formation. The leaf is petiolate; the petiole is long and slender; the longest one preserved is 4 cm but its very base is unknown.

The lamina varies in form and size; its height (or radius) varies from 3 cm to 12 cm except for the smallest ones (2 cm high and 3 cm wide) shown in text-fig. 7–24 and 25 and the largest one (17.1 cm high or more and 10.7 cm wide). There is some statistic relation between height of lamina and number of lobes; generally more number the



Text-fig. 3. 1–3. A-type leaves. 1 (Reg. no. F2-31C). 2. This is also shown in Plate 1 (Reg. No. F2-31–60). 3 (Reg. no. F2-35). 4–6. B-type leaves. 4 (Reg. no. F2-31C). 5 (Pl. 6, Fig. 1, Reg. no. A-5-96). 6 (Reg. no. F2-35).

lobes, the higher the lamina. The width of lamina also varies, but there is some statistic relation between height and width of lamina except the leaves shown in text-fig. 7–24 and 25. The lamina is usually divided into two primary lobes to form the most simple leaf by a median sinus reaching to the top of petiole or just above the first dichotomy. But usually each primary lobe is deeply and dichotomously divided into two secondary lobes, each of which is further deeply or shallowly divided by successive one-three dichotomies into narrow third-fifth lobes; the apex of lobe is usually rounded



Text-fig. 4. C-type leaves. 7 (Pl. 5, Fig. 1a, Reg. no. A-7-12). 8 (Pl. 5, Fig. 3a, Reg. no. A-8-13). 9 (Pl. 6, Fig. 5, Reg. no. E-1). 10 (Pl. 5, Fig. 3b, Reg. no. A-11-11). 11 (Reg. no. F2-31-51).

in broader one or obtusely pointed in filiform one. The number of lobes is usually unequal between both right and left sides of lamina bounded by the median sinus, but occasionally equal. Accordingly the number of ultimate lobes in a primary lobe is on paper to be 24, but is actually 14 in maximum. There is a tendency that the more number of times the division, the higher the lamina and also the narrower the lobes. The vascular bundle appears to be one in the petiole, then is divided dichotomously into two veins below the first dichotomy of lamina; each vein is dichotomously forking successively at or near the bases of the second and third lobes, then they are running parallel and ending at the distal margins of ultimate lobe, not converging but sometimes close together at apex. The number of veins is 9-11 (11-13.8 per cm) in the middle of narrower lobe and only one in the filiform lobe.

For the convenience of describing our leaves, we tentatively classified our leaves into the following five-types, A-E, except the leaves as shown in text-fig. 7-24 and 25, accord-

ing to the number of dichotomies of lamina. But as these types are continuous in macroscopic features each other, the boundaries between them are, of course, not fixed.

1) A-type of leaves (Text-fig. 3-1, -2, and -3): Simple bilobed leaves in which the median sinuses are not reaching to the top of petiole. The basal angle of lamina is 33–54 degrees. Such bilobed leaves are rare in occurrence.

2) B-type of leaves (Text-fig. 3-4, -5, and -6): The leaves in which the secondary dichotomies are, either deep or shallow, developing in the primary lobes. The basal angle is 34–107 degrees. These leaves are also rare in occurrence.

3) C-type of leaves (Text-figs. 4-7, -8, -9, -10, and -11; 5-12, -13, and -14; 6-17): The most common leaves in which the median sinus is reaching to the top or near the top of petiole and the third lobes are more or less developed and further the fourth lobes are seen in part (Text-figs. 4-10 and -11; 5-13 and -14). The basal angle is 43–173 degrees.

4) D-type of leaves (Text-figs. 5-15 and -16; 6-18 and -19; 7-20): Another common type of leaves in which the fourth lobes are commonly developed. The basal angle is 58–150 degrees.

5) E-type of leaves (Text-figs. 7-21, -22 and -23): The leaves in which the lamina is divided by four-five dichotomies all into filiform lobes, 0.5–2 mm wide, each with 1–4 veins. This type of leaves is generally larger in size and rather rare in the population. The largest one is more than 17 cm high and 10.7 cm wide (TAKAHASHI and OKAFUJI, 1968, pl. 2, fig. 4a). The basal angle is 75–86 degrees.

In all of our leaves no particular substance is recognized between veins.

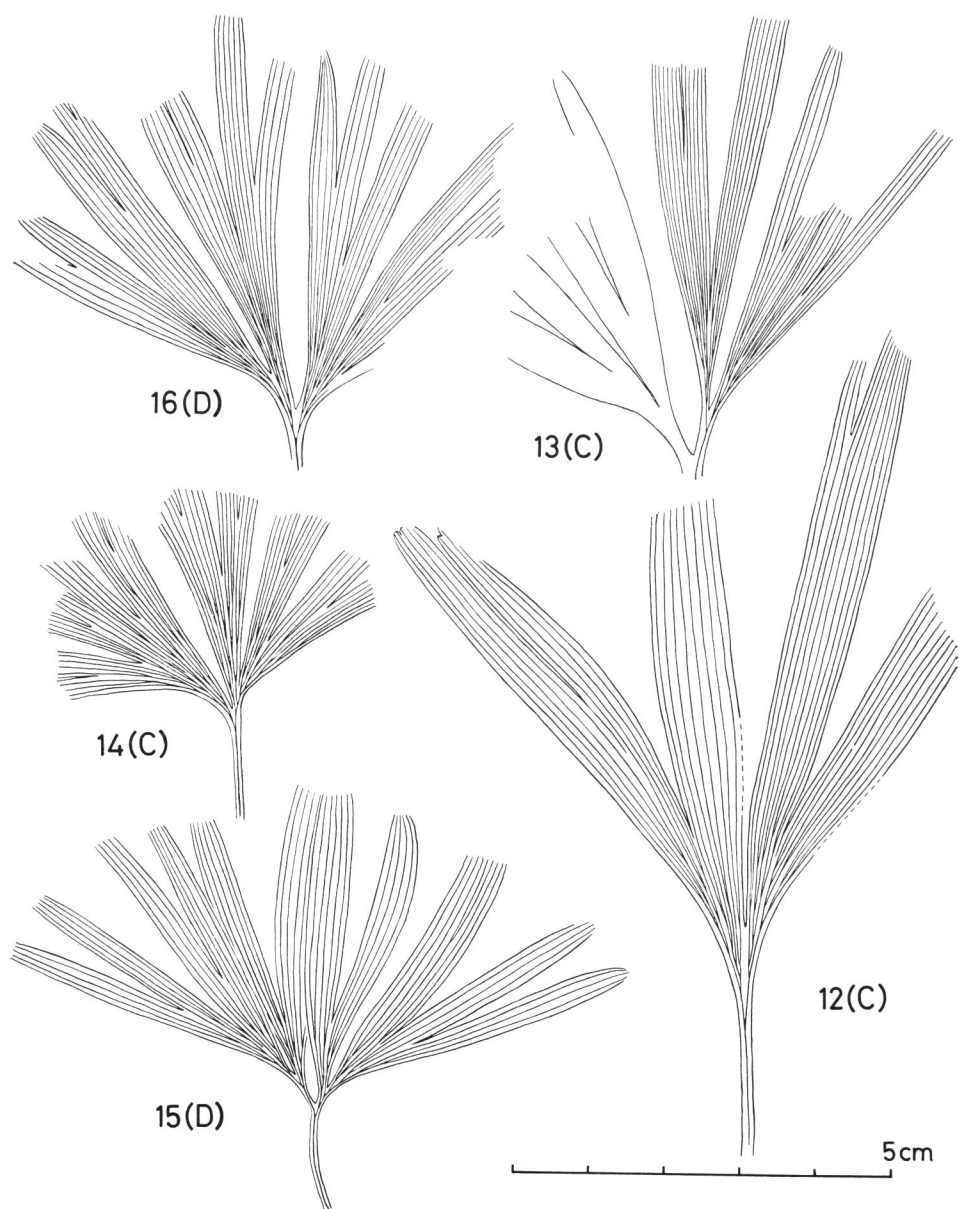
Among the leaves considered to belong to the same population, there are seven extreme ones. One is shown in Text-fig. 7-24. It is characterized by that in spite of its small size, 2 cm high and 3 cm wide, its lamina is divided by four dichotomies into comparatively broader lobes each with retuse or emarginate apex and with 1–4 parallel veins; its basal angle is about 150 degrees. Similar leaves are shown in Text-fig. 7-25. They are further characterized by their thick petioles, 2 mm wide and are attached alternately to the axis, 2.5 mm wide.

Cuticle is not preserved and no reproductive organ has been found.

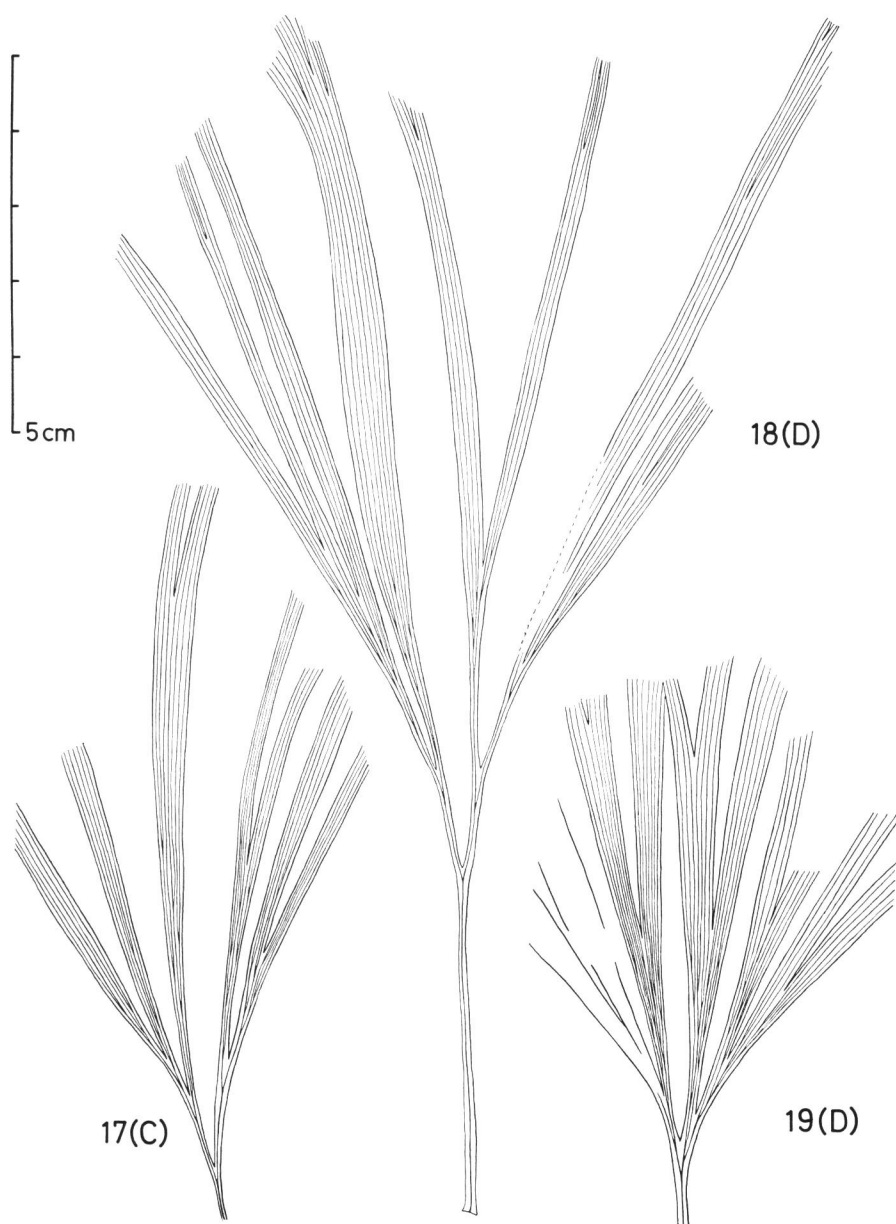
Distribution and occurrence: All leaves here described are derived from a single horizon in the Upper Coal Bed of Momonoki Formation (at a big open mine, now closed) where they are thickly massed and appressed. Apart from these leaves there is nothing that could be ginkgoalean.

Several leaves were collected from the Fujiyakawachi Coal Bed (at Arakawa, closed Ominé Mine and Yokomichi, closed Taimei Mine) of Momonoki Formation. A few leaves have been known from the shale bed below the Fujiyakawachi Coal Bed and the Hirabara Formation.

Discussion and comparison: We showed in text-figures representative leaf-forms. Among them our leaves with three-four dichotomies (C- and D-types) have been regarded by the previous authors as *Ginkgoites* (or *Ginkgo*) *sibirica* or *Baiera gracilis* and those with four-five dichotomies and with filiform lobes (E-type) as *Baiera lindleyana*.

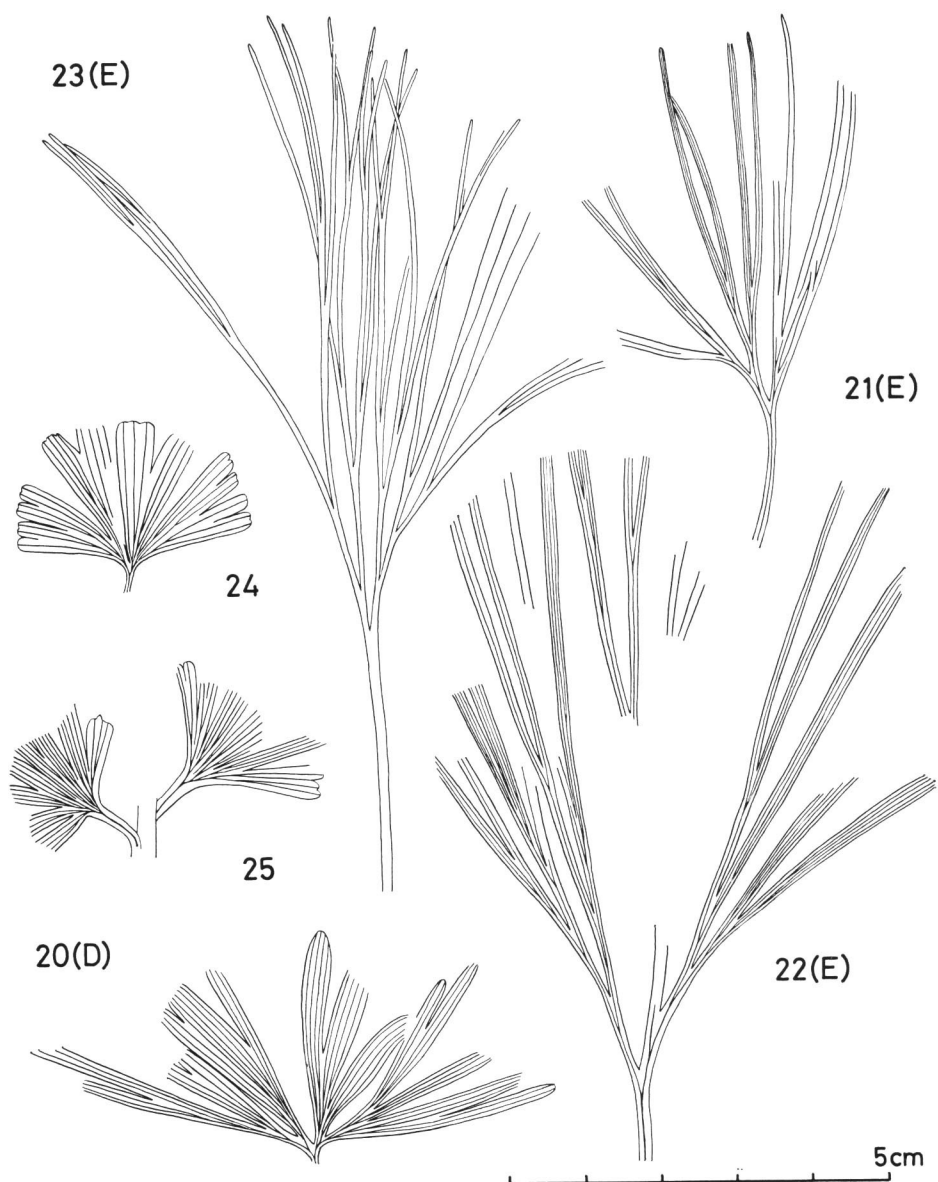


Text-fig. 5. 12–14. C-type leaves. 12 (Pl. 3, Fig. 1, Reg. no. F-2). 13 (Reg. no. F3–2–35). 14 (Pl. 6, Fig. 4, Reg. no. E-3). 15–16. D-type leaves. 15 (Pl. 3, Fig. 3, Reg. no. F2–33). 16 (Pl. 4, Fig. 2a, Reg. no. F2–31–49).



Text-fig. 6. 17. C-type leaf (Pl. 3, Fig. 4, Reg. no. F2-31). 18-19. D-type leaves. 18 (Pl. 4, Fig. 1, Reg. no E-106). 19 (Reg. no. F2-31-54).

We think, although their leaf-forms vary considerably, they belong to the same population and then they belong to a single species, because of their leaf-forms changing



Text-fig. 7. 20. D-type leaf (Pl. 3, Fig. 2, Reg. no. E-79). 21–23. E-type leaves. 21 (Pl. 4, Fig. 3, Reg. no E-103). 22 (Reg. no E-4B). 23 (Pl. 5, Fig. 4, Reg. no. F2–33–24). 24–25. Small-sized leaves. 24 (Pl. 3, Fig. 5, Reg. no. F3–4–10). 25 (a part of Pl. 6, Fig. 3, Reg. no. E-5).

serially from bilobed one (A-type), finally to multi-divided one with filiform lobes (E-type) and of their crowded occurrence.

TAKAHASI and OKAFUJI (1967) described six detached ginkgoalean leaves from Arakawa and Yokomichi of the Fujiyakawachi Coal Bed as *Ginkgoites sibirica* (HEER). Macroscopically they are referable in leaf-form to our C-type. *Ginkgoites sibirica* (HEER) and *Baiera lindleyana* (SCHIMPER) described also by TAKAHASI and OKAFUJI (1968) were derived from the same locality and horizon as ours. The leaves regarded by them as *Ginkgoites sibirica* are referable undoubtedly to our B-D types and those as *Baiera lindleyana* to our E-type. A single leaf illustrated by TAKAHASI and KIMURA (1965) as *Baiera lindleyana* from Shimotashiro, possibly belonging to the Fujiyakawachi Coal Bed is, though it is broken, referable to our C-type.

Baiera paucipartita described by YOKOYAMA (1905) from Yamanoi and by OISHI (1940) from Momonoki (its exact horizon uncertain), although their basal parts of leaves are missing, resembles in leaf-form and venation our D-type, especially so in our leaf as shown in Text-fig. 6-19, and thus we now think their *Baiera paucipartita* is referable to ours.

The original leaves of *Baiera paucipartita* from the Rhaetic of Sweden (NATHORST, 1886; LUNDBLAD, 1959 for its cuticle) is characterized by the leaves being attached by a narrow basal portion to a short shoot covered with scale-leaves, and then is now regarded by HARRIS and MILLER (1974) as the type species of their *Sphenarion* belonging to Czekanowskiales.

Under the circumstances, it is inadequate to refer Japanese leaves lacking their basal parts to Nathorst's species, together with those from the Nariwa Group.

1) Comparison with Yorkshire leaves

Similar series of ginkgoalean leaves was shown by HARRIS and MILLINGTON (1974) on the Yorkshire material. They described *Baiera furcata* and included in it *B. gracilis* BUNBURY, *B. lindleyana* (SCHIMPER) SEWARD, *B. scalbiensis* BLACK all of which were originally instituted on the Yorkshire material, and concluded that the various forms of leaves as mentioned above belonged to one species based on their serial change of leaf-forms and of cuticles, and on their occurrence.

However, our series of leaves is not fully agreed macroscopically with the Yorkshire series and differs in the following:

a) In Yorkshire leaves, lamina is divided by 2-6 successive dichotomies, while in ours the number of dichotomies is one-five. No bilobed leaf (our A-type) has been recorded from Yorkshire.

b) The Yorkshire ultimate lobes are subacute or acute at apex, but those of ours are obtuse or round at apex.

c) The Yorkshire ultimate lobe has 2-5 veins and they converge at apex, while in our ultimate lobe veins are 1-11 and they do not fully converge at apex but sometimes close together. Accordingly our series of leaves might be distinct from that of Yorkshire. But at present we refrain to give our leaves a new specific name based only on their macroscopic features and regard them as *Baiera* cf. *furcata*.

2) *Comparison with the leaves of Nariwa Group, Japan*

We reexamined the figured leaves from the Norian Nariwa Group based on the viewpoint of serial change of leaves. From the Nariwa Group, OISHI (1930) first described *Baiera* sp. cf. *B. paucipartita* and *B. sp.*, and later he (1932a) described the following ginkgoalean species: *Ginkgoites sibirica* (HEER) SEWARD, *Baiera elegans* OISHI, *B. filiformis* OISHI, *B. furcata* HEER, *B. guilhaumati* ZEILLER, *B. muensteriana* (PRESL), *B. paucipartita* NATHORST and *B. taeniata* BRAUN. In addition OISHI and HUZIOKA (1938) described *Ginkgoites digitata* (BRONGNIART) var. *huttoni* SEWARD.

As according to OISHI (1932a, 1940), they are derived from various localities in the Nariwa Group respectively, it is impossible to ascertain whether they belong to the same population or not.

His *Ginkgoites sibirica* [1932a, p. 347, pl. 49 (31), figs. 4–5] resembles in leaf-form our B-type, especially so in his fig. 4 having four lobes at most each with 7 veins.

Their *Ginkgoites digitata* var. *huttoni* is, according to OISHI and HUZIOKA (1938, p. 94, without figures) based on a single petiolate leaf with semi-circular lamina divided deeply into five broadly lanceolate lobes, each lobe bearing 5–6 parallel veins forking at their origin and converging to a rounded apex. Judging from their description, their leaf resembles such our C-type leaf as shown in Text-fig. 4–7. But in their lobes, they say the veins converge at apex. We suppose their veins do not converge entirely at apex but end at apex close to one another, like those sometimes seen in our lobes such as shown in Text-figs. 4–7, 5–15 and –16.

His small-sized *Baiera elegans* with five dichotomies of lamina are represented by six broken detached leaves and strongly remind us of our extreme leaf-form and venation shown in Text-figs. 7–24 and –25.

His *Baiera furcata* represented by two broken leaves resembles in leaf-form and venation our E-type, especially so in our leaf as shown in Text-fig. 7–22.

His *Baiera guilhaumati* [OISHI, 1932a, p. 353, pl. 53 (35), fig. 5: 1940, p. 371] is represented by several broken leaves and one is figured but without detailed description. The original leaves of *Baiera guilhaumati* described by ZEILLER (1902–3) from the Hongay Coal-Field are characterized by small-sized lamina divided by three dichotomies into slender lobes each with a few veins and with obtusely pointed or rounded apex. As OISHI's leaves lack their apices of lobes, it is difficult to refer them to ZEILLER's species. They rather resemble our C- or D-type such as shown in Text-fig. 6–17 or –19.

His *Baiera muensteriana* [OISHI, 1932a, p. 348, pl. 50 (32), fig. 1], later altered as *B. minuta* NATHORST (OISHI, 1940, p. 373) is represented by several broken leaves and resembles in leaf-form and venation our E-type, especially so in our leaf as shown in Text-fig. 7–22.

Baiera paucipartita described by OISHI [1930, p. 56, pl. 7, fig. 6b as *B. sp. cf. B. paucipartita*: 1932a, p. 351, pl. 50 (32), fig. 6], although they are quite incomplete, resembles our D-type, as well as those described by YOKOYAMA (1905) and OISHI (1940) from Yamanoi and Momonoki mentioned before.

Baiera sp. described by OISHI (1930, p. 56, pl. 7, figs. 6a, 7) is represented by the broken leaves of bilobed-type and later being regarded by OISHI (1932a, p. 260) as *B. paucipartita*. But his figs. 6a and 7 resemble closely our bilobed A-type and B-type respectively.

His *Baiera taeniata* [OISHI, 1932a, p. 350, pl. 50 (32), fig. 5] is represented by a single specimen and resembles closely our C-type in its leaf-form and venation.

Baiera sp. represented by a single broken leaf [OISHI, 1932a, p. 354, pl. 50 (32), fig. 7] resembles also our C-type. In its figured leaf, the apex of lobe appears to be acuminate, but as mentioned by OISHI, this would be caused by its longitudinal folds. Finally, his *Baiera filiformis* is represented by a single incomplete leaf and resembles in leaf-form our E-type, but is quite different from ours in its lobes each with 7–8 or more fine parallel veins.

Accordingly the leaves described from the Nariwa Group under the genera *Ginkgoites* and *Baiera* are not referable to the European and Indo-Chinese species as done by the previous authors, but mostly referable to our A-E types of *B. cf. furcata*, apart from one exception, *B. filiformis* OISHI.

3) Comparison with the leaves from the Upper Triassic Daedong Supergroup, Korea

YABE (1922), KAWASAKI (1925, 1926, 1939) and OISHI (1940) described various *Ginkgo* (or *Ginkgoites*) and *Baiera* species as follows from various localities in the Daedong Supergroup, Korean Peninsula: *Ginkgo huttoni* (STERNBERG), *Ginkgoites hermelini* HARTZ ?, *Ginkgo* (or *Ginkgoites*) *sibirica* HEER, *Ginkgoites digitata* (BRONGNIART) var. *huttoni* SEWARD, *Baiera concinna* (HEER) (or *B. asadai* YABE and OISHI), *B. (?) concinna* (HEER), *B. gracilis* BUNBURV, *B. guilhaumati* ZEILLER, *B. lindleyana* (SCHIMPER) and *B. phillipsi* NATHORST.

Although they are not abundant in occurrence and are derived from various localities, their leaf-forms appear to show a series similar to that of our leaves here described. The details of these Korean leaves will be shown by KIMURA and KIM as the result of restudies of Daedong flora in the near future.

4) Comparison with *Ginkgo sibirica* leaves

HEER (1876) originally described *Ginkgo concinna*, *G. flabellata*, *G. lepida*, *G. pusilla*, *G. schmidtiana* and *G. sibirica* from the Middle Jurassic Cheremkhovo Formation (according to DOLUDENKO and LEBEDEV, 1972), Irkutsk Basin, USSR. Most of authors have noticed that they are conspecific and have included them into *Ginkgo sibirica*, apart from *G. concinna*.

Ginkgo sibirica is characterized by its lamina divided by three-four dichotomies into lobes each with rounded or obtusely pointed apex and with 4–7 veins. HEER's original leaves of *Ginkgo sibirica* actually resemble in leaf-form and venation some of our C-type leaves, but they do not accompany such leaves as our A, B, D and E-types of leaves, apart from the leaves having regarded as *G. concinna*.

Ginkgo concinna-type leaves are characterized by its lamina divided by four-five

dichotomies into narrow lobes each with rounded apex and with 2–4 veins, and somewhat resemble some of our D-type leaves, but are distinguished from any our leaf by their large basal angle (usually over 180 degrees) and their small size (2.5–3.3 cm high from the first dichotomy).

Thus so far as HEER's original leaves are concerned, HEER's leaf-series would be distinct from that of ours.

Recently KIMURA and TSUJII (1983 in the press) described *Ginkgo* leaves as *G. ex gr. sibirica* from the Lower Jurassic Kuruma Group and Iwamuro Formation, Japan. These leaves are locally common in occurrence, but these *Ginkgo* leaves do not accompany any other form such as our A, B, D and E-types of leaves.

5) Comparison with Chinese leaves

From China various *Ginkgo* (or *Ginkgoites*) and *Baiera* species have been described from various stratigraphical horizons and localities. But now it is difficult to recognize the regional ginkgoalean populations based only on the published papers without the detailed information of occurrence.

Recently LI, B. X. (1981) originally described *Ginkgoites truncatus*, *G. wulungensis*, *G. fuxinensis* and *G. sp.* with their cuticles from the Upper Jurassic Haizhou Formation, Fuxin (Fushin), NE-China. At a glance, their leaf-forms appear to show a series successively from bilobed leaves (his *G. sp.*) to those divided by four dichotomies into slender lobes (his *G. fuxinensis*). But according to LI, his four species are derived not from a single horizon but from various horizons in the formation respectively.

In our opinion, it seems to be difficult to distinguish ginkgoalean leaves specifically depending only on their cuticles, because owing to our detailed observation on recent *Ginkgo biloba*, its leaf-cuticle is fairly varied according to the position on the same tree or even to the position of a single leaf, and some leaves are partly amphistomatic.

So far as LI's description of cuticles for his four species is concerned, it seems to be difficult to distinguish them depending only on his cuticular features.

Probably for this reason, for instance, some *Ginkgo* or *Baiera* species from the Jurassic-Cretaceous of NE-China studied macroscopically by YABE and OISHI (1933) and microscopically by OISHI (1933) have been disputed on their specific attributions: Their *Baiera manchurica* is, according to KRASSILOV (1972), distinct and their Cf. *Baiera concinna*, *B. cf. gracilis* and *B. minima* are conspecific with *B. manchurica*, but according to LI, their *B. cf. gracilis* is synonymous with his *Ginkgoites wulungensis*.

At any rate, however, LI's *Ginkgo* leaves do not accompany the leaves divided by multi-dichotomies into filiform lobes, thus even though they are actually in a series of leaves, it would be distinct from our series of leaves.

6) Comparison with the leaves of Bureja Basin

The Bureja Basin consisting of the Upper Jurassic Talynzhan and Tyrm Formations, the Jurasso-Cretaceous Ulgal Formation and the Lower Cretaceous Chagdamyn and Chemchukin Formations, has been known to be of abundant fossil ginkgoalean sites.

From these formations KRASSILOV (1972) described the following species together with their cuticles:

Ginkgoites dissectus KRASSILOV: Chemchukin Formation; small-sized *Ginkgo adiantoides*-type leaves.

Ginkgoites jampolensis (LEBEDEV) KRASSILOV: Chemchukin Formation; leaves are small-sized and divided by one-three dichotomies into lobes; known also from the Upper Jurassic of Zeia Basin (LEBEDEV, 1965).

Ginkgoites longipilosus KRASSILOV: Chagdamyn Formation; *Ginkgo adiantoides*-type leaves.

Ginkgoites sphenophyllus KRASSILOV: Ulgal Formation; bilobed leaves, sometimes the primary lobes are further lobed again.

Baiera kidoi YABE and OISHI: Tyrm Formation: This species was originally described by YABE and OISHI (1933) from the Lower Cretaceous Shahezi Formation, NE-China; leaves are divided by four dichotomies into narrow lobes. According to KRASSILOV, *Baiera orientalis* YABE and OISHI (1933) from the Shahezi Formation is conspecific with *B. kidoi*.

Baiera manchurica YABE and OISHI: Talynzhan and Ulgal Formations.

Macroscopically, apart from the leaves of *Ginkgo adiantoides*-type, *Ginkgoites dissectus* and *G. longipilosus*, the leaves regarded by KRASSILOV as *G. sphnophyllus*, *G. jampolensis*, *Baiera kidoi* and *B. manchurica* appear to form a series in leaf-form like those of ours. But at present it is difficult to ascertain their serial relation, because according to KRASSILOV (1972), they are not from a single horizon or formation.

The serial relation of ginkgoalean leaves like those of ours would be expected either macroscopically or microscopically in the Shahezi Formation, NE-China, because this formation yields abundant ginkgoalean leaves, and further *Ginkgo sibirica*-type and the leaves divided by multi-dichotomies into slender lobes such as *Baiera manchurica*-type are closely coexisted.

However, even though such series of leaves are recognized in the Bureja Basin and Liaoning Province, NE-China, these series would be distinct from that of ours, because from both regions, the leaves divided by multi-dichotomies into filiform lobes (our E-type) have not been recorded. So far as we know, the ginkgoalean leaf-series with the leaves with filiform lobes seems to be restricted in age from the late Triassic to early middle Jurassic in the northern half of Northern Hemisphere in those days.

Finally we feel uneasy about our dealing of the leaves shown in Text-fig. 7-24 and -25. We now think they are immature leaves being to be those divided by multi-dichotomies into filiform lobes (our E-type), because in spite of their small size, they are already divided by four dichotomies into lobes each with 1-4 veins and with retuse or emarginate apex (thus the total number of dichotomies is five). As these lobes and parts between adjacent dichotomies grow longer, then they would come up finally to the leaves of our E-type. Judging from the alternate attachment of leaves as shown in Text-fig. 7-25, our E-type and some of D-type leaves might have been attached singly and directly to the long shoots or occasional long shoots like those of extant *Ginkgo*

biloba bearing deeply multi-divided leaves. But this is speculative.

In extant *Ginkgo*-petioles, there are two vascular bundles which diverge at its top. But in our leaves the veins appear to converge unexceptionally into one vascular strand just below the first dichotomy. Similar venation is illustrated by HARRIS and MILLINGTON (1974) in their *Ginkgo* sp. cf. *sibirica* HEER (fig. 5D).

References

- ASAMA, K. & G. NAITO, 1978. Upper Triassic *Trizygia* (Sphenophyllales) from Omine, West Japan and evolution of *Trizygia* series. *Bull. Natn. Sci. Mus. Tokyo, ser. C*, **4** (3): 89–98, pl. 1.
- & T. OISHI, 1980. Upper Triassic *Parasphenophyllum* (Order Sphenophyllales) from Omine, Western Japan. *Ibid.*, **6** (4): 115–118.
- DOLUDENKO, M. P. & E. L. LEBEDEV, 1972. *Ginkgoites sibirica* and '*G. huttonii*' of East Siberia. In Mesozoic plants (Ginkgoales and Czekanowskiales) of East Siberia. *Trans. Geol. Inst., Acad. Sci. USSR*, **230**: 82–102, pls. 1–3. (in Russian.)
- HARRIS, T. M., MILLINGTON, W. & J. MILLER, 1974. The Yorkshire Jurassic flora IV. 1 Ginkgoales, 2 Czekanowskiales. viii+1–150 pp., 8 pls. London, Brit. Mus. (Nat. Hist.).
- HEER, O., 1876. Beiträge zur Jura-Flora Ostsibiriens und des Amurlandes. *Acad. Imp. Sci., St.-Petersb., Mém.*, **22**: 1–122, pls. 1–31.
- HUZIOKA, K. & E. TAKAHASI, 1973. A Triassic Hepatica from the Omine coal-field, southwest Honshu, Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (89): 24–26, pl. 7.
- INOUE, K., 1896. On the Mesozoic formation in the southern part of Nagato. *Jour. Geol. Soc. Tokyo*, **3** (35): 341–364. (in Japanese.)
- KON'NO, E., 1961. Some *Cycadocarpidium* and *Podozamites* from the Upper Triassic formations in Yamaguchi Prefecture, Japan. *Sci. Rep., Tohoku Univ., sec. ser.*, **32** (2): 195–211, pls. 22–24.
- 1962 a. Some coniferous male fructification from the Carnic formation in Yamaguchi Prefecture, Japan. *Ibid.*, Spec. Vol., (5): 9–19, pls. 1–8.
- 1962 b. Some species of *Neocalamites* and *Fquisetites* in Japan and Korea. *Ibid.*, Spec. Vol., (5): 21–47, pls. 9–18.
- 1968. Some Upper Triassic species of Dipteridaceae from Japan and Borneo. *Jour. Linn. Soc. (Bot.)*, **61** (384): 93–105, pls. 1–2.
- & G. NAITO, 1960. A new *Neocalamites* from the Carnic formation in Japan with brief notes on *Neocalamites* and *Lobatannularia* in Asia. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (40): 339–351, pls. 40–41.
- & ——— 1978. *Adiantopteris ishidae* KON'NO and NAITO, sp. nov., from the Carnic beds in Southwestern Japan. *Bull. Natn. Sci. Mus. Tokyo, ser. C*, **4** (1): 7–10, pls. 1–2.
- KAWASAKI, S., 1925. Some older Mesozoic plants in Korea. *Bull. Geol. Surv. Chosen (Korea)*, **4**, Pt. 1: 1–71, pls. 1–47.
- 1926. Addition to the older Mesozoic plants in Korea. *Ibid.*, Pt. 2: 1–35, pls. 1–11.
- 1939. Second addition to the older Mesozoic plants in Korea. *Ibid.*, Pt. 3: 1–69, pls. 1–16.
- KIMURA, T. & T. OHANA, 1980. Some fossil ferns from the Middle Carnic Momonoki Formation, Yamaguchi Prefecture, Japan. *Bull. Natn. Sci. Mus. Tokyo, ser. C*, **6** (3): 73–92, pls. 1–6.
- & M. TSUJII, 1983 (MS). Early Jurassic plants in Japan. Part 6. *Trans. Proc. Palaeont. Soc. Japan, N. S.* (submitted and accepted).
- KRASSILOV, V. A., 1972. Mesozoic flora from the Bureja River (Ginkgoales and Czekanowskiales). Far East Geol. Inst., Far East Sci. Centre, Acad. Sci. USSR, 1–103 pp. pls. 1–34. Moscow. (in Russian.)
- LI, B. X., 1981. On the cuticular structures of *Ginkgoites* from the Haizhou Formation (Upper Juras-

- sic) in Fuxin (Fushin), Western Liaoning. *Acta Palaeont. Sinica*, **20** (3): 208–215, pls. 1–4 (in Chinese with English abstract and description of new species).
- LUNDBLAD, A. B., 1959. Studies in the Rhaeto-Liassic floras of Sweden. II: 1 Ginkgophyta from the Mining District of NW Scania. *K. svensk. Vet.-Akad., Handl., N. S.*, **6** (2): 1–38, pls. 1–6.
- NATHORST, A. G., 1878–1886. Om floran i Skånes kolforande Bildningar I. Floran vid Bjuf. *Sverig. geol. Unders. Afh., Stockholm, ser. C*, **27**, **33**, **85**: 1–131, pls. 1–26.
- OISHI, S., 1930. Notes on some fossil plants from the Upper Triassic beds of Nariwa, Prov. Bitchu, Japan. *Jap Jour. Geol. Geogr.*, **7** (2): 49–58, pl. 7.
- 1932 a. The Rhaetic plants from the Nariwa District, Prov. Bitchu (Okayama Prefecture), Japan. *Jour. Fac. Sci., Hokkaido Imp. Univ., ser. 4*, **1** (3–4): 257–380, pls. 19–53.
- 1932 b. Rhaetic plants from Province Nagato (Yamaguchi Prefecture), Japan. *Ibid.*, **2** (1): 51–67, pls. 9–10.
- 1933. A study on the cuticles of some Mesozoic Gymnospermous plants from China and Manchuria. *Sci. Rep., Tohoku Imp. Univ., sec. ser.*, **12** (2B): 239–252, pls. 36–39.
- 1940. The Mesozoic floras of Japan. *Jour. Fac. Sci., Hokkaido Imp. Univ., ser. 4*, **5** (2–4): 123–480, pls. 1–48.
- & K. HUZIOKA, 1938. Fossil plants from Nariwa. A supplement. *Ibid.*, **4** (1–2): 69–101, pls. 7–12.
- & E. TAKAHASI, 1936. The Rhaetic plants from Province Nagato. A supplement. *Ibid.*, **3** (2): 113–133, pl. 10.
- OKAFUJI, G., 1971. Fossil monograph of Akiyoshi-dai and its neighbourhood, Yamaguchi Prefecture, Japan (Carboniferous, Late Triassic and Pleistocene). 1–87 pp., incl. 35 pls. Yamaguchi, Educational Foundation, Yamaguchi Prefecture. (in Japanese.)
- TAKAHASI, E., 1950. Two species of *Todites* from the Triassic Mine Series, Province Nagato (Yamaguchi Prefecture). *Jour. Geol. Soc. Japan*, **56** (660): 439–440.
- 1951. Descriptive notes on some Mesozoic plants from Province Nagato. *Ibid.*, **57** (664): 29–33.
- 1959. Floral changes since the Mesozoic age of Western Honshu, Japan. *Sci. Rep., Yamaguchi Univ.*, **10**: 181–237. (in Japanese.)
- 1973 a. Some Triassic and Jurassic plants from Prov. Nagato (Yamaguchi Pref.), Japan. *Ibid.*, **20**: 7–13, incl. pls. 1–2.
- 1973 b. Stratigraphic distribution of the Mine-type and the Toyora-type floras. *Ibid.*, **20**: 15–28. (in Japanese.)
- & T. MIKAMI 1975. The Triassic System in Yamaguchi Prefecture. *In* Geology of Yamaguchi Prefecture. 93–108 pp. incl. pls. 1–4. Yamaguchi Museum (in Japanese).
- & G. OKAFUJI, 1963. *Haplostigma*-like plant from the Triassic of Omine Coal-Field. *Sci. Rep., Yamaguchi Univ.*, **14**: 77–78. (in Japanese.)
- & ——— 1967. *Ginkgoites sibirica* (HEER) from the Triassic of the Omine Coal-Field. *Ibid.*, **17**: 15–17. (in Japanese.)
- & ——— 1968. *Ginkgoites* and *Baiera* from the Triassic of the Omine Coal-Field. *Ibid.*, **18**: 31–35, pls. 1–2. (in Japanese.)
- & ——— 1970. *Leptostrobus longus* HARRIS. *Ibid.*, **19**: 1–7, pls. 1–2. (in Japanese with English description.)
- , TAKEDA, K., NISHINO, H., HIRAO, M., TANAKA, T. & H. KIMURA, 1963 a. The Mesozoic strata in the northern part of Asa, Yamaguchi Prefecture. *Ibid.*, **14**: 53–69. (in Japanese.)
- , WATANABE, F. & T. TANAKA, 1963 b. Geology in the western part of Ube Coal-Field. *Ibid.*, **14**: 71–76. (in Japanese.)
- & H. KIMURA, 1965 a. Palaeozoic and Mesozoic formations of the Dai-Tashiro District of the Nagato Tectonic Zone. *Ibid.*, **15**: 21–31, pls. 1–2. (in Japanese.)
- , UCHIDA, M., YAMANE, T. & K. MATSUSHIGE, 1965 b. Palaeozoic and Mesozoic formations of

- the southern part of the Omine District and of the Atsu District, Yamaguchi Prefecture. *Ibid.*, **15**: 51–61. (in Japanese.)
- YABE, H., 1922. Notes on some Mesozoic plants from Japan, Korea and China, in the collection of the Institute of Geology and Palaeontology of the Tohoku Imperial University. *Sci. Rep., Tohoku Imp. Univ., sec. ser.*, **7** (1): 1–28, pls. 1–4.
- & S. OISHI, 1933. Mesozoic plants from Manchuria. *Ibid.*, **12** (2B): 195–238, pls. 30–35.
- YOKOYAMA, M., 1891. On some fossil plants from the Coal-bearing Series of Nagato. *Jour. Coll. Sci., Imp. Univ. Japan*, **4**, Pt. 2: 239–247, pls. 22–24.
- 1905. Mesozoic plants from Nagato and Bitchu. *Ibid.*, **20**, art. 5: 1–13, pls. 1–3.
- ZEILLER, R., 1902–3. Flore fossile des gîtes de Charbon du Tonkin (Etudes des gîtes minéraux de la France). 1–328 pp., 56 pls. Paris.

Explanation of Plates

Plate 1

The occurrence of *Baiera* cf. *furcata* (a part of a bedding plane): All types (A-E) of leaves are massed and lying one upon another (Reg. no. F2–31). Natural size.

Plate 2

The similar occurrence of *Baiera* cf. *furcata* (another part of the same bedding plane as shown in Plate 1): B-E types of leaves are thickly massed and appressed. Reproduced from OKAFUJI (1971). Natural size.

Plate 3

1. C-type leaf (Text-fig. 5–12) (Reg. no. F-2).
2. D-type leaf (Text-fig. 7–20) (Reg. no. E-79).
3. D-type leaf (Text-fig. 5–15) (Reg. no. F2-33).
4. C-type leaf (Text-fig. 6–17) (Reg. no. F2-31).
5. A small detached leaf similar in size and form to those shown in Pl. 6, fig. 3 (Text-fig. 7–24) (Reg. no. F3–4–10). (All natural size).

Plate 4

1. D-type leaf (Text-fig. 6–18) (Reg. no. E-106).
- 2a. D-type leaf (Text-fig. 5–16) (Reg. no. F2–31–49).
- 2b. D-type leaf (Reg. no.: E-50).
3. E-type leaf (Text-fig. 7–21) (Reg. no. E-103). (All natural size).

Plate 5

- 1a. C-type leaf (Text-fig. 4–7) (Reg. no. A–7–12).
- 1b. C-type leaf (Reg. no. A–7–10).
2. C-type leaf (Reg. no. F2–31–53).
- 3a. C-type leaf (Text-fig. 4–8) (Reg. no. A–8–13).
- 3b. C-type leaf (Text-fig. 4–10) (Reg. no. A–11–11).
4. E-type leaf (Text-fig. 7–23) (Reg. no. F2–33–24). (All natural size).

Plate 6

1. B-type leaf (Text-fig. 3–5) (Reg. no. A–5–96).
2. E-type leaf; an unusually large sized leaf (Reg. no. E-6).
3. Four small leaves among which three are attached to the axis (Text-fig. 7–25) (Reg. no. E-5).
- 4–5. C-type leaves resembling in size and form those shown in Pl. 6, fig. 3 (4; Text-fig. 5–14, Reg. no. E-3, 5; Text-fig. 4–9, Reg. no.: E-1). (All natural size).

