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Late Jurassic plants from the Tochikubo Formation (Oxfordian), Somanakamura Group, in the Outer Zone of Northeast Japan.* II

By

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(Continued from the previous number)

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Genus *Ptilophyllum* MORRIS, 1840: 327

Ptilophyllum jurassicum KIMURA et OHANA sp. nov.

Pl. 8, figs. 1–3; Pl. 9, figs. 1–2;
Pl. 10, fig. 1; Figs. 15a–d

Ptilophyllum pecten (PHILLIPS): OISHI, 1940, p. 348 (pars), pl. 35, fig. 3 (Kami-Manomura, possibly from the Tochikubo Formation).

Material: Holotype; NSM PP-8260 (Shidasawa). Paratypes; NSM PP-8258, 8259, 8260 (ditto). Examined specimens; NSM PP-8261～8285 and 54 other specimens. *Stratum typicum*: Tochikubo Formation. *Locus typicus*: Nakayashiki, Shidasawa. *Occurrence*: Locally abundant at Shidasawa, Aratozawa and rather rare at Bunasaka. *Derivatio nominis*: According to the derivation of this species from the Jurassic (Oxfordian) sediments.

Diagnosis: Leaf medium-sized, more than 14 cm long and up to 6 cm wide. (Whole leaf unknown.) Rachis rather thin in the middle part of a leaf, 2 mm wide, but becoming thicker to the petiole, up to 4 mm wide, sending alternately or suboppositely off closely set pinnae at an angle of 75 degrees from the upper sides of rachis;angle reduced apically. Pinnae long and narrow, straight, parallel-sided for the most part, narrowing abruptly to the obtusely pointed apex; both acroscopic and basiscopic basal margins straight, but sometimes acroscopic basal angle slightly rounded; typically 3 cm long and up to 5 mm wide at base; pinnae on the proximal part becoming shorter. Veins originated from whole of base, simple, running in parallel, not converging at apex, typically 15 in number in each pinna (50 per cm in density), but 13 in the proximal pinnae. (Reproductive organs not known.)

Discussion and *comparison*: According to our careful examination of a number of *Ptilophyllum* leaves collected from the Jurassic and Lower Cretaceous plant-beds in Japan, we have tended to establish *P. jurassicum* as a new species on the basis of numerous specimens derived from the Tochikubo Formation.

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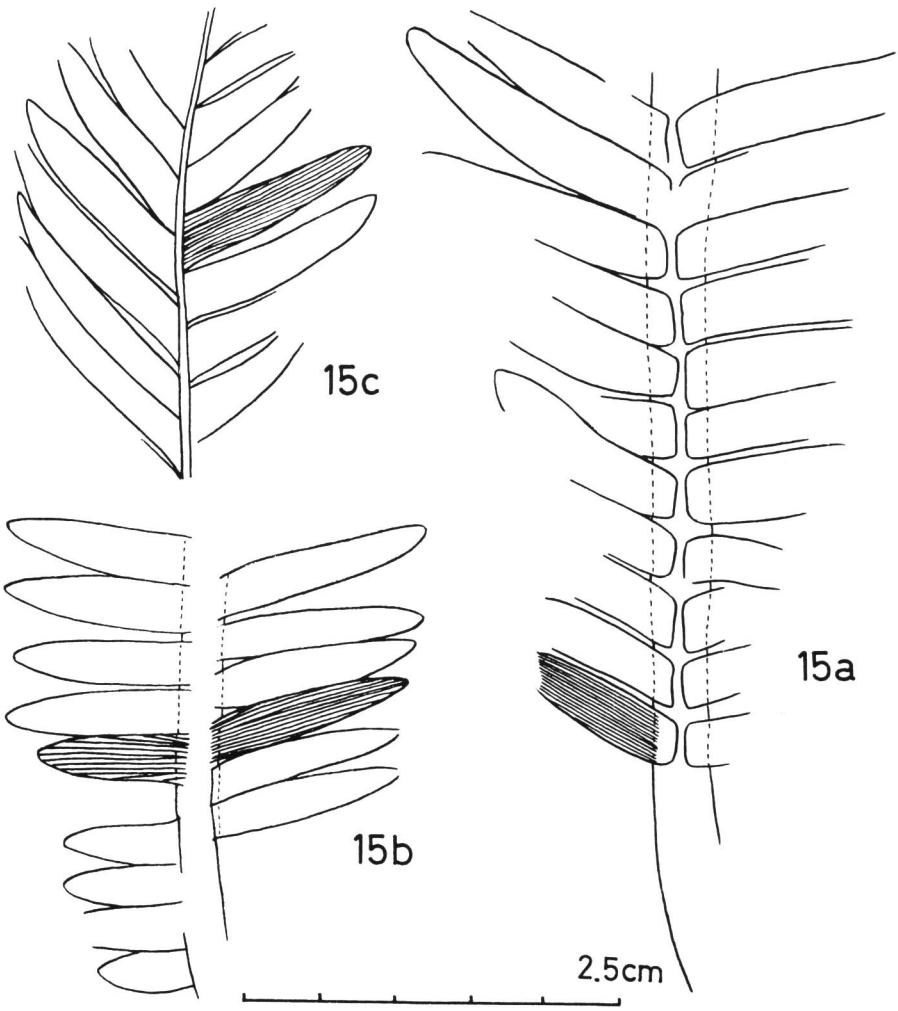
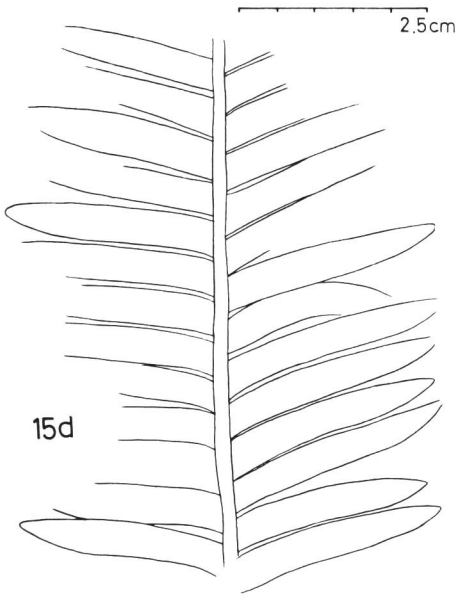


Figs 15a–d (a–c: Enlarged twice, d: Natural size). *Ptilophyllum jurassicum* KIMURA et OHANA sp. nov. 15a (NSM PP-8261). 15b (NSM PP-8259, paratype drawn partly from Pl. 8, fig. 2). 15c (NSM PP-8268). 15d (NSM PP-8257, holotype, drawn partly from Pl. 8, fig. 1). Loc. Shidasawa.

Ptilophyllum jurassicum is characterized by its medium-sized leaf bearing long and narrow pinnae of which the ratio of L/W is typically 5.8–(6.3)–6.8, but it is 4.7–(6.4)–(9.5) in the apical pinnae (Fig. 15c) and 2.4–(4.5)–6.0 in the proximal pinnae (Fig. 15b).

Ptilophyllum jurassicum is close to *P. kochiense* (KIMURA and OHANA, MS) and *P. oshikaense* (KIMURA and OHANA, MS), but differs from *P. kochiense* bearing more narrower pinnae and from *P. oshikaense* bearing more shorter and elongate-triangular pinnae.



OISHI (1940) described a *Ptilophyllum* leaf as *P. pecten* (PHILLIPS) (his pl. 35, fig. 3) from Kami-Mano-mura (possibly from the Tochikubo Formation). It agrees well with our *Ptilophyllum jurassicum*.

So far as the emended diagnosis and illustrations of *Ptilophyllum pecten* given by HARRIS (1969) on the basis of the leaves from the Middle Junrassic of Yorkshire are concerned, its pinnae are not elongated but shorter and small-sized, and no such elongated pinnae as those of *P. jurassicum* are shown in his illustrations. We are of the opinion that no *Ptilophyllum* leaves safely referable to those of *P. pecten* have been found in Japan.

Some leaves regarded by HARRIS (1969) as *Ptilophyllum pectinoides* (PHILLIPS), such as his fig. 26C resemble in pinna form and size those of *P. jurassicum*, but the former is distinguished by its gradually narrowing pinnae with small number of veins (8 in number in each pinna).

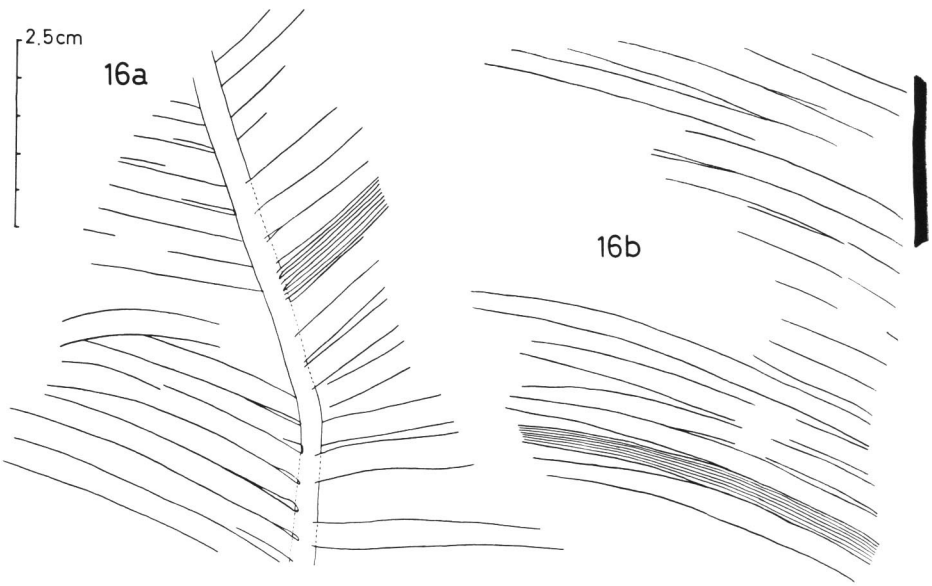
Cf. *Ptilophyllum* sp. A described by PERSON and DELEVORYAS (1982) from the Middle Jurassic of Oaxaca, Mexico resembles in external leaf-form and size *P. jurassicum*.

Ptilophyllum sp. F

Pl. 10, fig. 2; Figs. 16a–b

Material: NSM PP-8286～8288 (Aratozawa). *Occurrence*: Rare.

Description: Obtained are only three leaf-fragments. Of these, a leaf shown in Pl. 10, fig. 2 is the largest leaf-fragment preserved more or less twisty. The leaf is large-



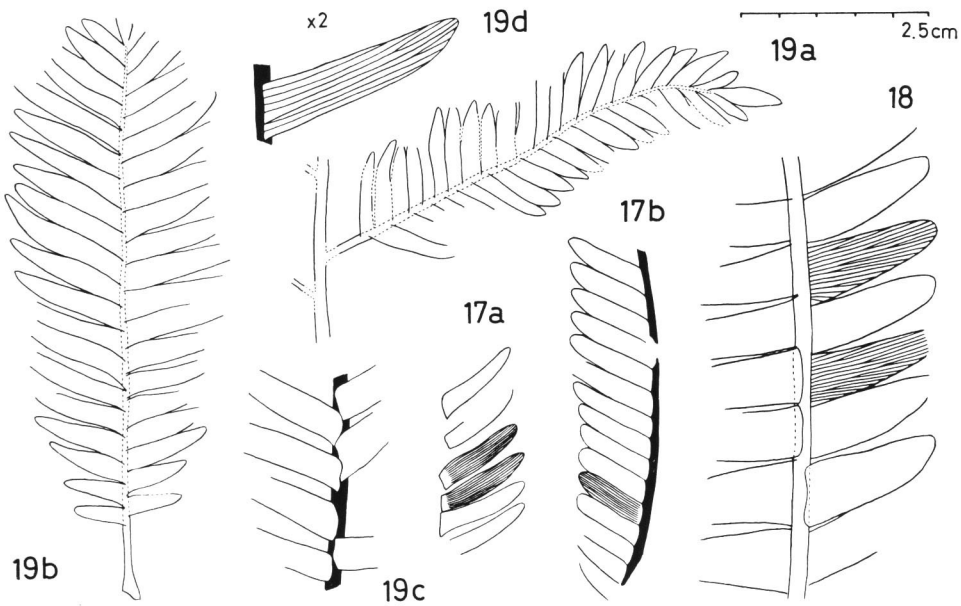
Figs. 16a–b (Natural size.) *Ptilophyllum* sp. F. 16a (NSM PP-8287, drawn partly from the counterpart of Pl. 10, fig. 2). 16b (NSM PP-8288). Loc. Aratozawa.

sized, more than 12 cm wide, with comparatively thick rachis, 3.5 mm wide. The pinnae are set closely, attached to the upper sides of rachis at an angle of about 70 degrees, long and narrow, up to 6.5 cm long, nearly parallel-sided for the most part, typically 3.5 mm wide, then narrowing gradually towards the acutely pointed apex. Pinna base is asymmetric; its basiscopic basal margin is slightly decurrent and acroscopic one contracted and forming a round angle, but not forming an auricle. The veins arise from whole region of attachment, simple, parallel, ending near the apex; typically 7 in number in each pinna. Reproductive organs are not known.

Remarks: We assigned our leaves to *Ptilophyllum* because their pinnae are attached to the upper sides of rachis and the basiscopic basal margin of pinna, although not so marked, decurrent and acroscopic one is contracted and rounded.

Our *Ptilophyllum* sp. F is characterized by its large-sized leaf bearing long and narrow pinnae. Among various *Ptilophyllum* species hitherto described, most close is Cf. *P. acutifolium* MORRIS described by PERSON and DELEVORYAS (1982) from the Middle Jurassic of Oaxaca, Mexico. They included the large-sized leaves from Veracruz regarded by WIELAND (1914–16) as *Ptilophyllum acutifolium* var. *maximum* into their Cf. *P. acutifolium*. The broadest Mexican leaf is up to 8.5 cm wide and veins are typically 12 in number in each pinna. But our leaves are distinguished from the Mexican leaves by far larger size and small number of veins in each pinna.

Ptilophyllum acutifolium var. *maximum* described by FEISTMANTEL (1877, p. 117, pl. 40, figs. 1–5) from Rajmahal Hills is also similar in leaf-form and is characterized



Figs. 17–19 (Natural size, unless otherwise indicated).

17. *Ptilophyllum* sp. G. 17a–b (NSM PP-8289, drawn from Pl. 10, fig. 3). Loc. Aratozawa.
18. *Ptilophyllum* sp. H (NSM PP-8290, slightly twisted in preservation, drawn from Pl. 9, fig. 3). Loc. Umenokizawa.
19. *Nipponoptilophyllum bipinnatum* KIMURA et TSUJII (Reinserted from KIMURA and TSUJII, 1984). 19a, b, d (NSM PP-8399, holotype, originally ARA-875). 19c (NSM PP-8401, paratype, originally ARA-391). Loc. Aratozawa.

by its large-sized leaves, but is distinguished by its narrower leaves (8 cm wide) than ours and its pinnae with markedly decurrent base and rounded acroscopic basal angle.

BOSE and KASAT (1972) regarded FEISTMANTEL's variety as *Ptilophyllum acutifolium* and illustrated one leaf as the largest one so far collected from India (their fig. 115). According to their emended diagnosis given to *Ptilophyllum acutifolium*, the leaf-width is 4–10.5 cm. Thus, our leaves are far broader than those of Indian *Ptilophyllum acutifolium*.

Ptilophyllum sp. G

Pl. 10, fig. 3; Figs. 17a–b

Material: NSM PP-8289 (Aratozawa). *Occurrence*: Only two leaf-fragments on a single small slab.

Description: Leaf is small-sized, up to 2.2 cm wide, nearly parallel-sided, for the most part. Pinnae are set closely, attached at an angle of 65 degrees to the upper sides of slender rachis, 1 mm wide; elongate-rectangular in form, typically 1.2 cm long

and 2.5 mm wide for the most part and with rounded apex; acroscopic basal margin is straight or slightly contracted and basiscopic basal margin is slightly decurrent. Veins are 9 in number in each pinna, simple, running in parallel, ending at the distal margins. Reproductive organs are not known.

Remarks: *Ptilophyllum* sp. G is characterized by its closely set elongate rectangular pinnae with rounded apex. *Ptilophyllum* sp. G resembles in pinna form and size *P. cutchense* MORRIS (e.g. BOSE and KASAT, 1972) and *P.* sp. D (from the Lower Cretaceous Choshi Group; KIMURA *et al.*, 1988 MS), but is distinguished by its simple veins, instead of slightly radiate and forked veins in the latter two.

Ptilophyllum sp. G also resembles in pinna form and size *P.* sp. cf. *P. cutchense* MORRIS (KIMURA and OHANA, 1987b; KIMURA and TSUJII, 1982), but is distinguished by its pinnae with vein-number as twice as the latter.

Therefore, we now think that *Ptilophyllum* sp. G is distinct, but we reserve to give it a new specific name, because it is represented only by two leaf-fragments.

Ptilophyllum sp. H

Pl. 9, fig. 3; Fig. 18

Material: NSM PP-8290~8293 (Umenokizawa). *Occurrence*: Rare.

Description: The whole leaf is uncertain because obtained are only four ill-preserved leaf-fragments, but the pinna form and venation are characteristic. The pinnae are attached suboppositely and nearly perpendicularly to the upper sides of rachis by whole base, closely set, rectangular in form; pinna apex is obliquely truncated or rounded and is neither auriculate nor decurrent at base. The veins are 13 in number at pinna base, then radiating and forking once or rarely twice. Reproductive organs are not known.

Remarks: We think that it is appropriate to place our leaves in *Ptilophyllum*, although in our pinnae, acroscopic base is not contracted and basiscopic base is not decurrent. The venation of our pinnae is of *Ptilophyllum hirsutum*-type. In fact, *Ptilophyllum* sp. H resembles *P. hirsutum* THOMAS et BANCROFT (HARRIS, 1949, 1969) in its pinnae of similar size, without decurrent base, and venation. But *Ptilophyllum hirsutum* is distinguished from *P.* sp. H by its more elongate pinnae with slightly contracted acroscopic base.

Genus *Nipponoptilophyllum* KIMURA et TSUJII, 1984: 385

Nipponoptilophyllum bipinnatum KIMURA et TSUJII

Figs. 19a–d

Nipponoptilophyllum bipinnatum KIMURA et TSUJII: KIMURA and TSUJII, 1984, p. 385, figs 1–10

Material: Holotype; NSM PP-8399 (formerly ARA-875). Paratypes; NSM PP-8400~8406 (formerly ARA-876, 391, 432, 456, 573, 576, 773 respectively). Examined specimens; NSM PP-8407~8418 and 30 other specimens. *Occurrence*: Locally

abundant at Aratozawa.

Remarks: This species is represented by the leaves of bipinnate habit and is characterized by the elongate-oblanceolate or elongate-obovate penultimate pinnae. The forms of the penultimate and ultimate pinnae are unique and are different from the leaves and pinnae of other *Ptilophyllum* species known in Japan.

Detailed description of this species was already made by KIMURA and TSUJII (1984). Very recently the second *Nipponoptilophyllum* species was found from the Lower Cretaceous Monobe Formation, Kochi Prefecture.

Order Cycadales

Genus *Pseudoctenis* SEWARD, 1911: 691

Pseudoctenis brevipennis OISHI

Pl. 14, fig. 1; Figs. 20a–b

Pseudoctenis brevipennis OISHI: OISHI, 1940, p. 322, pl. 28, figs. 5–7 (Zusahara and Ishigami-mura, possibly from the Tochikubo Formation).

Material: NSM PP-8294, 8295 (Shidasawa). *Occurrence*: Rare.

Description: Obtained are only two leaf-fragments of which pinnae are set rather closely, oblong in form, typically 2.8 cm long and up to 0.75 cm wide, with rounded apex and slightly contracted base, and attached suboppositely to the lateral sides of slender rachis. Veins are 10 in number at base, dichotomously forked repeatedly; acroscopic two sets and basiscopic three sets of veins radiating, and ending at the lateral margins of pinna.

Remarks: OISHI (1940) founded this species on the basis of three broken leaves. Our leaves are somewhat different from OISHI's original ones in some minor points as mentioned below: In OISHI's leaves, pinnae are set closely, rather smaller in size, typically 2.5 cm long and 5–7 mm wide and veins are less in number (8–10 in each pinna) and quite prominent. The veins of our pinnae are not so prominent and we now think that this is due to the disimilarity of the mode of preservation. Further leaves are expected because both the original and our leaves are represented only by a few leaf-fragments.

Pseudoctenis sp. A

Pl. 8, fig. 4; Fig. 21

Material: NSM PP-8296, 8297 (counterpart of 8296) (Aratozawa).

Occurrence: Very rare.

Description: Obtained is a single leaf-fragment which is thought to be an apical portion of leaf with 7 subopposite pairs of pinnae incompletely preserved. Pinnae are rather remotely set, attached to the lateral sides of slender axis at an angle of 55 degrees, but angle reducing apically. Pinna form is uncertain, because pinna apices are all missing, but pinnae are narrowed gradually towards the base and decurrent; maximum pinna width preserved is 5 mm. Veins are prominent, 5 in number at base;

forking dichotomously and running in parallel, 10–11 in number at the preserved tip.
Remarks: The general feature of our leaf resembles that of *Pseudoctenis* sp. described by KIMURA *et al.* (1986) from the upper Liassic Nishinakayama Formation, but the pinnae of the latter are far narrower.

OISHI (1940) described the leaves as *Pseudoctenis lanei* THOMAS from the Upper Jurassic Oginohama Formation, but it is diffcult to make detailed comparison of our leaf with them because of the incompleteness of our pinnae.

Genus *Nilssonia* BRONGNIART, 1825: 200

Nilssonia sp. cf. *N. canadensis* BELL

Pl. 11, figs. 1–3; Figs. 22a–d

Cf. *Nilssonia orientalis* HEER: NATHORST, 1890, p. 5, pl. 1, figs. 4–5 (Lower Cretaceous Ryoseki Formation).

Nilssonia orientalis HEER: OISHI, 1940, p. 307 (pars), pl. 26, figs. 2–3 (Upper Jurassic Kogoshio or Moné Formation).

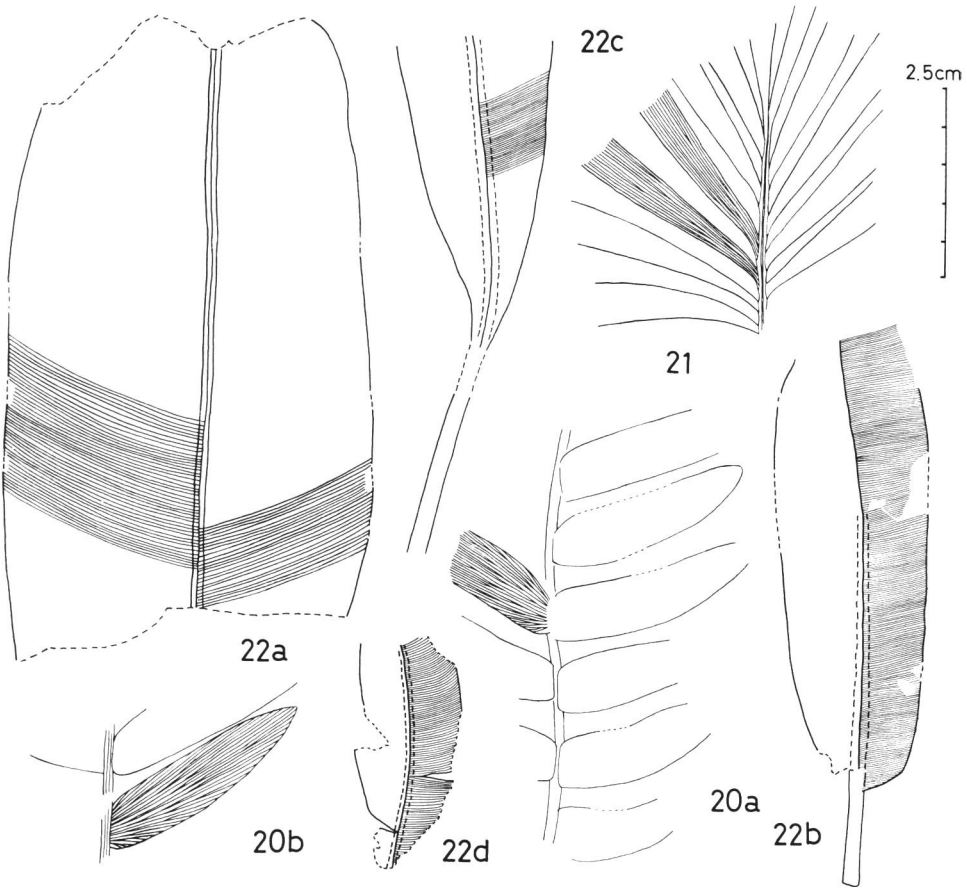
Material: NSM PP-8298～8301 (Shidasawa), 8302 (Aratozawa), 8303 (Okushidasawa) and 18 other specimens. *Occurrence*: Locally common at Shidasawa, but rather rare at Aratozawa and Bunasaka.

Description: The leaves obtained are all detached and broken, variable in size and with long petiole, more than 2.9 cm long. The lamina covers completely upper surface of rachis, elongate-oblong in form, abruptly narrowing towards the the broadly rounded and shallowly notched apex, contracting to the rotund or narrowly cuneate base; the leaf-base is slightly asymmetric; margins are entire. The rachis is thick, typically 2 mm wide. The largest leaf is up to 4.9 cm wide and the smallest one is 1.2 cm wide. The veins are simple, nearly perpendicular or about 80 degrees to the rachis, running straight to the margin or slightly curved upwards near the margin. The vein-density is variable according to the leaf or to position on the same leaf, 11–40 per cm; generally denser in smaller leaves and coarser in larger ones.

Remarks: None of our leaves is complete, but a few show their base and apex. Our leaves are specifically most close to those of *Nilssonia canadensis* originally described by BELL (1956) from the Lower Cretaceous of Western Canada, but don't fully agree with Bell's original leaves as follows: 1) BELL's rachises are more thicker (up to 4 mm wide). 2) In BELL's leaves, their apices are bluntly pointed or narrowly rounded. 3) In BELL's leaves, the vein-density is 10–18 per cm and the occasional veins are forked at their origin or on the course to the margin.

Under the circumstances, we at present regard our leaves as *Nilssonia* sp. cf. *N. canadensis* BELL.

OISHI (1940) described similar leaves as *Nilssonia orientalis* HEER from the Upper Jurassic Kogoshio or Moné Formation (exact locality and horizon are uncertain). They are referable to our *Nilssonia* sp. cf. *N. canadensis*, because his illustrated leaves



Figs. 20–22 (Natural size).

20. *Pseudoctenis brevipennis* OISHI. 20a (NSM PP-8294, drawn from Pl. 14, fig. 1). 20b (NSM PP-8295). Loc. Shidasawa.
21. *Pseudoctenis* sp. A (NSM PP-8296, drawn from Pl. 8, fig. 4). Loc. Aratozawa.
22. *Nilssonia* sp. cf. *N. canadensis* BELL. 22a (NSM PP-8300, drawn from Pl. 11, fig. 1). 22b (NSM PP-8299, drawn from Pl. 11, fig. 2). Loc. Shidasawa. 22c (NSM PP-8303). Loc. Upper course of the Shidasawa. 22d (NSM PP-8302). Loc. Aratozawa.

as shown in his pl. 26, fig. 2 (basal part of a leaf) and fig. 3 (small-sized leaves) are indistinguishable from our corresponding leaves.

NATHORST (1890) described similar medium-sized laeves as Cf. *Nilssonia orientalis* from the Lower Cretaceous Ryoseki Formation (Togodani locality). They are also indistinguishable from our corresponding leaves.

Many *Nilssonia* leaves collected from Togodani locality are kept in the Makino Botanical Garden, Kochi City. They are also indistinguishable from our present leaves.

Nilssonia orientalis is, in fact, one of the allied species to our *N.* sp. cf. *N. canadensis*, but its original leaves described by HEER (1878) are distinguished from our leaves by their small size, their irregularly undulated lateral margins and their deeply notched apex. KIMURA and TSUJII (1983) pointed out that the specific definition of *Nilssonia orientalis* had conveniently been expanded by some of previous authors.

The distinction between *Nilssonia canadensis* and its allied species, such as *N. iohnstrupi* HEER, *N. taeniopteroides* HALLE, *N. yukonensis* HOLLICK and *N. densinervis* (FONTAINE) BERRY has already been discussed by BELL (1956). In addition, KIMURA and TSUJII (1983) discussed the systematic distinction among the taenioid (or belt-like) *Nilssonia* leaves hitherto described.

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

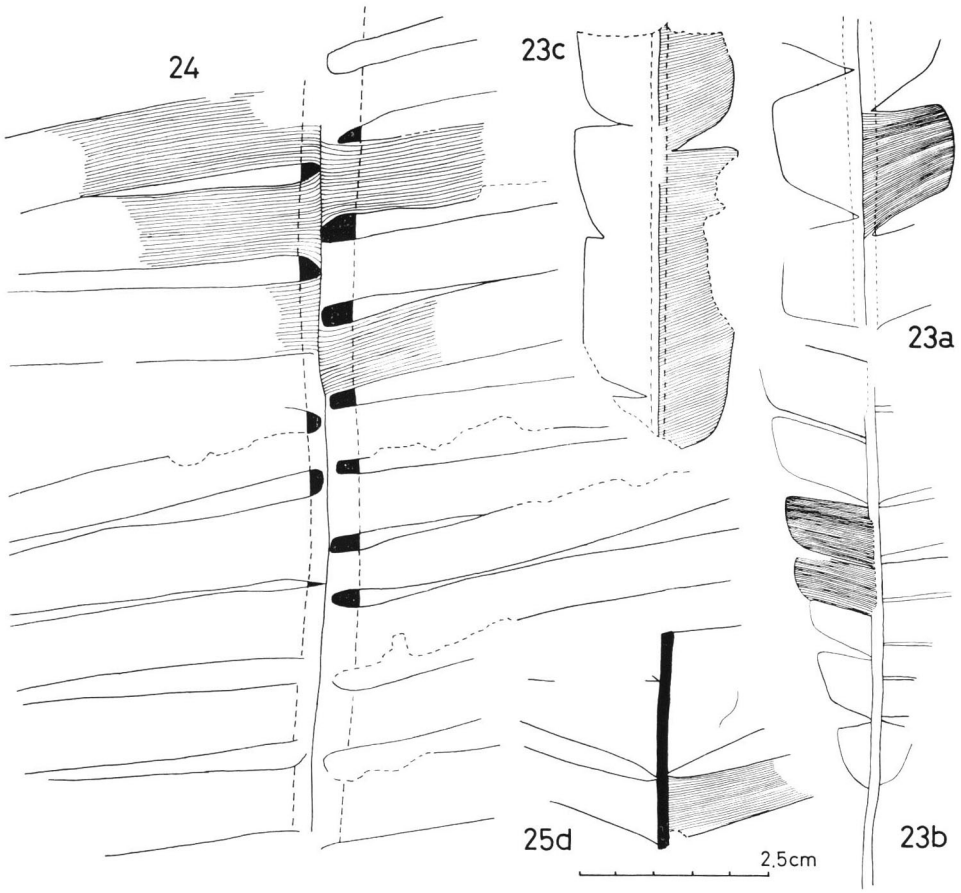
Pl. 9, fig. 4; Pl. 11, figs. 4–8; Figs. 23a–c

Material: NSM PP-8304 (Shidasawa), 8305, 8306 (Bunasaka), 8307～8310 (Aratozawa) and 19 other specimens. *Occurrence*: Locally common at Aratozawa and rather rare at Shidasawa and Bunasaka.

Description: Obtained are all detached broken leaves which are petioled and variable in size and form. The lamina covers entirely the upper surface of thick rachis and is elongate-obovate in outline, typically dissected rather regularly into segments of varying width by the sinuses reaching the rachis except occasional leaves of which the laminae are irregularly dissected by shallow or deep sinuses (Fig. 23c). The segments are rectangular, irregularly quadrilateral or subrhombic in outline and their upper margin is mostly straight, but their lower margin is convex forming a broad angle towards the outer margin which is sometimes truncated. The tip of the leaf was in no case found. The veins are simple, straight and perpendicular to the rachis, but the lower ones in each segment bend upwards near the outer margin of segment. The veindensity is also variable according to the leaf, typically 50–60 per cm; generally coarser in large leaf and denser in small leaf. The largest leaf is more than 10 cm long, nearly parallel-sided for the most part, and up to 4 cm wide. Its lamina is irregularly segmented by deep or shallow sinuses (Pl. 11, fig. 8). Its rachis is up to 3.5 mm wide and its veins are invisible. Pl. 11, fig. 5 (Fig. 23c) shows an unusual leaf-fragment in which the lamina is irregularly segmented by sinuses not reaching to the rachis as mentioned above.

Remarks: *Nilssonia densinervis* was first described by FONTAINE (1889) from the Lower Cretaceous Potomac Group as *Platypteridium densinerve* and *P. rogerisianum*. Most FONTAINE's original leaves including those of his *Platypteridium rogerisianum* are similar and most close in leaf-form and mode of segmentation of lamina to our leaves, but they are markedly large-sized [70 cm long and 15–18 cm wide, according to BERRY (1911)]. As no such large-sized leaf has been found in our collection, we at present regard our leaves specifically as *Nilssonia* sp. cf. *N. densinervis*.

OISHI (1940) and KIMURA and KANSHA (1978) described similarly sized leaf-frag-



Figs. 23–25(d) (Natural size).

23. *Nilssonia* sp. cf. *N. densinervis* (FONTAINE) BERRY.
23a (NSM PP-8305, drawn from Pl. 11, fig. 4). Loc. Bunasaka.
23b (NSM PP-8309, drawn from Pl. 11, fig. 7). 23c (NSM PP-8310, drawn from Pl. 11, fig. 5). Loc. Aratozawa.

24. *Nilssonia longipinnata* KIMURA et OHANA sp. nov. (NSM PP-8311, holotype, drawn partly from Pl. 12, fig. 1). Loc. Bunasaka.

25d. *Nilssonia oblique-truncata* KIMURA et OHANA sp. nov. (NSM PP-8327). Loc. Aratozawa.

ments from the Lower Cretaceous Yuasa Formation in the Outer Zone of Southwest Japan as *Nilssonia densinerve* and *N. densinervis* respectively. Medium-sized leaves were also described by OISHI (1940) and KIMURA and OHANA (1987b) from the Middle Jurassic Utano Formation as *Nilssonia densinerve* and *N.* sp. cf. *N. densinervis* respectively.

Pl. 11, fig. 6 resembles closely in leaf-form and mode of segmentation of lamina a laef illustrated by KRASSILOV (1967) from the Lower Creatceous of Southern Primorye

as *Nilssonia densinervis*.

So far as the leaf-size and mode of segmentation of lamina are concerned, *Nilssonia nicanica* PRYNADA described by KRASSILOV (1967) from the Lower Cretaceous of Southern Primorye resembles our *N.* sp. cf. *N. densinervis*, but it might be distinguished by its segments not with obliquely rounded outer margin but mostly with obliquely truncated and sometimes very shallowly undulated outer margin.

OISHI (1940) and other previous authors once compared *Nilssonia densinervis* with *N. princeps* (OLDHAM et MORRIS) in leaf-size, form and mode of segmentation, but according to the recent knowledge of this Indian species (e.g. BOSE and BANERJI, 1981), its mode of segmentation of lamina is quite different from that of other *Nilssonia* species.

Nilssonia longipinnata KIMURA et OHANA sp. nov.

Pl. 12, fig. 1; Pl. 13, fig. 1; Fig. 24

Material: Holotype; NSM PP-8311 (Bunasaka). Paratypes; NSM PP-8312 (Bunasaka), 8313, 8314 (Aratozawa). Examined specimens; NSM PP-8315~8318 and 21 other specimens. *Stratum typicum*: Tochikubo Formation. *Locus typicus*: Bunasaka and Aratozawa. *Occurrence*: Locally common at Aratozawa, but rather rare at Bunasaka. *Derivatio nominis*: According to markedly elongate pinnae.

Diagnosis: Leaf large, more than 23 cm long and more than 12 cm wide. (Whole leaf unknown.) Rachis thick, 0.5 mm wide at middle, 0.75 cm wide at the basal part of leaf and 0.2 cm wide at the distal part of leaf, giving alternately off the pinnae at nearly right angle. Pinnae closely set, elongate-rectangular in form, typically 1 cm wide and more than 9 cm long, entirely covering the upper surface of rachis, both acroscopic and basiscopic bases expanded, and adjacent basal laminae often contiguous each other laterally. Veins simple, parallel, typically 21 (about 20 per cm) in number in each pinna. (Reproductive organs not known.)

Discussion and *comparison*: Many large-sized specimens were obtained, but none of them was complete. However, the leaf must have been very large. The present leaf is characterized by the parallel-sided and elongate pinnae nearly perpendicularly to the rachis. Judging from the isolated pinna fragments, the present pinnae are supposed to have been 20 cm long, but pinna apices are all missing.

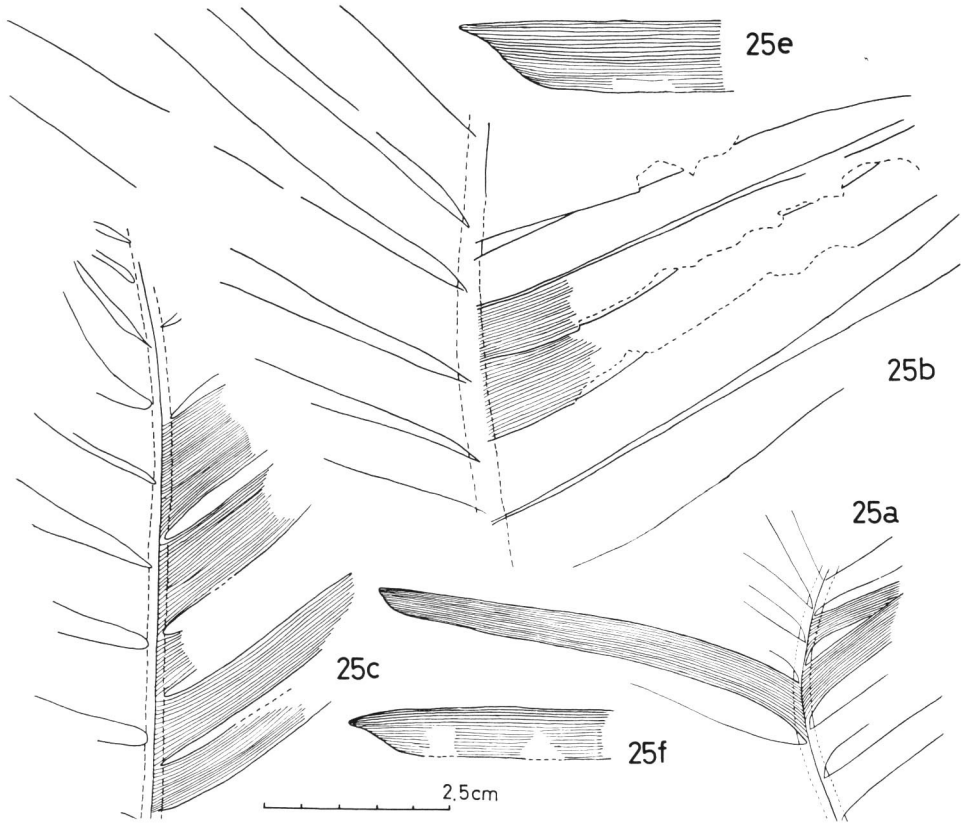
The present leaves are comparable with those of the following *Nilssonia* species:

Nilssonia syllis HARRIS from Yorkshire (HARRIS, 1964) is distinguished by its pinnae, typically not exceeding 5 cm long and gradually tapering distally.

Nilssonia pterophylloides NATHORST (NATHORST, 1879) is distinguished by its obliquely set and narrower and shorter pinnae (5–10 cm long), gradually tapering towards the apex and with small number of veins (5–7 in number in each pinna).

Nilssonia linearis SZE (SZE, 1933) is distinguished by its narrower and widely spread pinnae.

Nilssonia valentinae IMINOV (IMINOV, 1976) is distinguished by its obliquely set



Figs. 25(a–c, e–f) (Natural size).
Nilssonia oblique-truncata KIMURA et OHANA sp. nov.
25a (NSM PP-8319, holotype, drawn from Pl. 12, fig. 2).
25b (NSM PP-8320, paratype, drawn partly from Pl. 14, fig. 2).
25c (NSM PP-8321, drawn from Pl. 5, fig. 5). 25e–f (NSM PP-8321, paratype, drawn from Pl. 14, fig. 3). Loc. Aratozawa.

and widely spaced pinnae with small number of veins (up to 15 in number in each pinna).

Under the circumstances, we here propose *Nilssonia longipinnata* sp. nov. to accommodate our leaves.

Nilssonia macrophylla and *N. polymorpha* var. *major* originally described by JACOB and SHUKLA (1955) are most close to our species. But *Nilssonia macrophylla* is distinguished by its pinnae with densely crowded veins (40 per cm) and *N. polymorpha* var. *major* by its more broader pinnae, sometimes twice as broad as our pinnae.

In the back-side view, our leaves would be taken to be those of *Pterophyllum*.

Nilssonia oblique-truncata KIMURA et OHANA sp. nov.

Pl. 9, fig. 5; Pl. 12, fig. 2; Pl. 14, figs. 2–3; Figs. 25a–f

Material: Holotype: NSM PP-8319 (Aratozawa). Paratypes; NSM PP-8320, 8321 (ditto). Examined specimens; NSM PP-8322～8331 (ditto).
Stratum typicum: Tochikubo Formation *Locus typicus*: Aratozawa.
Occurrence: Locally common at Aratozawa. *Derivatio nominis*: According to the pinnae with obliquely truncated apex.
Diagnosis: Leaf medium-sized, more than 13 cm wide. (Whole leaf unknown.) Rachis thick below, 3.5 mm wide but thinner above, sending off alternately long and narrow pinnae at an angle of 70 degrees, but angle reduced apically; laminae completely covering the upper surface of rachis. Lower pinnae more than 8 cm long and 0.7 cm wide, nearly parallel-sided for the most part, expanded at base, decurrent and obliquely truncated at apex; acroscopic apical margin sometimes cuspidately projected. Apical pinnae suddenly becoming shorter and narrower. Venis simple, parallel and ending at the truncated margin; 8 in number in a small-sized pinna and 18 in number in a large-sized pinna. (Reproductive organs not known.)

Discussion and *comparison*: Our leaves are characterized by their long and narrow pinnae with obliquely truncated apex. So far as we know, such an external feature has not been recorded except for a pinna fragment illustrated by HARRIS (1964) in *Pseudoctenis* sp. A. Therefore, we here propose *Nilssonia oblique-truncata* sp. nov. to accommodate our leaves.

Nilssonia obique-truncata resembles in external leaf-form *N. mediana* (LECKENBY et BEAN) FOX-STRANGWAYS, but is distinguished by its pinnae with obliquely truncated apex, instead of the latter pinnae with bluntly pointed or rounded apex (SEWARD, 1911, text-fig. 13C).

Nilssonia oblique-truncata is distinguished from *N. longipinnata* described in this paper by its obliquely inserted pinnae, instead of the latter pinnae which are unexceptionally inserted perpendicularly to the rachis.

Nilssonia ex gr. *schaumburgensis* (DUNKER) NATHORST

Pl. 12, fig. 3; Pl. 13, figs. 2–6; Pl. 14, figs. 4–5; Figs. 26a–h

Material: NSM PP-8332, 8333, 8335～8337 (Bunasaka), 8334, 8338～8345 (Aratozawa) and 175 other specimens. *Occurrence*: Locally abundant at Aratozawa and Bunasaka, but rather rare at Shidasawa, Koyamada and Kitanoirisawa.
Description: A large number of specimens were obtained. They are all detached leaf-fragments and locally crowded in occurrence and sometimes massed and appressed on the same bedding plane. The leaves are variable in external form, size and vein-density, but we think they belong to the same fossil population and thus belong to one and the same species because of their occurrence.

The leaf is long and narrow; the largest ones are more than 18.6 cm (Pl. 13, fig. 2; Fig. 26a) and 17 cm (Pl. 13, fig. 5; Fig. 26b) and up to 1.8 cm and 1.3 cm wide

respectively. The lamina is entire or irregularly dissected by the sinuses reaching or not reaching to the rachis. Pl. 13, fig. 2 shows a distal half of leaf in which the lamina is nearly parallel-sided for the most part, abruptly narrowing towards the broadly rounded and shallowly notched apex; margins are entire.

Pl. 13, fig. 5 (Fig. 26b) shows a proximal half of leaf in which the lamina is irregularly and broadly segmented, narrowing gradually towards the cuneate base; the incisions are mostly V-shaped and the corners of each segment are mostly rounded. The veins are simple and perpendicular to the rachis and the density is 30–40 per cm in the leaf shown in Pl. 13, fig. 2 and 40 per cm in that shown in Pl. 13, fig. 5.

Pl. 14, fig. 5 (Figs. 26g–h) shows a small-sized leaf, more than 7.5 cm long and 0.6 cm wide; its width is nearly constant in its distal half, but gradually narrowing towards the base. The lamina is irregularly and broadly segmented like that of the leaf shown in Pl. 13, fig. 5, but having larger number of incisions; vein-density is 50–60 per cm.

Pl. 14, fig. 4 (Fig. 26c) shows a distal part of leaf in which its apex is not notched but rounded, and the rachis is suddenly narrowed at its tip and is beyond the lamina for 1 mm.

Pl. 13, fig. 6 shows a part of leaf in which the lamina is rather regularly and narrowly segmented and each segment has mostly broadly rounded distal margin.

Remarks: Common features of the variously formed and sized leaves are as follows: 1) Surface of lamina is flat or convex upwards. 2) Their laminae unexceptionally cover entirely the upper surface of rachis except for the basal part of a leaf. 3) Veins are prominent, arising perpendicularly from the rachis except for the apical portion of a leaf where the angle is slightly reduced. 4) Concentration of veins is 30–60 per cm. 5) All leaves are represented by their adaxial surface exposed and in these, the rachis is seen only when the substance of the lamina is broken away, but in all leaves its position is indicated by a depression of the lamina. The depression retains its width to the distal part of the leaf.

Similar leaves have been described as follows:

Lower Cretaceous of North Germany:

DUNKER (1846); *Pterophyllum schaumburgense*,

SCHENK (1871); *Anomozamites schaumburgensis*

Lower Cretaceous of England:

SEWARD (1895) and WATSON (1969); *Nilssonia schaumburgensis*

Lower Cretaceous of North America;

FONTAINE (in WARD, 1905) and BELL (1956); *Nillsonia schaumburgensis*

Lower Cretaceous of Southern Primorye:

KRASSILOV (1967); *Nilssonia schaumburgensis*

Lower Cretaceous of South Korea:

TATEIWA (1929) and OISHI (1940); *Nilssonia schaumburgensis* and *N. schaumburgensis* var. *parvula*

Upper Jurassic of Northeast Japan (possibly from the Tochikubo Formation):

OISHI (1940); *Nilssonia schaumburgensis*

Lower Cretaceous of the Outer Zone of Japan:

NATHORST (1890); *Nilssonia* cf. *schaumburgensis*

YOKOYAMA (1894), YABE (1913, 1927) and OISHI (1940); *Nilssonia schaumburgensis*,

KIMURA (1976), KIMURA and KANSHA (1978), KIMURA and MATSUKAWA (1979); *Nilssonia* ex gr. *schaumburgensis*.

They are variable in form, size and mode of segmentation, but it is difficult to separate specifically these leaves including the present ones on the basis of their external morphology alone. However, it is marked that the present leaves are larger in size than those from the Lower Cretaceous plant-beds.

We are of the opinion that the *Nilssonia schaumburgensis*-type leaves are peculiar to the Ryoseki-type (or 'Wealden-type') floras of the Late Jurassic-Early Cretaceous time with one exception illustrated by SAMYLINA (1964) from the Lower Cretaceous of Kolyma Basin, East Siberia.

Our larger leaves and smaller leaves closely resemble in external leaf-form and size those of *Nilssonia tenuinervis* SEWARD and *N. revoluta* HARRIS (HARRIS, 1964) respectively.

Unclassified Cycadopsida

Form-genus *Cycadites* STERNBERG, 1825: 32

Cycadites sp.

Pl. 10, fig. 4; Pl. 15; Fig. 27

Material: NSM PP-8346~8349 and many other leaf-fragments (Bunasaka).

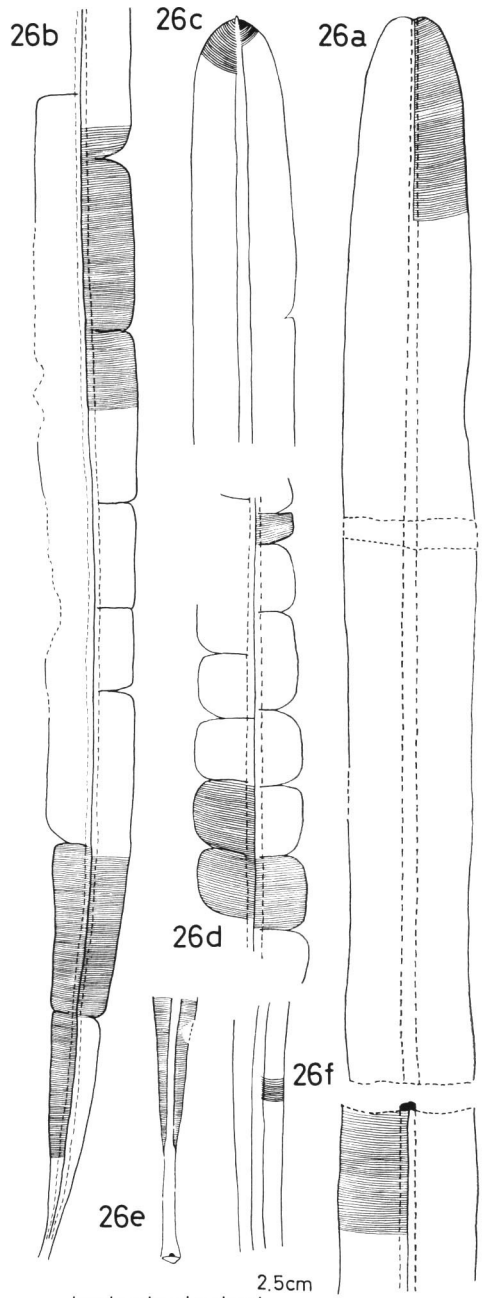
Occurrence: Locally common at Bunasaka.

Description: The leaf is large, more than 20 cm wide, but whole leaf is unknown. Pinnae are closely set, attached to the grooves just above the lateral margins of stout rachis at an angle of 70 degrees, but the angle is reduced towards the apex. Pinnae are linear, more than 11.5 cm long and up to 5 mm wide, parallel-sided for the most part, but slightly contracted near their origin and expanded at their base; pinna apices are all missing. Margins are entire but often reflexed longitudinally. Midnerve is distinct, occupying about one-third of breadth of a pinna. Reproductive organs are not known.

Remarks: *Cycadites* is a non-committal genus, but has been used for fossil leaves agreeing in external habit with those of extant *Cycas*.

Based on the cuticular features, both *Pseudocycas* NATHORST, 1907 with syndetocheilic stomata and *Paracycas* HARRIS, 1964 with haplocheilic stomata have been picked out of *Cycadites*. Therefore, it is now impossible to determine the attribution of such fossil leaves resembling those of extant *Cycas* only on the basis of their external morphology.

Among a good number of species hitherto described under the generic names of



Figs. 26(a–f) (Natural size).
Nilssonia ex gr. *schaumburgensis* (DUNKER) NATHORST.
26a (NSM PP-8340, drawn parlty from Pl. 13, fig. 2).
26b (NSM PP-8342, drawn from Pl. 13, fig. 5). 26c (NSM PP-8344, drawn from Pl. 14, fig. 4). 26d (NSM PP-8338, drawn from Pl. 12, fig. 3). 26e (NSM PP-8334). Loc. Aratozawa. 26f (NSM PP-8335). Loc. Bunasaka.

Cycadites, *Pseudocycas* and *Paracycas*, our leaf is externally quite close, especially in size, to those of *Pseudocycas insignis* originally described by NATHORST (1907) from the Cenomanian plant-bed of Greenland.

Our leaf is characterized by its large-size, and is distinguished from those of other *Cycadites* species mentioned below:

Cycadites blomqvisti ANTEVS: ANTEVS, 1919; Liassic of Sweden: Its rachis is far thicker than ours.

C. saladini ZEILLER: ZEILLER, 1902–3; Norian of North Viet Nam: Its leaf is narrower, up to 10 cm wide.

C. sulcatus KRYSHTOFOVICH et PRYNADA: KRYSHTOFOVICH and PRYNADA, 1932; KRASSILOV, 1967; Lower Cretaceous of Southern Primorye: Its leaf is also narrower, up to 10 cm wide.

The cuticle of *Cycadites manchuriensis* described by OISHI (1935) from the Lower Cretaceous (?) Dong-ning (Tung-ning) Formation, Eastern Heilongjiang is, in our opinion, obviously of the cycadalean-type, and *Nilssonia pecten* described also by OISHI from the same formation on the basis of splendid leaves is, according to KRASSILOV (1967) synonymous with *Cycadites sulcatus*.

In Japan, similar leaves have been described from the upper Liassic Negoya Formation (KIMURA and TSUJII, 1983), Middle Jurassic Utano Formation (KIMURA and OHANA, 1987b) and Lower Cretaceous Oguchi Formation (KIMURA and SEKIDO, MS). But they are all represented by the small-sized leaves.

Coniferales

Conifers are rare in occurrence and only represented by three forms, *Elatocladus* sp. A, *Pagiophyllum* sp. and *Parasequoia* sp. cf. *P. cretacea*. What is worse, as they are all represented by sterile broken leafy-shoots, it is difficult to make their specific or even generic attribution.

Form-genus *Elatocladus* HALLE, 1913: 84

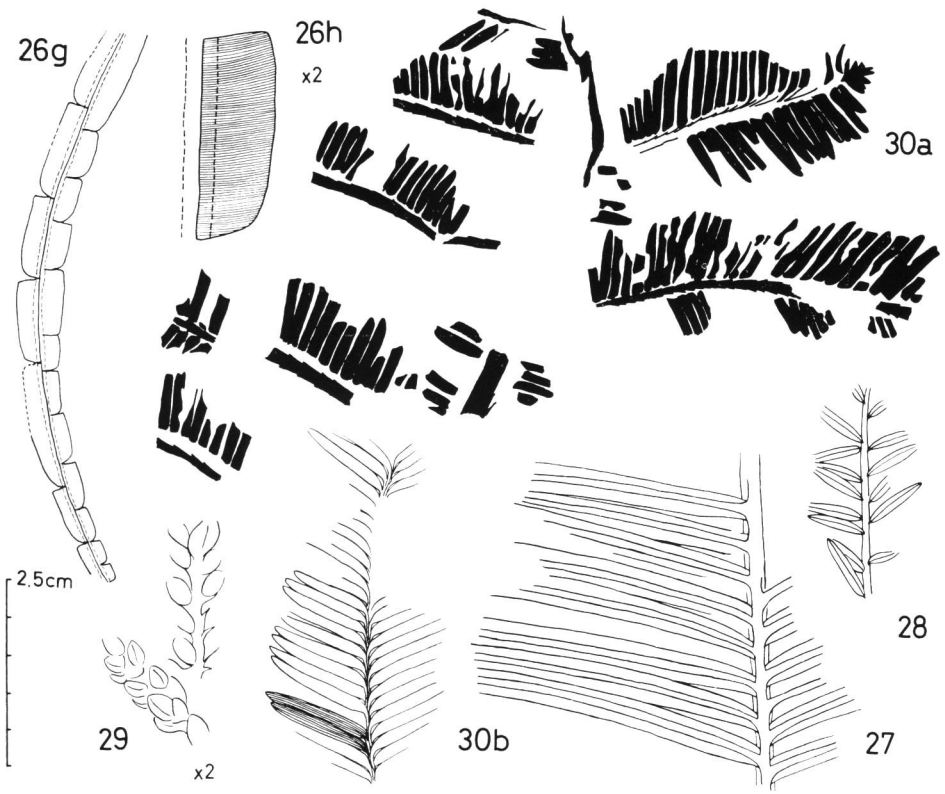
Elatocladus sp. A

Pl. 16, figs. 1–2; Fig. 28

Material: NSM PP-8350 (Bunasaka), 8351 (Aratozawa). *Occurrence*: Very rare at Bunasaka and Aratozawa.

Description and *remarks*: Our leafy-shoots are referable to non-committal genus *Elatocladus* redefined by HARRIS (1979) as 'fossil conifer shoot bearing elongated, dorsiventrally flattened leaves with a single vein and leaves divergent from stem'.

Our leaves are elongate-elliptical in form, sessile, 0.8 cm long and up to 2 mm wide, with rounded apex and attached oppositely to the axis. They appear to be originally decussate in arrangement, then their leaf-bases bending and twisting to bring each lamina into the horizontal plane and at right angle to the axis.



Figs. 26(g–h)–30 (Natural size, unless otherwise indicated).
26(g–h). *Nilssonia* ex gr. *schaumburgensis* (DUNKER) NATHORST. 26g (NSM PP-8343, drawn from Pl. 14, fig. 5). 26h (ditto, showing the venation). Loc. Aratozawa.
27. *Cycadites* sp. (NSM PP-8347, drawn partly from Pl. 10, fig. 4). Loc. Bunasaka.
28. *Elatocladus* sp. A (NSM PP-8351, drawn partly from Pl. 16, fig. 2). Loc. Aratozawa.
29. *Pagiophyllum* sp. (NSM PP-8385). Loc. Fukanonakayama.
30. *Parasequoia* sp. cf. *P. cretacea* KRASSILOV.
30a (NSM PP-8354, drawn from Pl. 16, fig. 5). 30b (NSM PP-8352, drawn partly from Pl. 16, fig. 6). Loc. Aratozawa.

Form-genus *Pagiophyllum* HEER, 1881: 11
Pagiophyllum sp.

Pl. 12, fig. 4; Pl. 16, figs. 3–4; Fig. 29

Elatocladus obtusifolia OISHI: OISHI, 1940, pl. 41, figs. 1, 1a (Kami-Mano-mura; possibly from the Tochikubo Formation).

Material: NSM PP-8373, 8374 (Umenokizawa), 8375～8386 (Fukanonakayama).

Occurrence: Locally common at Fukanonakayama, but rare at Umenokizawa.

Description: Obtained are all small fragments of coniferous leafy-shoots. The

branch-stem preserved is 6 mm wide, send off slender and delicate ultimate leafy-branches at a wide angle. The ultimate branches are not flattened, more than 3 cm long with slender axis. The leaves are arranged helically, widest at base or just above it, envelop the axis closely; probably thick and succulent; not adherent but free, directed forwards, diverging, markedly falcate at the distal portion, oval in abaxial view, with obtusely pointed or rounded apex, markedly convex and keeled abaxially and flat or concave adaxially, then triangular in form transversely; leaf-bases normally concealed by leaves below; typically 1.5 mm long and up to 1 mm wide. Reproductive organs are not known.

Remarks: The detached ultimate leafy-branches of delicate habit are locally common at the Fukanonakayama locality, but none of them is complete. The present coniferous leafy-branches are characterized by very slender axis covered with helically arranged, closely set, thick, oval-shaped, free, markedly keeled and falcate leaves.

On the fracture of matrix, these leaves are usually preserved only leaving their keels and missing the convex part of leaves (Pl. 12, fig. 4).

OISHI (1940) instituted *Elatocladus obtusifolia* on the basis of sterile coniferous leafy-branches obtained from Kami-Mano-mura locality (possibly from the Tochikubo Formation). The diagnosis given by OISHI is 'shoot with pinnate (?) branching; habit slender; branchlets narrower; leaves deltoid, with an obtuse apex, and a dorsal keel decurrent at the base, crowded, sometimes recurved, arranged in spiral, and at a wide angle to the axis, the lamina being free except the base'.

We now believe that OISHI's leafy-branches are the same as those of ours. Possibly he did not observe the real leafy-branches, but observed those fructured by various planes.

OISHI (1940) compared his leafy-branches with those of *Muscites sternbergianus* originally described by DUNKER (1846) from the Wealden of Germany. But DUNKER's leafy-branches (in his pl. 7, fig. 10) are quite different in leaf-form from ours.

The coniferous leafy-branches described by KARSSILOV (1967) as *Elatocladus obtusifolia* from the Lower Cretaceous of Southern Primorye are, in our opinion, referable to the present *Pagiophyllum* sp.

The general feature of our leafy-branches may fit in the emended diagnosis of *Pagiophyllum* given by HARRIS (1979). Our leaves resemble those of *Pagiophyllum maculosum* KENDALL known from Yorkshire (HARRIS, 1979), but differ in their far smaller size. The leaf-cushion of the present *Pagiophyllum* sp. differs in habit from that of *Brachyphyllum*.

Form-genus *Parasequoia* KRASSILOV, 1967: 212
Parasequoia sp. cf. *P. cretacea* KRASSILOV

Pl. 16, figs. 5–6; Figs. 30a–b

Material: NSM PP-8352~8372 (Aratozawa) and 29 other specimens.

Occurrence: Locally common at Aratozawa, but rather rare at Bunasaka and

Shidasawa.

Description: Leafy-shoots are preserved in flat. Main axis preserved is thick, 2.5 mm wide, sends off oppositely ultimate leafy-branches at a wide angle. Ultimate leafy-branch is more than 4.7 cm long and 2 cm wide, nearly parallel-sided for the most part, and with thick axis; some are terminated by a cone-like organ. Leaves are shortly petioled, numerous, possibly decussately arranged but decurrent petioles bend and twist to bring each lamina into the horizontal plane and at a wide or a right angle to the axis. The leaf-lamina is linear, long and narrow, nearly parallel-sided for the most part, typically 1.5 cm long and 2 mm wide, obtusely pointed at apex and rounded at base. Veins are simple, parallel, 5 in number in each leaf, and end at the distal margin, not converge at apex.

Remarks: Our leaf is characterized by its parallel veins. Externally our leafy-branches resemble closely those of *Parasequoia cretacea* originally described by KRASSILOV (1967) from the Lower Cretaceous of Southern Primorye. However, we at present regard our leafy-branches as *Parasequoia* sp. cf. *P. cretacea*, because our leafy-branches are only represented by impressions and our leaves are more longer than KRASSILOV's leaves. The details of the terminated cone-like organs are still uncertain.

Very recently H. FURUOYA, one of the graduate students of our university collected very fine leafy-branches referable to *Parasequoia* sp. cf. *P. cretacea* from the Upper Jurassic Oginohama Formation.

Unclassified seed

Form-genus *Carpolithes* SCHLOTHERIM, 1820: 418

Carpolithes sp. A

Material: NSM PP-8387~8395 (Aratozawa), 8396 (Shidasawa), 8397~8398 (Bunasaka). *Occurrence*: Locally common at Aratozawa, but rare at Shidasawa and Bunasaka.

Description and *remarks*: Obtained are all isolated seeds, oval in form; their dimension (length, width, thickness) measured is, although crushed vertically, as follows: 17 mm-13 mm-?, 20(+)–16–? 16–14–9, 21–16–6(+), 8.5–6–3, 19–12–? and 18–15–5 (+). Unfortunately their whole shape and inner structure are uncertain.

Judging from their crowded occurrence, our seeds might belong to a single species, and resemble in general outline and size one shown by KRASSILOV (1967) from the Lower Cretaceous of Southern Primorye. According to him, his seeds are also in association with the leaves of *Nilssonia schaumburgensis*. At the Aratozawa locality also, our seeds are in association with the detached leaves of *Nilssonia* ex gr. *schaumburgensis* described in this paper.

Supplementary notes: 1) The following line-drawings were made by M. TSUJII: Figs. 16a–b, 17a–b, 18, 20a, 22a–d, 23c, 24, 25b–f, 26a–e, g–h, and 30a. 2) All photographs in the plates were printed by K. SAIKI. 3) Specimens described in this paper are all kept in the National Science Museum, Tokyo.

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Explanation of plates

Plate 8 (Natural size):

Figs. 1–3. *Ptilophyllum jurassicum* KIMURA et OHANA sp. nov. 1 (NSM PP-8257; a part of holotype). 2 (NSM PP-8259; paratype) Loc. Shidasawa. 3 (NSM PP-8273; apical part of a leaf). Loc. Aratozawa.

Fig. 4. *Pseudoctenis* sp. A (NSM PP-8296). Loc. Aratozawa.

Plate 9 (Natural size):

Figs. 1–2. *Ptilophyllum jurassicum* KIMURA et OHANA sp. nov. 1 (NSM PP-8260; paratype). Loc. Shidasawa. 2 (NSM PP-8275; apical part of a leaf). Loc. Aratozawa.

Fig. 3. *Ptilophyllum* sp. H (NSM PP-8290). Loc. Umenokizawa.

Fig. 4. *Nilssonia* sp. cf. *N. densinervis* (FONTAINE) BERRY (NSM PP-8307). Loc. Aratozawa.

Fig. 5. *Nilssonia oblique-truncata* KIMURA et OHANA sp. nov. (NSM PP-8331). Loc. Aratozawa.

Plate 10 (Natural size):

Fig. 1. *Ptilophyllum jurassicum* KIMURA et OHANA sp. nov. (NSM PP-8281). Loc. Bunasaka.

Fig. 2. *Ptilophyllum* sp. F (NSM PP-8286). Loc. Aratozawa.

Fig. 3. *Ptilophyllum* sp. G (NSM PP-8289). Loc. Aratozawa.

Fig. 4. *Cycadites* sp. (NSM PP-8347). Loc. Bunasaka.

Plate 11 (Natural size):

Figs. 1–3. *Nilssonia* sp. cf. *N. canadensis* BELL. 1 (NSM PP-8300). 2 (NSM PP-8299). Loc. Shidasawa. 3 (NSM PP-8303). Loc. Upper Course of the Shidasawa.

Figs. 4–8. *Nilssonia* sp. cf. *N. densinervis* (FONTAINE) BERRY. 4 (NSM PP-8305). 8 (NSM PP-8306). Loc. Bunasaka. 5 (NSM PP-8310). 7 (NSM PP-8309). Loc. Aratozawa. 6 (NSM PP-8304). Loc. Shidasawa.

Plate 12 (Natural size, unless otherwise indicated).

Fig. 1. *Nilssonia longipinnata* KIMURA et OHANA sp. nov. (NSM PP-8311; a part of holotype). Loc. Bunasaka.

Fig. 2. *Nilssonia oblique-truncata* KIMURA et OHANA sp. nov. (NSM PP-8319; holotype). Loc. Aratozawa.

Fig. 3. *Nilssona* ex gr. *schaumburgensis* (DUNKER) NATHORST (NSM PP-8338). Loc. Aratozawa.

Fig. 4. *Pagiophyllum* sp. (a part of NSM PP-8380). Loc. Fukanonakayama.

Plate 13 (Natural size):

Fig. 1. *Nilssonia longipinnata* KIMURA et OHANA sp. nov. (NSM PP-8313; a part of paratype) Loc. Aratozawa.

Figs. 2–6. *Nilssonia* ex gr. *schaumburgensis* (DUNKER) NATHORST. 2 (NSM PP-8340). 5 (NSM PP-8342). Loc. Aratozawa. 3 (NSM PP-8333). 4 (NSM PP-8337). 6 (NSM PP-8332). Loc. Bunasaka.

Plate 14 (Natural size):

Fig. 1. *Pseudoctenis brevipennis* OISHI (NSM PP-8294). Loc. Shidasawa.

Figs. 2–3. *Nilssonia oblique-truncata* KIMURA et OHANA sp. nov. 2 (NSM PP-8320; a part of paratype). 3 (NSM PP-8321; paratype). Loc. Aratozawa.

Figs. 4–5. *Nilssonia* ex gr. *schaumburgensis* (DUNKER) NATHORST. 4 (NSM PP-8344). 5 (NSM PP-8343). Loc. Aratozawa.

Plate 15 (Natural size):

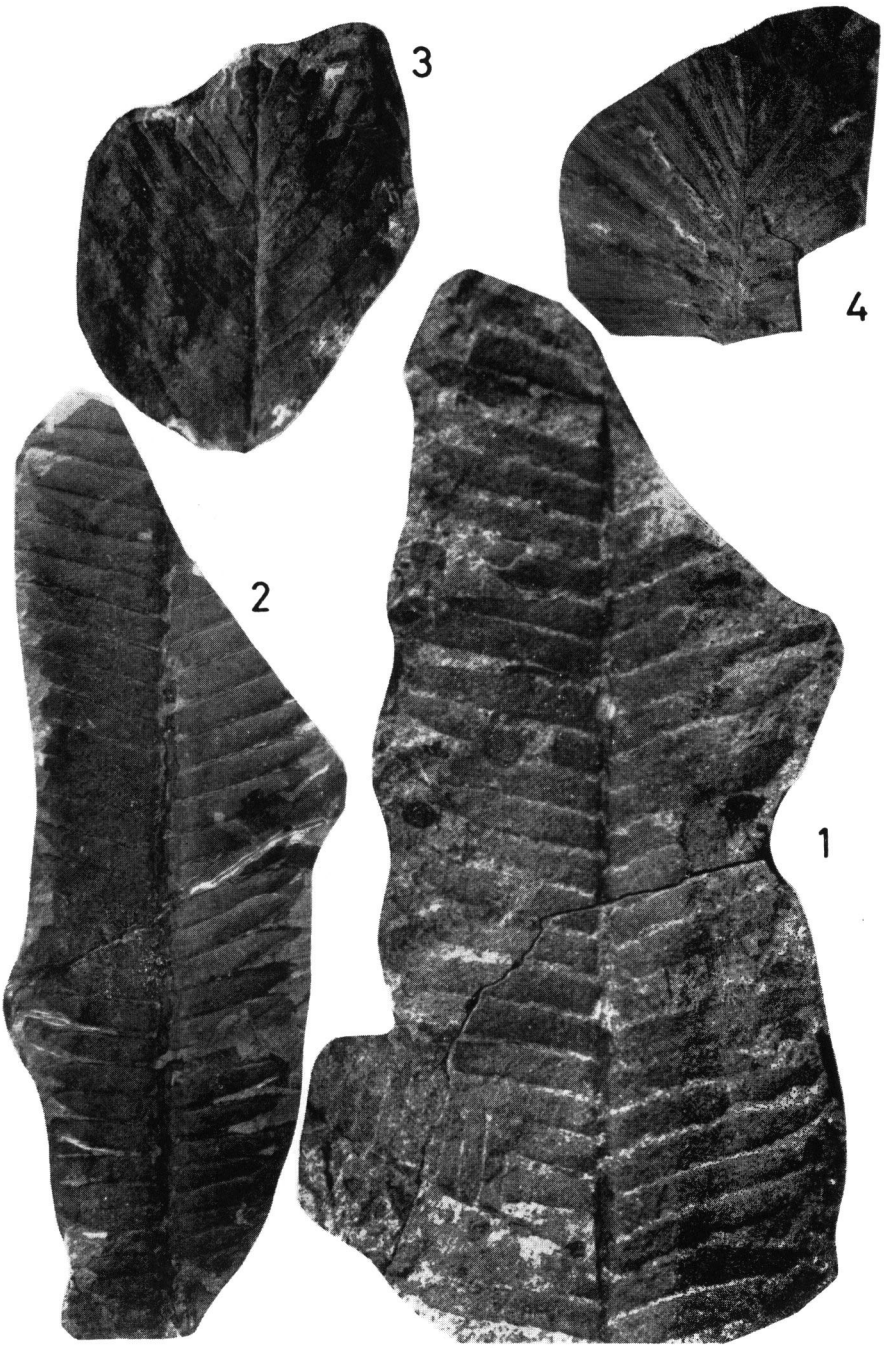
Cycadites sp. (a part of NSM PP-8346). Loc. Bunasaka.

Plate 16 (Figs. 1–4: Enlarged twice, Figs. 5–6: Natural size):

Figs. 1–2. *Elatocladus* sp. A. 1 (NSM PP-8350). Loc. Bunasaka. 2 (NSM PP-8351). Loc. Aratozawa.

Figs. 3–4. *Pagiophyllum* sp. 3 (NSM PP-8375). 4 (NSM PP-8383). Loc. Fukanonaka-yama.

Figs. 5–6. *Parasequoia* sp. cf. *P. cretacea* KRASSILOV. 5 (NSM PP-8354). 6 (NSM PP-8352). Loc. Aratozawa.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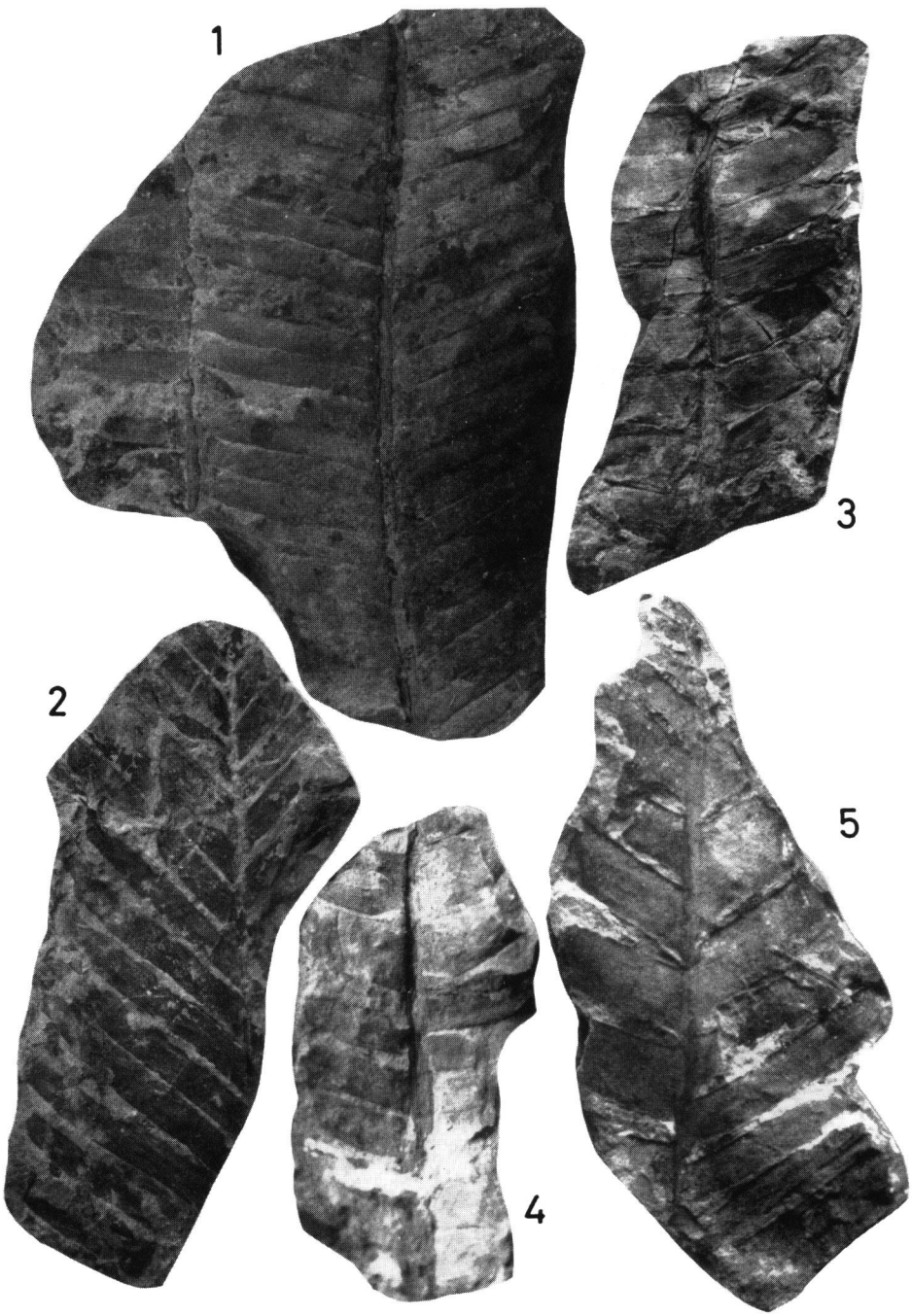
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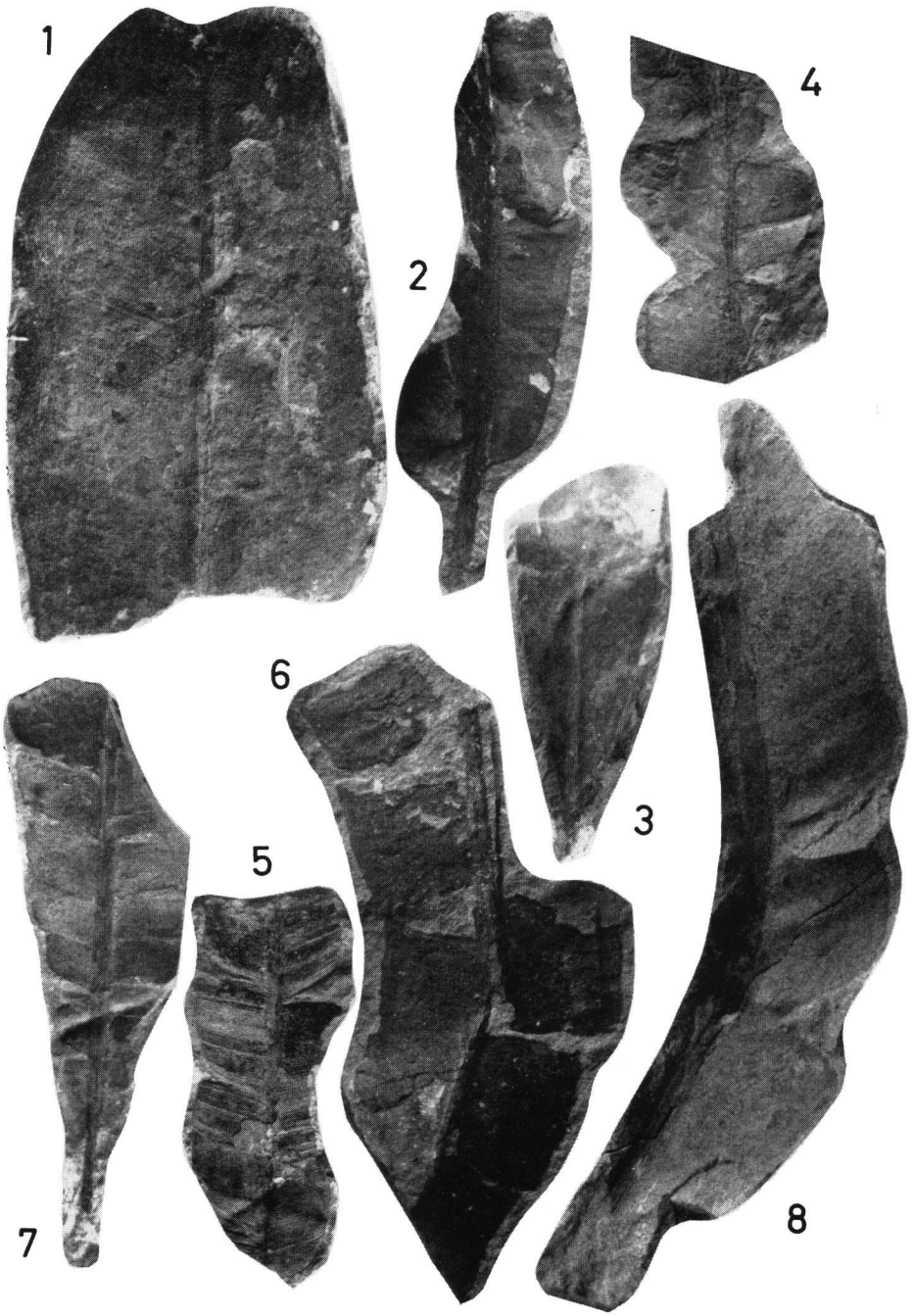
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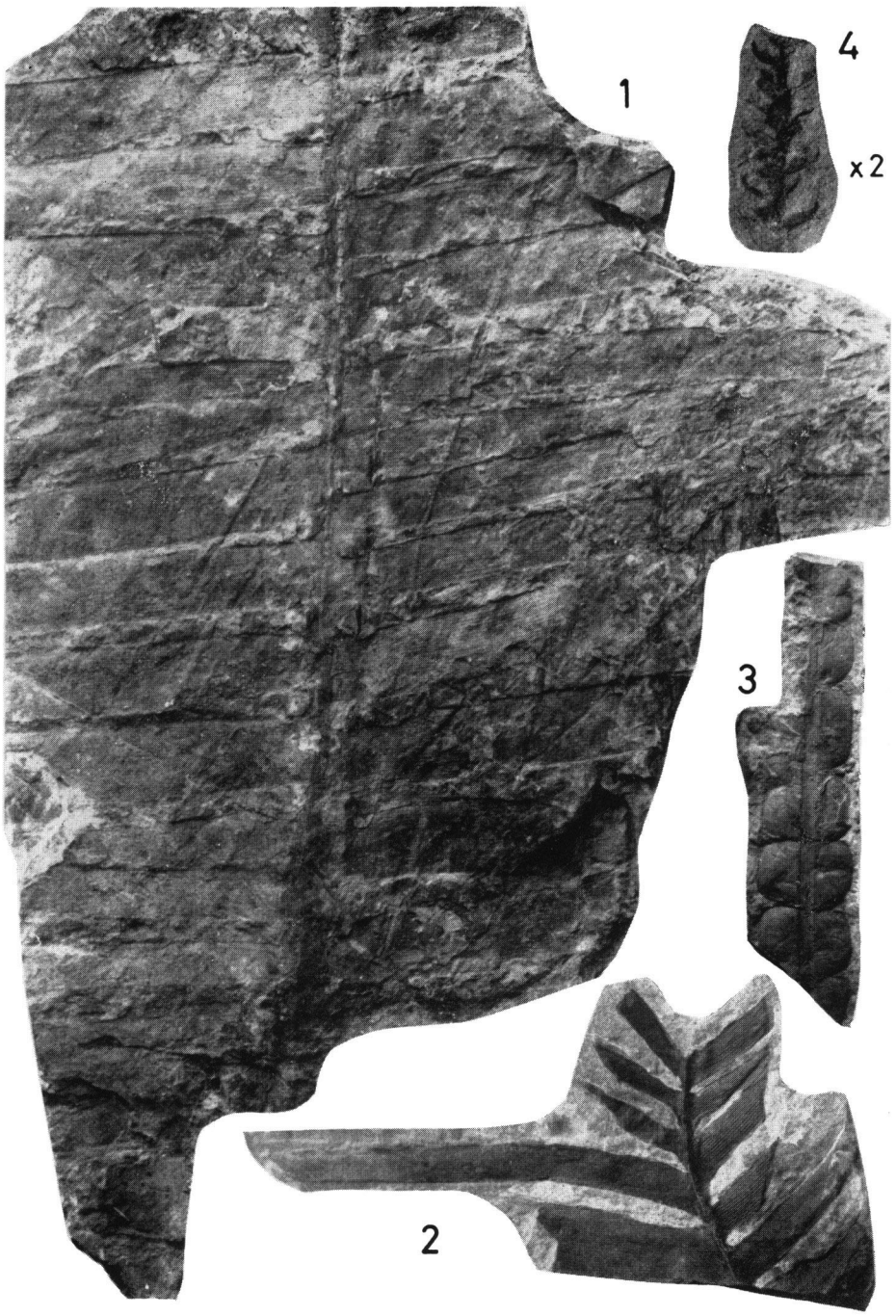
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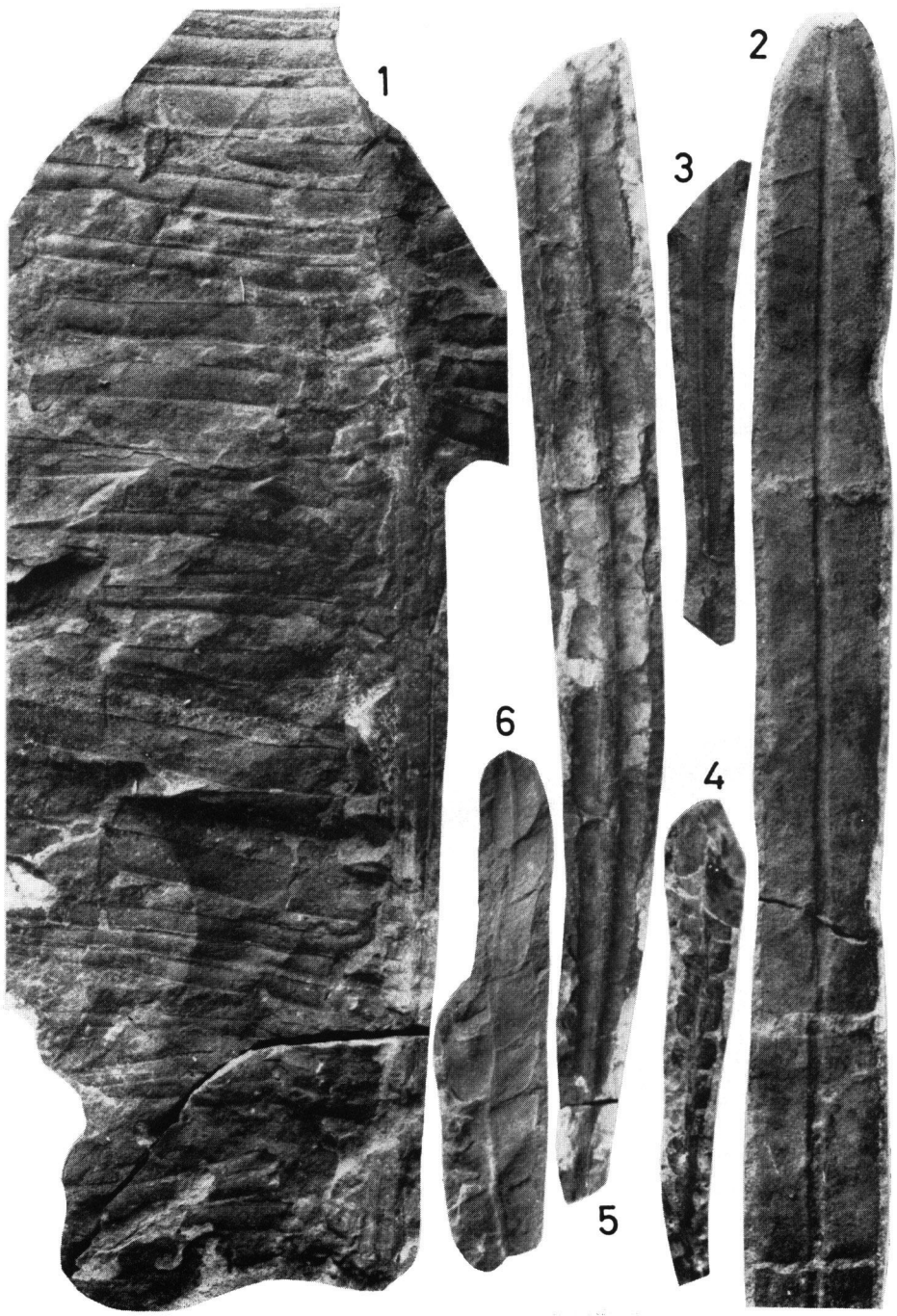
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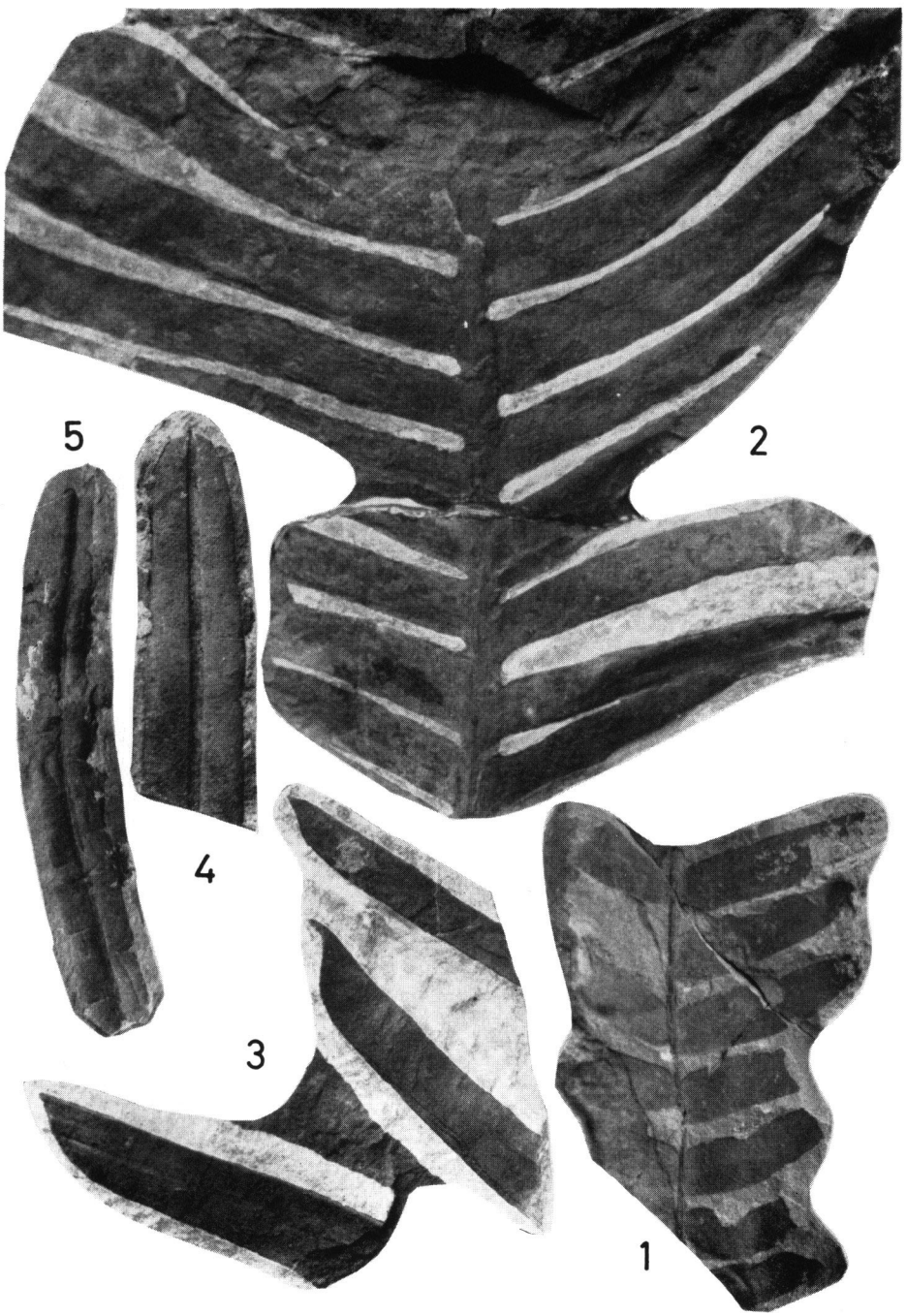
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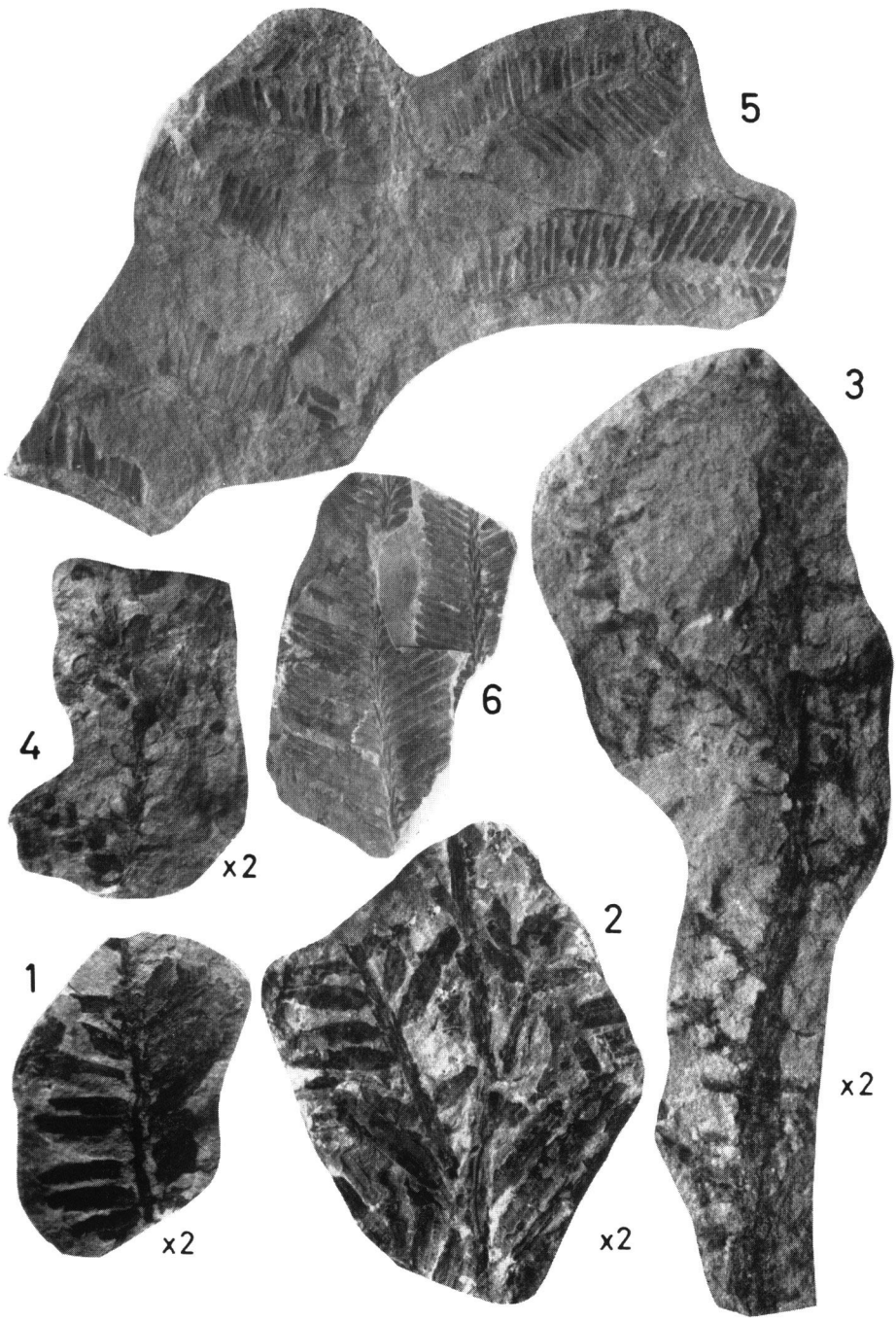
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