

Late Jurassic plants from the Shishiori Group, in the Outer Zone of Northeast Japan (II)

By

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Continued from our previous paper (I)

Systematic description

Bennettitales

Genus *Otozamites* BRAUN, 1842

Otozamites sp. cf. *O. kondoi* OISHI

(Figs. 24a–b)

Material: NSM PP-8806 ~ 8808. *Horizon and locality*: Middle part of the Kogoshio Formation. Loc. no. 7. *Occurrence*: Very rare.

Description: The specimens obtained are represented by detached pinnae. The pinnae are rectangular or elongate-ovate in outline, 2.5 cm long and 1.3 cm wide at base, with broadly rounded apex and with slightly constricted basiscopic base; acroscopic basal angle is undeveloped. The veins are densely crowded, originated from the pinna base, repeatedly forked dichotomously and radiated.

Remarks: OISHI (1940) originally described *Otozamites kondoi* on the basis of several leaf-fragments derived from Oshima (corresponding possibly to our Loc. no. 4). The present pinnae resemble those of OISHI's species except for densely crowded veins in the former.

Otozamites sp. cf. *O. kondoi* was described by KIMURA and OHANA (1988b) from the Upper Jurassic Tochikubo Formation on the basis of four detached pinnae. The pinnae are close to those of OISHI's species in the density of veins. At any rate, it is highly probable that both pinnae mentioned above are referable to those of OISHI's species, but at present we refrain from making their full identity, because they are represented only by detached ones.

Genus *Zamites* BRONGNIART em. HARRIS, 1969

Zamites sp. cf. *Z. choshiensis* KIMURA et OHANA

(Figs. 25a–b)

Material: NSM PP-8809~8817. *Horizons and localities*: Lower part of the Moné Formation (Loc. no. 3) and middle part (Loc. nos. 4, 7, 8) and upper part (Loc. nos. 5, 6) of the Kogoshio Formation. *Occurrence*: Locally common.

Remarks: Many leaf-fragments were obtained. In external features, the present leaves agree well with those described by the previous authors as *Zamiophyllum buchianum* (ETTINGSHAUSEN) NATHORST or *Zamites buchianus* (ETTINGSHAUSEN) SEWARD from the Lower Cretaceous plant-beds in the Outer Zone of Japan.

KIMURA and OHANA (1985) established *Zamites choshiensis* on the basis of the leaves with preserved cuticle obtained from the Lower Cretaceous Choshi Group in the Outer Zone of Japan.

The leaves mentioned above are externally indistinguishable from those regarded as *Zamiophyllum buchianum* or *Zamites buchianus* in Japan, but the cuticle of the Choshi leaves is quite different from those of *Zamiophyllum buchianum* recorded from the European Wealden [e. g. CARPENTIER (1938) and DABER (1960)] and from the Lower Cretaceous of Southern Primorye (KRASSILOV, 1967). Therefore, we use the name, *Zamites* sp. cf. *Z. choshiensis* for the Japanese leaves without preserved cuticle.

Zamites choshiensis and *Z. sp. cf. Z. choshiensis* are the most characteristic species in the Upper Jurassic-Lower Cretaceous plant-beds in the Outer Zone of Japan. They are common or abundant in occurrence and are sometimes thickly massed and appressed on the bedding planes.

On the contrary, no *Zamites* species have been found in the Tetori-type floras in the Inner Zone of Japan.

***Zamites* sp. cf. *Z. megaphyllus* (PHILLIPS) SEWARD**

(Fig. 26)

Material: NSM PP-8818. *Horizon and locality*: Middle part of the Kogoshio Formation. Loc. no. 8. *Occurrence*: Very rare.

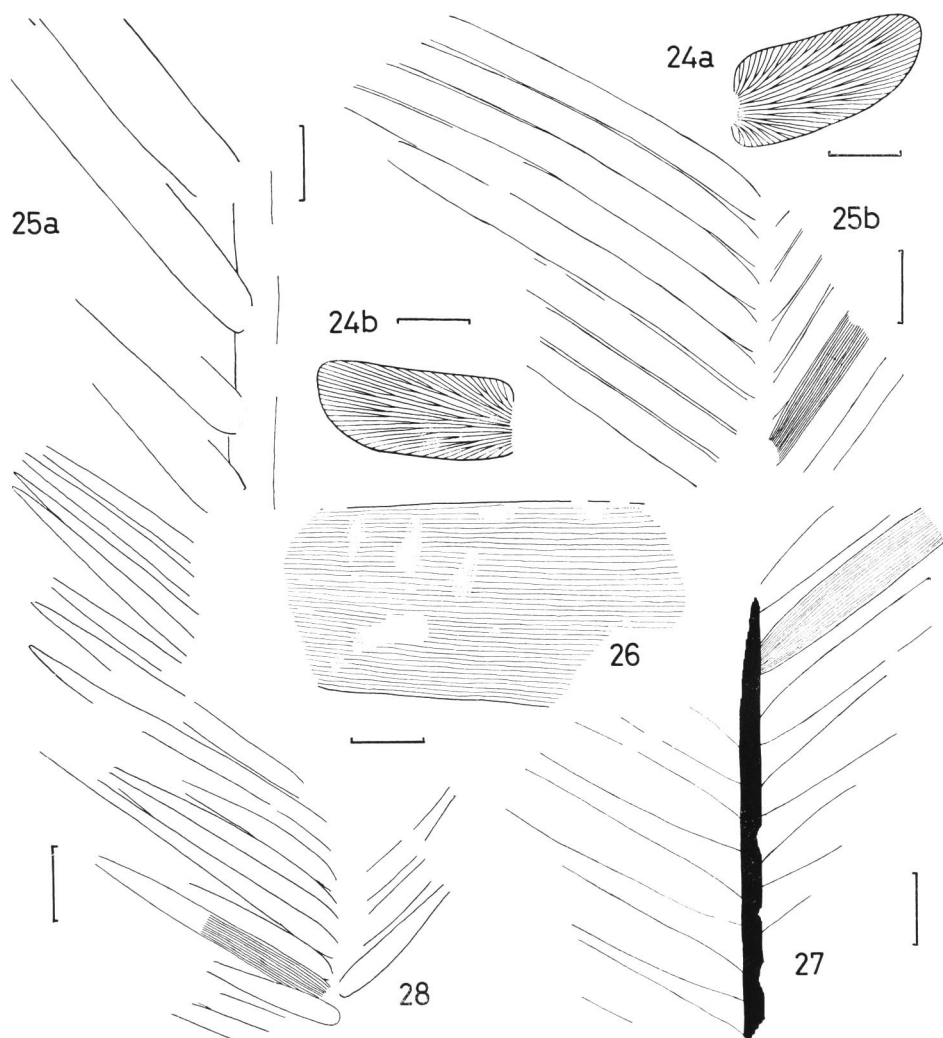
Description: A few pinna fragments were obtained. Their both ends are unknown. The pinnae are 2.8 cm wide. The veins are delicate, simple, parallel and 16 per cm in density.

Remarks: The present pinna fragments resemble closely those described by OISHI (1940) as Cf. *Zamites megaphyllus* from Oshima (corresponding to our Loc. no. 4) and those described by KIMURA and OHANA (1988a, 1989b) as *Z. sp. cf. Z. megaphyllus* from the Upper Jurassic Tochikubo and Oginohama Formations respectively.

***Zamites nipponicus* KIMURA et OHANA**

(Fig. 27)

Cf. *Zamites feneonis* BRONGNIART: OISHI, 1940, p. 355 (pars), pl. 38, fig. 1.
Glossozamites cf. hoheneggeri (SCHENK): OYAMA, 1954, p. 106, pl. 5, fig. 8.



Figs. 24–28 (Each bar indicates 1 cm scale)

24. *Otozamites* sp. cf. *O. kondoi* OISHI: Two detached pinnae with densely crowded veins. 24a; NSM PP-8808, 24b; NSM PP-8807.
25. *Zamites* sp. cf. *Z. choshiensis* KIMURA et OHANA: Two leaf fragments. 25a; each pinna is attached to the upper surface of rachis with semi-amplexicaul base; NSM PP-8811, 25b; NSM PP-8814.
26. *Zamites* sp. cf. *Z. megaphyllus* (PHILLIPS) SEWARD: A pinna fragment; NSM PP-8818.
27. *Zamites nipponicus* KIMURA et OHANA: A poorly preserved leaf-fragment (wrong side view); NSM PP-8819.
28. *Zamites* sp. cf. *Z. tosanus* OISHI: A poorly preserved leaf-fragment; NSM PP-8820.

Zamites nipponicus KIMURA et OHANA: KIMURA and OHANA, 1988a, p. 121, pl. 6, figs. 2–3; pl. 7, fig. 3; figs. 13a–c: 1989a, p. 14, pl. 2, fig. 4; pl. 4, fig. 3; pl. 5, figs. 2–3.

Material: NSM PP-8819. *Horizons and localities*: Lower part (Loc. no. 1) and upper part (Loc. no. 2) of the Moné Formation. *Occurrence*: Rather rare.

Remarks: The present leaves agree well with those of *Zamites nipponicus* originally described by KIMURA and OHANA (1988a) from the Upper Jurassic Tochikubo Formation and later (1989a) from Oginohama Formation.

Zamites nipponicus resembles in external leaf-form *Z. feneonis* emended by BARALE (1981) on the basis of many French specimens with preserved cuticle. But the former is distinguished from the latter having pinnae attached to the rachis at narrower angle and veins crowded.

***Zamites* sp. cf. *Z. tosanus* OISHI**

(Fig. 28)

Material: NSM PP-8820, 8821. *Horizon and locality*: Middle part of Kogoshio Formation. Loc. no. 7. *Occurrence*: Locally common.

Remarks: The present leaves resemble those of *Zamites* sp. cf. *Z. choshiensis* described in this paper, but differ from the latter in the mode of insertion of pinnae; that is, in the latter, pinnae are attached to the upper surface of the rachis by the concave semi-amplexicaul base.

The present leaves are most close in leaf-form and size to those of *Zamites tosanus* originally described by OISHI (1940) and later by KIMURA and OHANA (1987a) from the Lower Cretaceous plant-beds in the Outer Zone of Japan. However, we refrain to identify them with OISHI's species, because of their poor preservation.

Genus *Pterophyllum* BRONGNIART, 1828

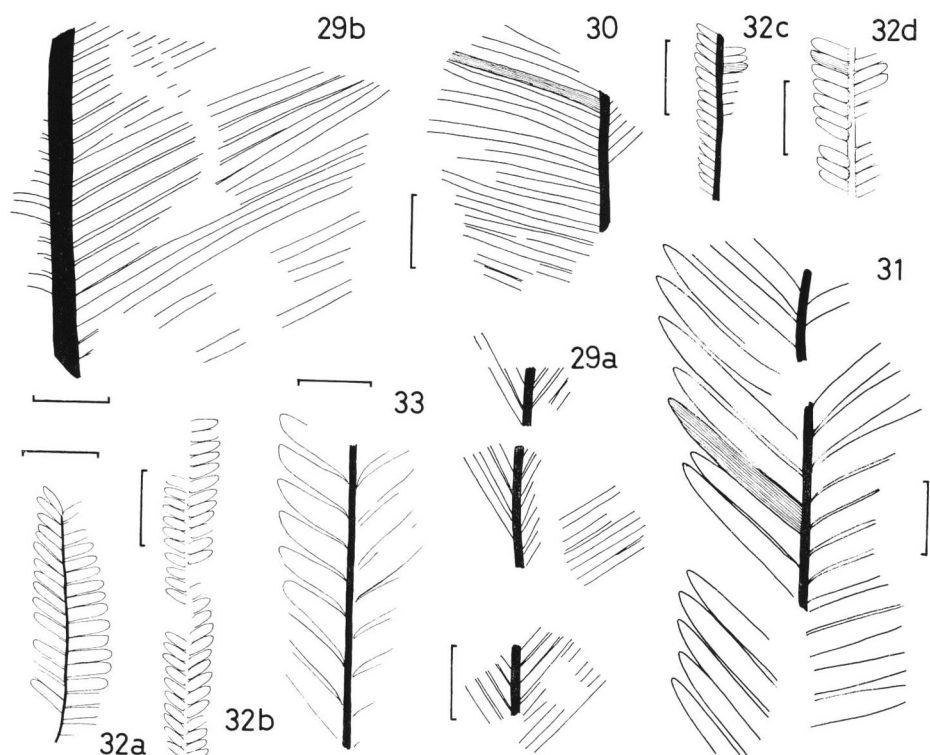
***Pterophyllum* sp. A**

(Figs. 29a–b)

Material: NSM PP-8822~8827. *Horizon and localities*: Middle part of the Kogoshio Formation. Loc. nos. 7 and 8. *Occurrence*: Rather rare.

Description: The leaves are rather medium-sized. The pinnae are long and narrow, 5 cm long and 2 mm wide at middle, and attached to the lateral sides of rachis at an angle of about 60 degrees. The veins are indistinct, several and parallel.

Remarks: Although the present leaves are poorly preserved and the veins are indistinct, it is highly probable that they belong to *Pterophyllum* because the pinnae are not constricted at base and are attached to the lateral sides of rachis. Externally the present leaves remind us of those of *Cycadites*, but differ from the latter in having parallel veins in each pinna.



Figs. 29–33 (Each bar indicates 1 cm scale)

29. *Pterophyllum* sp. A: Two leaf-fragments with long and narrow pinnae. 29a; NSM PP-8826, 29b; NSM PP-8822.
30. *Ptilophyllum linearifolium* KIMURA et OHANA: A poorly preserved leaf-fragment (wrong side view); NSM PP-8829.
31. *Ptilophyllum oshikaense* KIMURA et OHANA: A poorly preserved leaf-fragment (wrong side view); NSM PP-8831.
32. *Ptilophyllum* sp. G: Typical leaf-forms (32a–d), 32a; NSM PP-8834, 32b; NSM PP-8837B, 32c; NSM PP-8833B, 32d; NSM PP-8837A.
33. *Ptilophyllum* sp. I: A poorly preserved leaf-fragment (wrong side view); NSM PP-8839.

Genus *Ptilophyllum* MORRIS, 1840

Ptilophyllum linearifolium KIMURA et OHANA

(Fig. 30)

Ptilophyllum pecten (PHILLIPS) MORRIS: OISHI, 1940, p. 348 (pars), pl. 35, fig. 1: Hirata, 1972, pl. 17.

Ptilophyllum linearifolium KIMURA et OHANA: KIMURA and OHANA, 1989a, p. 53, pl. 9, figs. 1–4; figs. 16a–c.

Material: NSM PP-8828~8830. *Horizons and localities:* Lower part of the Moné Formation (Loc. no. 3) and middle part of the Kogoshio Formation (Loc. nos. 7 and 4).

Remarks: *Ptilophyllum linearifolium* is characterized by its markedly elongate and narrow pinnae. The present leaves, though poorly preserved, agree well with those of *Ptilophyllum linearifolium* originally described by KIMURA and OHANA (1989a).

This species, though not so abundant in occurrence, is one of the characteristic ones in the Ryoseki-type floras.

***Ptilophyllum oshikaense* KIMURA et OHANA**

(Fig. 31)

Ptilophyllum oshikaense KIMURA et OHANA: KIMURA and OHANA, 1989b, p. 55, pl. 9, figs. 5–8; pl. 10, figs. 1–3; pl. 12, fig. 1; figs. 17a–g.

Material: NSM PP-8831, 8832. *Horizon and locality:* Middle part of the Kogoshio Formation. Loc. no. 7. *Occurrence:* Rather rare.

Remarks: A few leaf-fragments were obtained. They are referable to those of *Ptilophyllum oshikaense* established by KIMURA and OHANA (1989b) on the basis of a number of specimens collected from the Upper Jurassic Oginohama Formation.

***Ptilophyllum* sp. G**

(Figs. 32a–d)

Ptilophyllum sp. G: KIMURA and OHANA, 1988b, p. 155, pl. 10, fig. 3; figs. 17a–b.

Material: NSM PP-8833~8838. *Horizons and localities:* Middle part (Loc. no. 7) and lower part (Loc. no. 9) of the Kogoshio Formation. *Occurrence:* Locally common.

Description: The leaves look small-sized from the preserved pieces. The pinnae are finger-shaped, 4–6 mm long and 1–1.5 mm wide, with obtusely pointed or rounded apex, and attached to the upper sides of rachis. The veins are usually indistinct, 4–5 in number in each pinna.

Remarks: The present leaves are characterized by their small size. They resemble those of *Ptilophyllum* sp. G described by KIMURA and OHANA (1988b) from the Tochikubo Formation, in leaf-form and size, but are somewhat different from the latter in less crowded veins.

Although they resemble the ultimate branches of *Nipponoptilophyllum ryosekiense* of bipinnate habit, originally described by OHANA *et al.* (1989) from the Lower Cretaceous plant-bed in the Outer Zone of Southwest Japan, yet they are different in less crowded veins.

It is difficult to determine these small-sized leaves without preserved cuticle. Therefore, the species we tentatively regard as *Ptilophyllum* sp. G.

Similar leaves have been described as *Ptilophyllum* cf. *cutchense* MORRIS (NATHORST, 1890), *P. cutchense* MORRIS (YABE, 1927), *P. pecten* (PHILLIPS) MORRIS (OISHI,

1940), *P. ex gr. pecten* (PHILLIPS) MORRIS (KIMURA and KANSHA, 1978b), *P. sp.* (KIMURA, 1976) and *Nilssonia pterophylloides* YOKOYAMA (non NATHORST) (YOKOYAMA, 1894) from the Upper Jurassic-Lower Cretaceous plant-beds in the Outer Zone of Japan.

At present careful reexamination of these small-sized *Ptilophyllum* leaves is requested.

***Ptilophyllum* sp. I**

(Fig. 33)

Material: NSM PP-8839~8842. *Horizon and locality*: Middle part of the Kogoshio Formation. Loc. no. 7. *Occurrence*: Rare.

Description: Several leaf-fragments were obtained and none of them was complete. The pinnae are rectangular in outline, typically 1.2 cm long and 4 mm wide, attached alternately to the upper sides of rachis at an angle of 55 degrees, decurrent and with obtusely pointed or rounded apex. The veins are invisible.

Remarks: It is highly probable that the present leaves belong to *Ptilophyllum*, because their pinnae are attached to the upper sides of rachis with decurrent base.

Similar leaves have been known from the Lower Cretaceous plant-beds in the Outer Zone of Japan.

Cycadales (or Nilssoniales)

Genus *Nilssonia* BRONGNIART, 1825

Nilssonia sp. cf. *N. canadensis* BELL

(Figs. 34a-c)

Cf. *Nilssonia orientalis* HEER: NATHORST, 1890, p. 5, pl. 1, figs. 4-5.

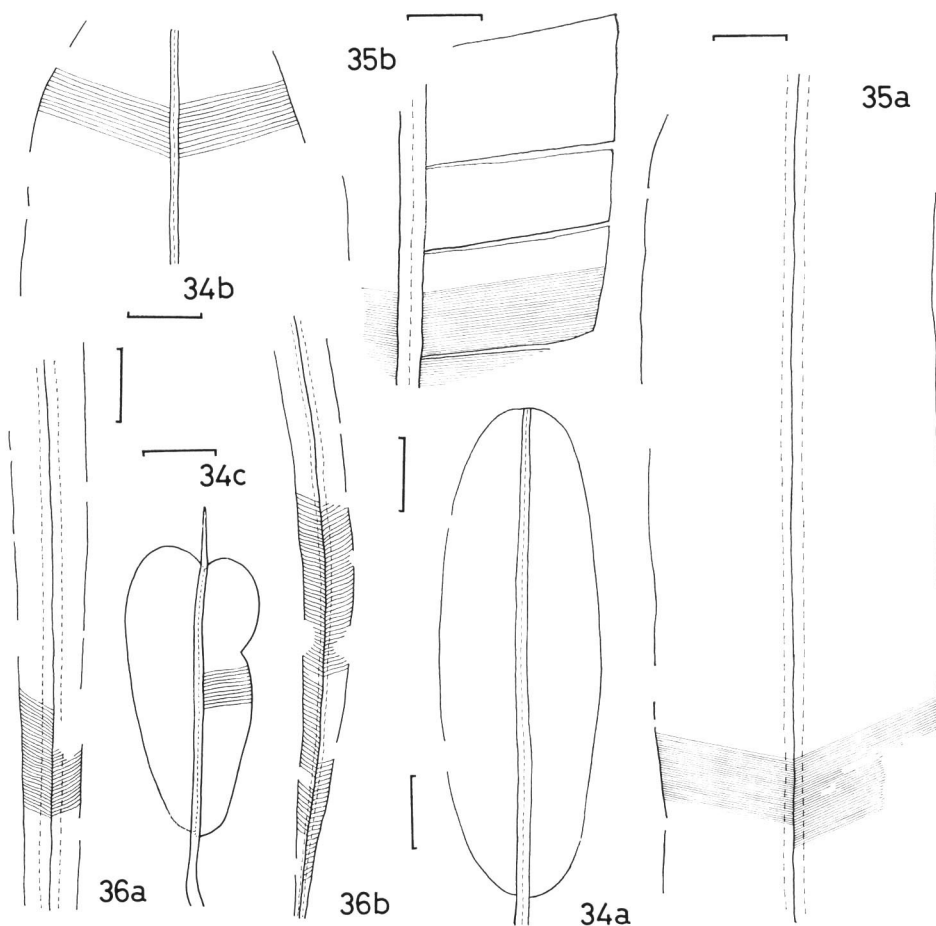
Nilssonia orientalis HEER: OISHI, 1940, p. 307 (pars), pl. 26, figs. 2-3.

Nilssonia sp. cf. *N. canadensis* BELL: KIMURA and OHANA, 1988b, p. 156, pl. 11, figs. 1-3; figs. 22a-d: OHANA *et al.*, 1989, p. 57, figs. 7-10, 14-18.

Material: NSM PP-8859, 8861, 8862, 8866, 8868. *Horizon and locality*: Middle part of the Kogoshio Formation. Loc. no. 8. *Occurrence*: Rare.

Description: The laminae cover the upper surface of rachis entirely and are elliptical, 6.5 cm long or more and up to 4.5 cm wide with rather stout rachis and short petiole with rounded apex and rounded or wedge-shaped base. The veins are simple, parallel and 14-16 per cm in density. Lamina is usually entire, but sometimes dissected irregularly. In some small-sized leaves, the rachis is projected beyond the emarginate apex (Fig. 34c).

Pemaks: KIMURA and OHANA (1988b) made the detailed description of *Nilssonia* sp. cf. *N. canadensis* BELL on the basis of a number of specimens collected from the Upper Jurassic Tochikubo Formation. Externally the present leaves agree well with those from the Tochikubo Formation.



Figs. 34–36 (Each bar indicates 1 cm scale)

34. *Nilssonia* sp. cf. *N. canadensis* BELL: Showing varied leaf-forms and rather coarser veins (all wrong side view). 34a; NSM PP-8859, 34b; NSM PP-8861, 34c; NSM PP-8860.
35. *Nilssonia* sp. cf. *N. densinervis* (FONTAINE) BERRY: Showing the laminae with entire margins (35a) and irregularly dissected margins (35b). 35a; NSM PP-8866, 35b; NSM PP-8867.
36. *Nilssonia* sp. cf. *N. nigracollensis* WIELAND: Showing long and narrow leaves with entire margins and coarser veins. 36a; NSM PP-8853, 36b; NSM PP-8846.

***Nilssonia* sp. cf. *N. densinervis* (FONTAINE) BERRY**

(Figs. 35a–b)

Nilssonia densinerve (FONTAINE) BERRY: OISHI, 1940, p. 300, pl. 24, figs. 2–4.

Nilssonia densinervis (FONTAINE) BERRY: KIMURA and KANSHA, 1978b, p. 174, pl. 2, fig. 6; fig. 13.

Nilssonia sp. cf. *N. densinervis* (FONTAINE) BERRY: KIMURA and OHANA, 1987b, p. 131, pl. 9, fig. 3; text-figs. 37a–b: 1988b, p. 160, pl. 9, fig. 4; pl. 11, figs. 4–8; figs. 23a–c. *Material*: NSM PP-8863~8868. *Horizon and locality*: Middle part of the Kogoshio Formation. Loc. nos. 7 and 8. *Occurrence*: Locally common.

Description: The leaves are elongated, more than 12 cm long and 5 cm wide. The laminae cover the upper surface of entire rachis; the margins are entire or irregularly dissected into rectangular segments. The veins are delicate, simple and parallel, and originate at an angle of 70–80 degrees to the rachis.

Remarks: The present leaves remind us of those of *Nilssonia orientalis* HEER (HEER, 1878) and *N. japonica* KIMURA et TSUJII (KIMURA and TSUJII, 1983), but differ in having rectangular segments almost without rounded distal margin.

Owing to the lack of preserved cuticle, it is difficult to make specific identification of the present leaves and therefore we regard them as *Nilssonia* sp. cf. *N. densinervis*, because being externally closest to those of *Nilssonia densinervis*.

Similar leaves have been recorded from the Upper Jurassic-Lower Cretaceous plant-beds in the Outer Zone of Japan and from the Middle Jurassic Utano Formation. *Nilssonia densinervis* (FONTAINE) described by KRASSILOV (1967) from the Lower Cretaceous of Southern Primorye is externally indistinguishable from the present species.

Nilssonia sp. cf. *N. nigracollensis* WIELAND

(Figs. 36a–b)

Material: NSM PP-8846, 8849, 8853, 8854. *Horizon and locality*: Middle part of the Kogoshio Formation. Loc. no. 7. *Occurrence*: Locally abundant.

Description: The leaves are small. The laminae cover the upper surface of rachis completely and are long, narrow, belt-like in form, narrowed gradually toward the base, with rounded apex and entire margins, more than 7 cm long and up to 1 cm wide. The veins are distinct, simple, parallel and originated at an angle of 60–70 degrees to the rachis, and 18–24 per cm in density. They slightly curve upward near the margin of lamina.

Remarks: The present leaves are characterized by long and narrow lamina with entire margins and less crowded veins, and therefore they are distinguished easily from those of *Nilssonia* ex gr. *schaumburgensis*.

The leaves described here resemble in external form and size those of *Nilssonia nigracollensis* WIELAND described by FONTAINE (in WARD, 1905) from the Upper Jurassic (or Lower Cretaceous) of Oregon and by BELL (1956) from the Lower Cretaceous of Western Canada. But at present we refrain from making their identity to the North American species.

Nilssonia ex gr. *schaumburgensis* (DUNKER) NATHORST

(Figs. 37a–f)

Japanese specimens hitherto described:

Nilssonia cf. *schaumburgensis* (DUNKER) NATHORST: NATHORST, 1890, p. 5, pl. 1, figs. 6–9a.

Nilssonia *schaumburgensis* (DUNKER) NATHORST: YOKOYAMA, 1894, p. 227, pl. 20, figs. 12, 14; pl. 21, fig. 14; pl. 22, figs. 5–7; OISHI, 1949, p. 311, pl. 27, figs. 5–11; pl. 28, fig. 2.

Nilssonia ex gr. *schaumburgensis* (DUNKER) NATHORST: KIMURA, 1976, p. 202, pl. 3, fig. 5; figs. 14a–c, h–k; KIMURA and KANSHA, 1978b, p. 175; KIMURA and MATSUKAWA, 1979, p. 106, pl. 4, figs. 8–9; figs. 12a–c; KIMURA and OHANA, 1988b, p. 164, pl. 12, fig. 3; pl. 13, figs. 2–6; pl. 14, figs. 4–5; figs. 26a–h; 1989b, p. 59.

Material: NSM PP-8843~8845, 8847~8848, 8850~8852, 8855~8858.

Horizon and localities: Middle part of the Kogoshio Formation. Loc. nos. 7 and 8.

Occurrence: Locally abundant.

Description: The leaves obtained are all detached, varied in size and form, long, narrow, more than 15 cm long and up to 1.2 cm wide, nearly parallel-sided for the most part, but gradually narrowed proximally, passed to a somewhat stout petiole, about 1.5 cm long, with rounded apex. The laminae cover upper surface of rachis completely with entire or irregularly dissected margins. The veins are densely crowded, nearly perpendicular to the rachis, simple, parallel and 36–52 per cm in density. Figs. 37a–f show varied leaf-forms.

Remarks: The present leaves agree well with those described by KIMURA and OHANA (1988b) as *Nilssonia* ex gr. *schaumburgensis* from the Upper Jurassic Tochikubo Formation in their leaf-size, form and venation.

Similar leaves are abundant in the Ryoseki-type floras in Japan, but the Late Jurassic leaves are generally larger in size than the Early Cretaceous leaves.

Judging from the varied leaf-forms, it is highly probable that *Nilssonia* ex gr. *schaumburgensis* is an aggregative species, but unfortunately the leaves obtained so far have no preserved cuticles.

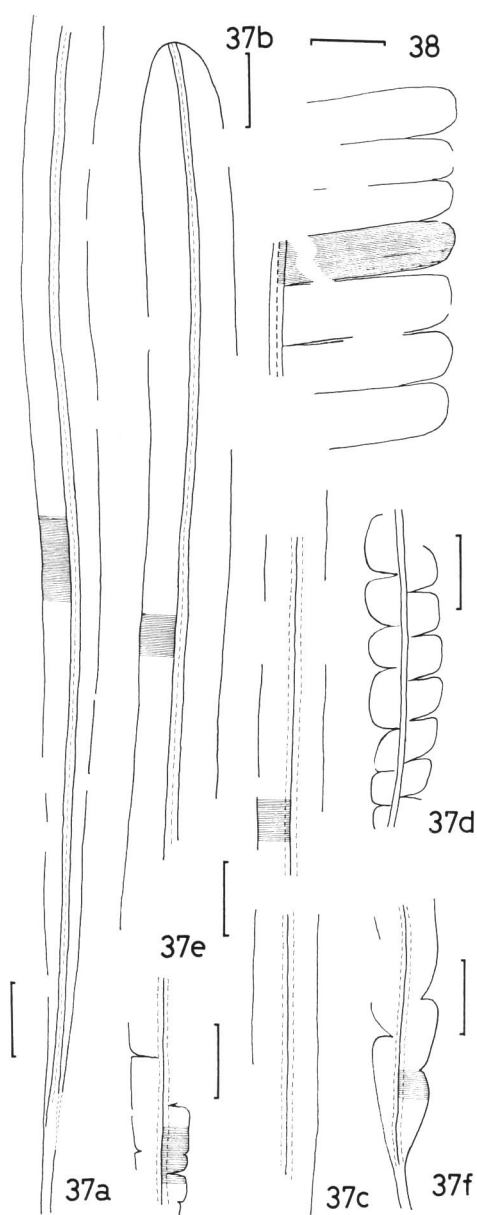
Nilssonia ex gr. *schaumburgensis* is one of the characteristic forms in the Ryoseki-type floras and has not been recorded so far in the coeval Tetori-type floras in East Asia.

Nilssonia sp. A

(Fig. 38)

Material: NSM PP-8869~8873. *Horizon and locality*: Middle part of the Kogoshio Formation. Loc. no. 7. *Occurrence*: Rare.

Description: The leaves obtained are fragmental. The laminae cover the upper surface of rachis completely and are deeply dissected regularly into transversely rectangular pinnae. The pinnae are 2.3 cm long and 6–7 mm wide and with broadly



Figs. 37–38 (Each bar indicates 1 cm scale)

37. *Nilssonia* ex gr. *schaumburgensis* (DUNKER) NATHORST: Varied leaf-forms and densely crowded veins. 37a; NSM PP-8843, 37b; NSM PP-8850, 37c; NSM PP-8844, 37d; NSM PP-8847, 37e–f; NSM PP-8851.
38. *Nilssonia* sp. A: A poorly preserved leaf-fragment; NSM PP-8873.

rounded apex. The veins are delicate, simple, parallel and 38–42 per cm in density. *Remarks:* The present leaves are characterized by the regularly dissected rectangular pinnae with delicate and crowded veins, and thus are distinguished from those of *Nilssonia* sp. cf. *N. densinervis* described in this paper.

The present leaves somewhat resemble those of *Nilssonia pseudomediana* DOBRUSKINA described by KRASSILOV (1967) from the Lower Cretaceous of Southern Primorye, but differ from the latter in having much crowded veins (vein-density of *Nilssonia* leaves is fairly variable even in the same species).

Coniferales

Form-genus *Elatocladus* HALLE, 1913

Elatocladus sp. C

(Fig. 39)

Material: NSM PP-8874~8879. *Horizon and locality:* Middle part of the Kogoshio Formation. Loc. no. 8. *Occurrence:* Rare.

Description: Several leafy-shoot fragments were obtained. The leaves are bifacial and spirally disposed, but expanded in approximately the same plane by twisting of the decurrent leaf-bases. The leaves are linear, oblanceolate or elongate-elliptical in outline, uninerved, 2 cm long and up to 3 mm wide, constricted at base with obtusely pointed apex; the midvein is expanded from the leaf-apex to form a short spine-like protrusion.

Remarks: The present leafy-shoots remind us of those of extant *Cephalotaxus*. The present leafy-shoots differ from those of *Elatocladus* sp. A and *E.* sp. B known from the Tochikubo and Oginohama Formations respectively in much larger and oblanceolate leaves.

Genus *Frenelopsis* SCHENK em. REYMANOWNA et WATSON

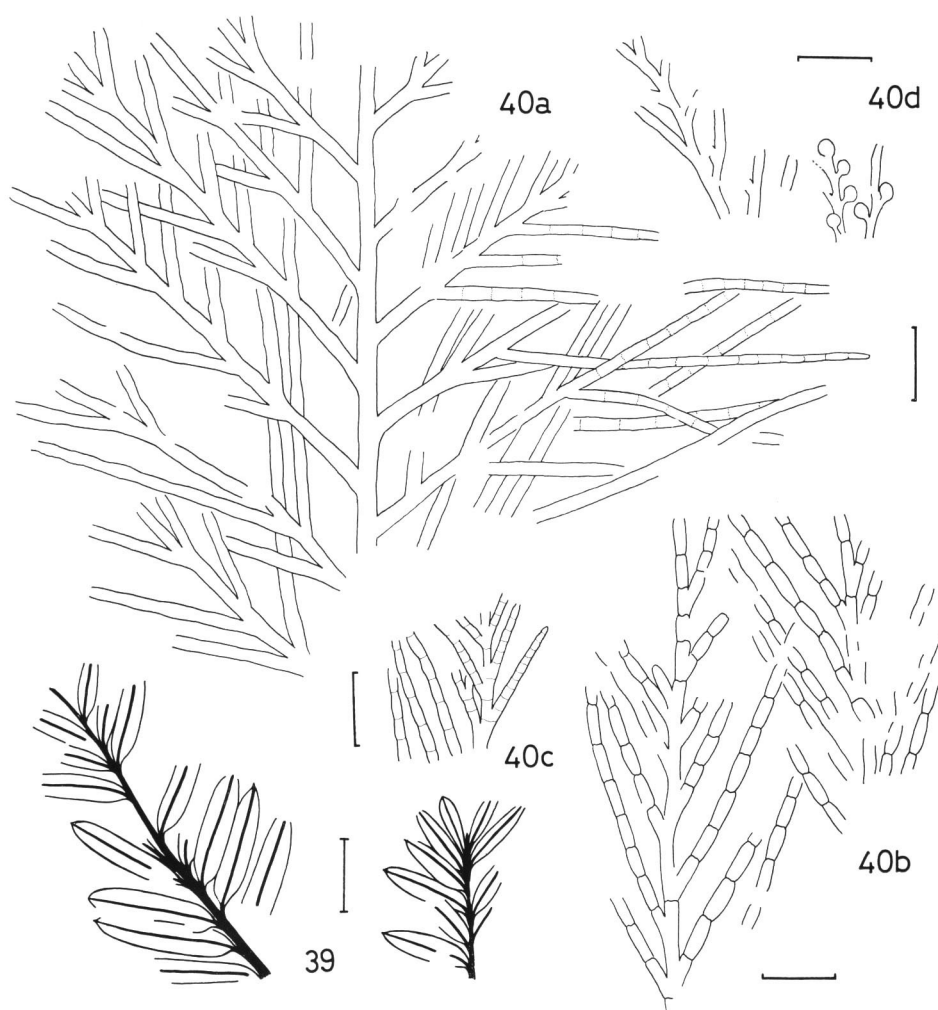
Frenelopsis sp. cf. *F. choshiensis* KIMURA, SAIKI et ARAI

(Figs. 40a–d)

Frenelopsis cf. *hoheneggeri* (ETTINGSHAUSEN) SCHENK: YABE, 1922, p. 27, pl. 3, figs. 6–7; text-fig. 26.

Frenelopsis hoheneggeri (ETTINGSHAUSEN) SCHENK: OISHI, 1940, p. 388, pl. 30, fig. 2b; pl. 40, figs. 2–4.

Material: NSM PP-8899~8921. *Horizons and localities:* Lower part (Loc. nos. 9 and 10) and middle part (Loc. nos. 4 and 8) of the Kogoshio Formation. *Occurrence:* Locally abundant. Sometimes thickly massed and appressed on the bedding planes. *Description:* Many large-sized leafy-shoots were obtained. They are articulate, pinnate, repeatedly branched 3–4 times in the same plane at an angle of 45 degrees to the axis-shoot at intervals of about 1 cm. The ultimate branch-shoots are long



Figs. 39–40 (Each bar indicates 1 cm scale)

39. *Elatocladus* sp. C: Two detached leafy-shoots on the same bedding plane; NSM PP-8874.
40. *Frenelopsis* sp. cf. *F. choshiensis* KIMURA, SAIKI et ARAI: Branched leafy-shoots (40a–c) and the circular bodies (40d). 40a; NSM PP-8918, 40b–c; NSM PP-8911, 40d; NSM PP-8900.

and narrow, more than 5 cm long and 1.4 mm wide at base, then gradually narrowed toward the rounded apex. The internodes are typically 5 cm long and 2 mm wide. Two oppositely arranged small-sized leaves are recognizable at each node. Sometimes the length of internode is markedly reduced, in some 1–1.5 mm long. At the marginal part of a large leafy-shoot, there can be seen shortened ultimate branches each with

a circular terminal body, 2 mm in diameter.

Remarks: KIMURA *et al.* (1985) originally described *Frenelopsis choshiensis* from the Lower Cretaceous Choshi Group in the Outer Zone of Japan, on the basis of its external form and preserved cuticle. The shoots of *Frenelopsis choshiensis* are characterized by the opposite and decussate leaves.

Externally the present leafy-shoots, though they are poorly preserved, are very close to those of *Frenelopsis choshiensis* especially in opposite and decussate disposed leaves at each node. However, we could not find the 'paired secondary branches' as seen in the original specimen of *Frenelopsis choshiensis*. Owing to the poor preservation of our leafy-shoots, we at present regard them as *Frenelopsis* sp. cf. *F. choshiensis*.

It is highly probable that *Frenelopsis* cf. *hoheneggeri* and *F. hoheneggeri* described by YABE (1922) and OISHI (1940) from Oshima (corresponding possibly to our Loc. nos. 4–6) respectively and from the Lower Cretaceous Ayukawa Formation (OISHI, 1940) belong to *Frenelopsis* sp. cf. *F. choshiensis*, though they also are poorly preserved. Unfortunately details of the circular bodies are uncertain.

Form-genus *Brachyphyllum* BRONGNIART, 1828

Brachyphyllum sp. A

(Figs. 41a–b)

Material: NSM PP-8880~8898. *Horizon and locality:* Lower part of the Kogoshio Formation. Loc. no. 9. *Occurrence:* Locally common.

Description: Many branch fragments were obtained together with those *Frenelopsis* sp. cf. *F. choshiensis*. The branches are covered with spirally disposed scale leaves. The ultimate branches arise alternately at an angle of about 45 degrees from the penultimate branches, 2.5 cm long and 3 mm wide at base. Toward the apex of ultimate branch, the leaves are reduced in size and are decussate.

Remarks: Judging from the external features of our specimens, it is true that they belong to the form-genus *Brachyphyllum*. But nothing can be added to our description mentioned above, because we do not have more information on the present specimens. Nevertheless, *Brachyphyllum* is one of the characteristic forms of the Ryoseki-type floras in the Outer Zone of Japan, and is absent in the Tetori-type floras in the Inner Zone of Japan.

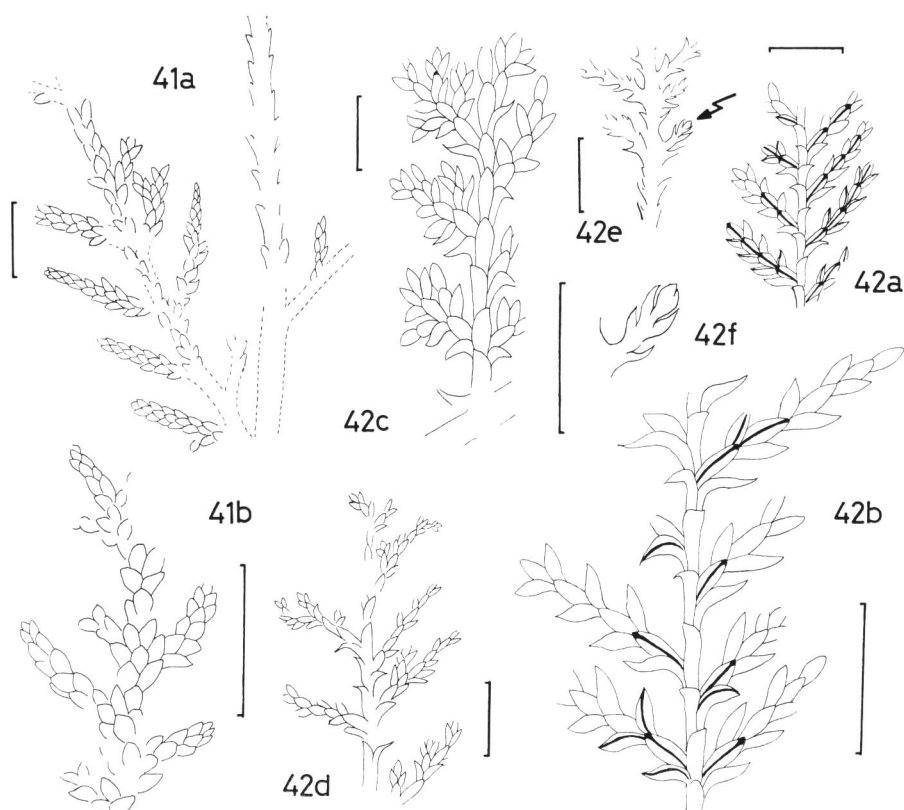
Form-genus *Cupressinocladus* SEWARD, 1919

Cupressinocladus koyatoriensis OISHI

(Figs. 42a–f)

Cupressinocladus koyatoriensis OISHI: OISHI, 1940, p. 397, pl. 42, figs. 1, 1a; KIMURA and OHANA, 1989b, p. 60, pl. 11, fig. 5; figs. 19a–b.

Material: NSM PP-8922~8928. *Horizon and locality:* Lower part of the Moné



Figs. 41–42 (Each bar indicates 1 cm scale)

41. *Brachyphyllum* sp. A: Two sterile branched leafy-shoots. 41a–b; NSM PP-8881.
 42. *Cupressinocladus koyatoriensis* OISHI: Branched leafy-shoots (42a–d), and an axillary young cone (?) (42e, indicated by an arrow) and its enlargement (42f). 42a; NSM PP-8924, 42b; NSM PP-8927, 42c; NSM PP-8928, 42d; NSM PP-8923, 42e–f; NSM PP-8925.

Formation. Loc. no. 3. *Occurrence*: Locally abundant.

Remarks: A number of leafy-shoot fragments were obtained. They are thickly massed and appressed on the bedding planes. They agree well with those of *Cupressinocladus koyatoriensis* originally described by OISHI (1940) from the Upper Jurassic Oginoama Formation and later by KIMURA and OHANA (1989b) from the same formation.

Cupressinocladus koyatoriensis is characterized by its one pair of the decussate scaly leaves appressed to the axis and the other pair is free except at the base.

The leafy-shoots of *Cupressinocladus pseudoexpansum* originally described by BARNARD and MILLER (1976) from the Middle Jurassic of Iran is externally indistinguishable from the present leafy-shoots.

Cupressinocladus, though it is a non-committal form-genus, is also one of the characteristic genera in the Ryoseki-type floras and has not been recorded in the Tetori-type floras in Japan.

Cupressinocladus sp. C

(Figs. 43a–b)

Cupressinocladus sp. C: KIMURA and OHANA, 1987a, p. 22, pl. 1, figs. 5–7; figs. 8a–b: 1989b, p. 60.

Material: NSM PP-8929~8934. *Horizon and localities*: Lower part of the Moné Formation. Loc. nos. 1 and 3. *Occurrence*: Locally abundant.

Description: A number of broken leafy-shoots were obtained. They are sometimes thickly massed and appressed on the same bedding plane. The leafy-shoots are delicate in habit, repeatedly branched 4–6 times with a very narrow angle and bearing opposite and decussate small scaly leaves. The ultimate shoots are 4 cm long and 1 mm wide and the leaves are typically 1.2 mm long and 0.6 mm wide.

A single vertically elongated cone (?) is present as shown in Fig. 43b, but its details are uncertain.

Remarks: The present leafy-shoots agree well with those of *Cupressinocladus* sp. C known from the Lower Cretaceous Ayukawa Formation (KIMURA and OHANA, 1987a) in all respects.

The present leafy-shoots occur together with those of *Cupressinocladus koyatoriensis*, but the former are distinguished by their delicate leaves all appressed to the axis.

Our leafy-shoots resemble those of *Cupressinocladus mimotoi* originally described by KIMURA and OHANA (1987a) from the Lower Cretaceous Upper Monobegawa Formation (Aptian-Albian in age) and later by OHANA *et al.* (1989) from the lower part of the Monobe (or Lower Monobegawa) Formation (early Barremian in age), but the latter is distinguished by its branches inserted at a wide angle.

The leafy-shoots of *Cupressinocladus japonicus* (YOKOYAMA) described by KIMURA and MATSUKAWA (1979) from the Sebayashi Formation (Aptian in age) are also distinguished from the present leafy-shoots by its leaf-form. In addition, the former species has a circular cone terminally on each branch-shoot.

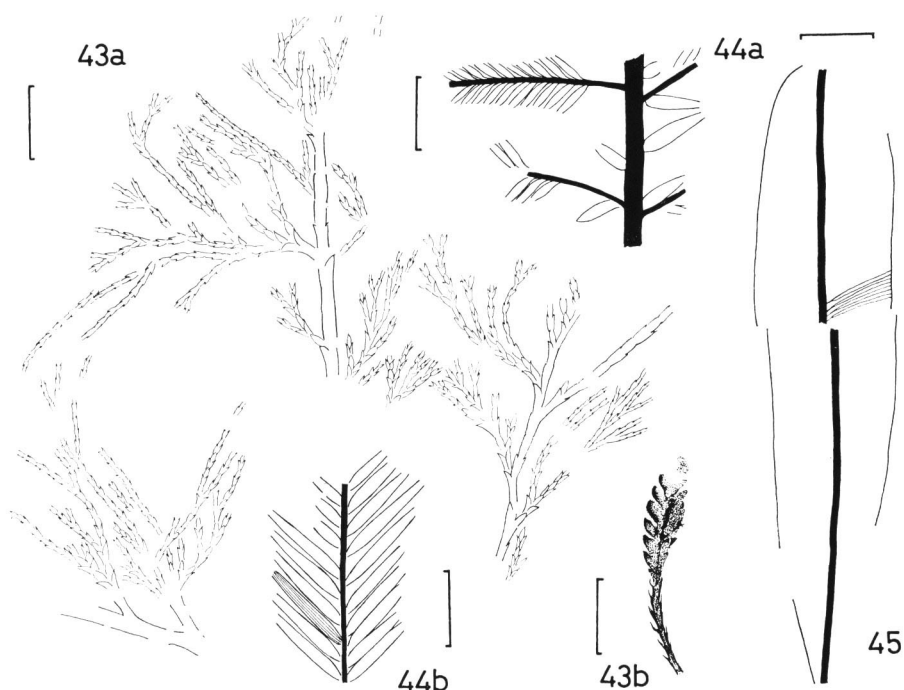
Genus *Parasequoia* KRASSILOV, 1967

Parasequoia sp. cf. *P. cretacea* KRASSILOV

(Figs. 44a–b)

Parasequoia sp. cf. *P. cretacea* KRASSILOV: KIMURA and OHANA, 1988b, p. 170, pl. 16, figs. 5–6; figs. 30a–b: 1989b, p. 60, pl. 12, fig. 3; pl. 13, fig. 1; figs. 20a–b.

Material: NSM PP-8935~8941. *Horizon and locality*: Lower part of the Moné Formation. Loc. no. 3. *Occurrence*: Rather rare.



Figs. 43–45 (Each bar indicates 1 cm scale)

43. *Cupressinocladus* sp. C: Branched leafy-shoots (43a) and a single vertically elongated cone (?) with leafy-peduncle (43b). 43a; NSM PP-8930, 43b; NSM PP-8929.
 44. *Parasequoia* sp. cf. *P. cretacea* KRASSILOV: A part of branched leafy-shoots (44a) and the leaf-form and venation (44b). 44a–b; NSM PP-8937.
 45. *Taeniopteris* sp. G: A poorly preserved leaf (or pinna); NSM PP-8943.

Remarks: KIMURA and OHANA (1989b) illustrated fine specimens as *Parasequoia* sp. cf. *P. cretacea* from the Oginohama Formation (collected by H. FURUOYA). The present leafy-shoots, though they are represented by tiny fragments, agree well with those of *Parasequoia* sp. cf. *P. cretacea* in all respects.

Unclassified plant

Form-genus *Taeniopteris* BRONGNIART, 1828

Taeniopteris sp. G

(Fig. 45)

Material: NSM PP-8942~8945. **Horizon and locality:** Middle part of the Kogoshio Formation. Loc. no. 7. **Occurrence:** Locally common.

Description: Many detached leaves (or pinnae ?) were obtained. They are ribbon-like or spatula-like in outline with entire margins, typically 9 cm long and up to 1.7

cm wide. The laminae are attached to the lateral sides of axis. The veins originate at a wide angle to the axis, forked dichotomously near the base, parallel and 18–22 per cm in density.

Remarks: Some of the present leaves (or pinnae ?) resemble those of *Taeniopteris* sp. F described by KIMURA and OHANA (1989b) from the Oginohama Formation, but differ from those of the latter by having spatulate form, instead of gradually narrowed apical half in the latter. Therefore, we in the meantime regard the present leaves (or pinnae ?) as *Taeniopteris* sp. G.

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