

Onychiopsis yokoyamai (YABE) comb. nov. from the Lower
Cretaceous Plant-beds in the Outer Zone of Japan

By

Tatsuaki KIMURA¹ and Hiroaki AIBA²

¹Department of Astronomy and Earth Sciences, Tokyo
Gakugei University, Koganei, Tokyo

²Motohachioji Junior High School, Hachioji, Tokyo
(Communicated by Ikuo OBATA)

Abstract *Onychiopsis*, a fern genus with uncertain affinity is common in occurrence in the Middle Jurassic-Lower Cretaceous plant-beds in Japan and all *Onychiopsis* leaves known from the Japanese plant-beds had been regarded as *O. elongata*, the type species of the genus by the previous authors. In this paper, however, we propose *Onychiopsis yokoyamai* (YABE) based on its leaves of bipinnate habit with sessile fertile organ and reveal that *O. yokoyamai* is peculiar in occurrence to the Upper Jurassic-Lower Cretaceous plant-beds in the Outer Zone of Japan and is specifically distinct from *O. elongata* represented by the leaves of tripinnate habit with stalked fertile organ. We also make here the detailed comparison of *Onychiopsis yokoyamai* with other *Onychiopsis* species hitherto known based mainly of their forms of leaves and fertile organs. The recognition of *Onychiopsis yokoyamai* in the Late Jurassic-Early Cretaceous floras in the Outer Zone of Japan strongly supports the senior author (KIMURA)'s idea that the Late Jurassic-Early Cretaceous Tetori-type floras in the Inner Zone of Japan are distinct in floristic character from the coeval Ryoseki-type floras in the Outer Zone of Japan.

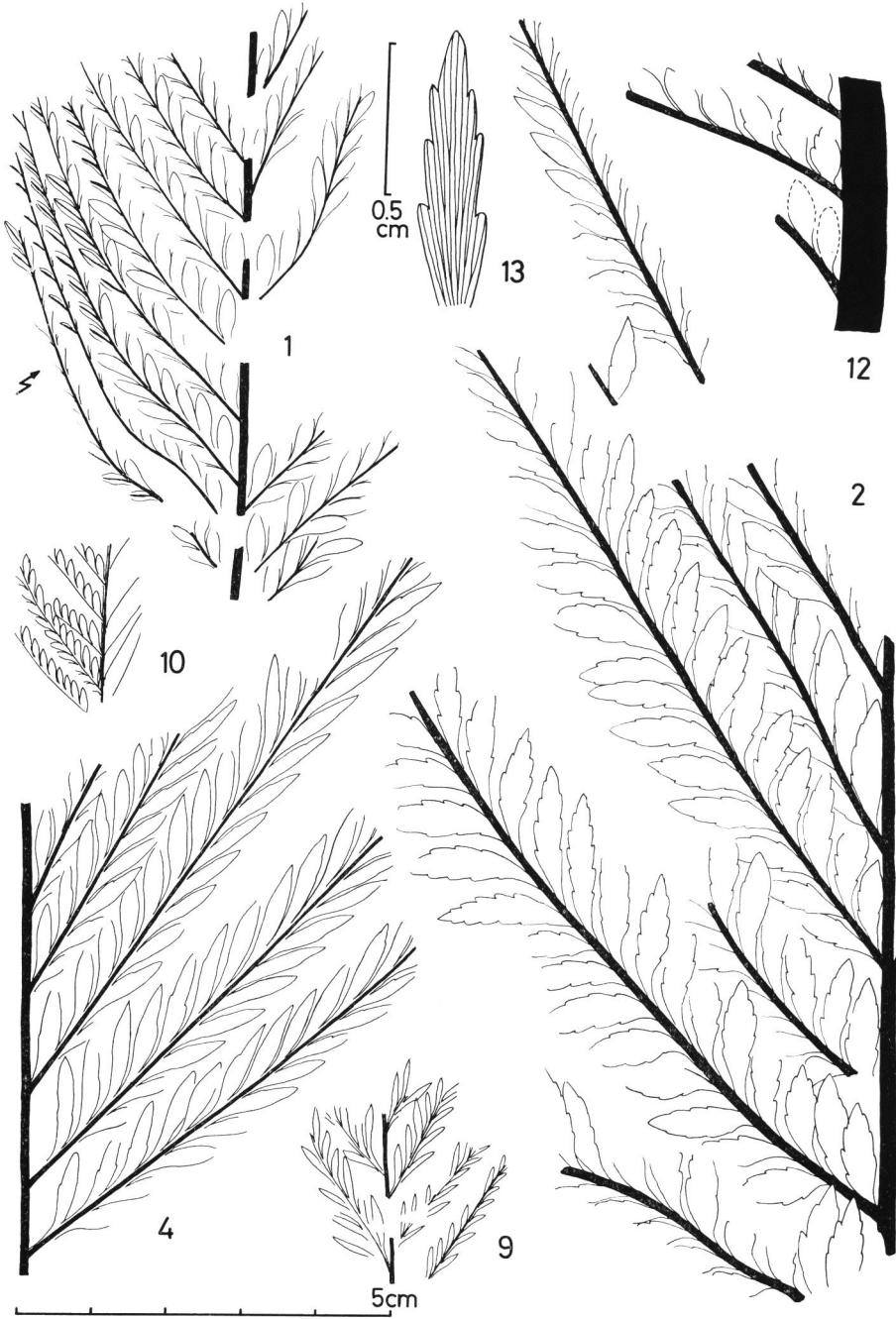
Foreword and Acknowledgements

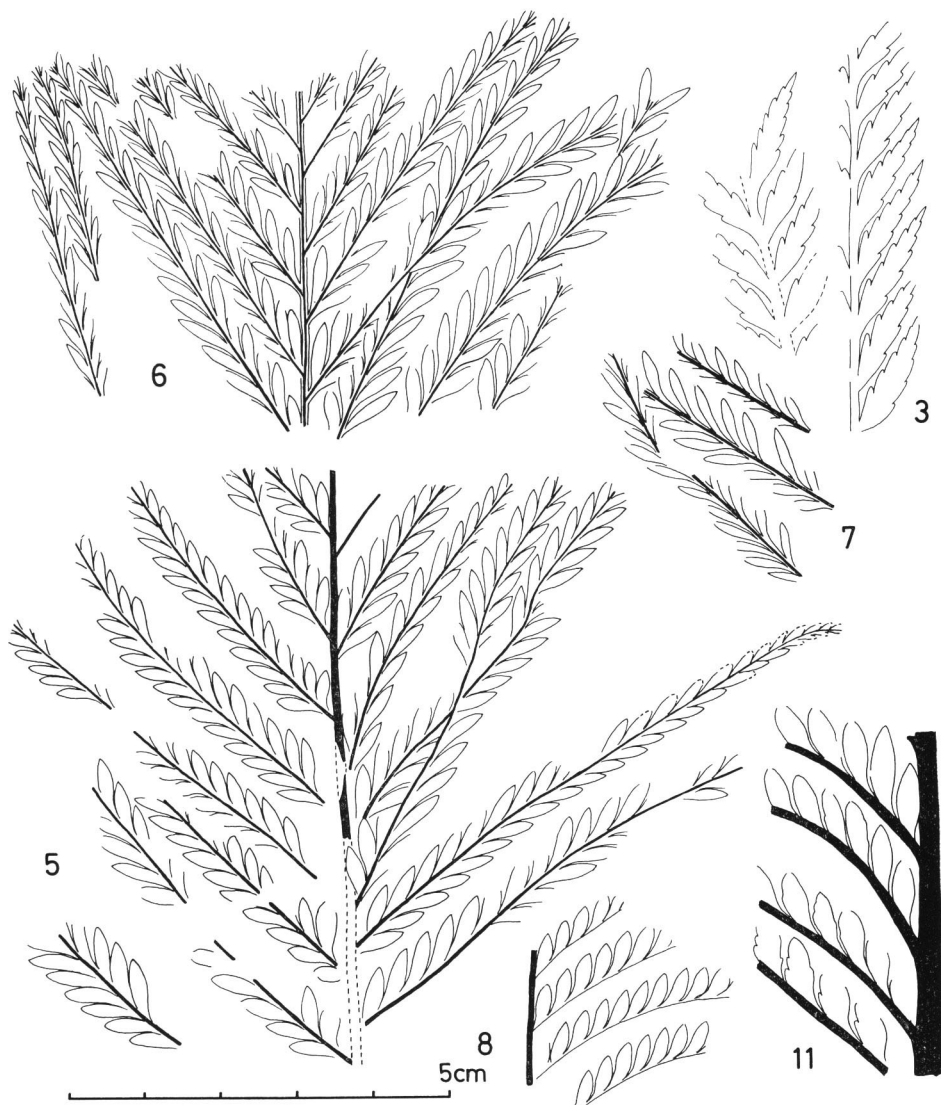
Genus *Onychiopsis* was established by YOKOYAMA (1889) based on GEYLER's *Thyrsopteris elongata* (1877) and his own material collected both from the Lower Cretaceous Oguchi Formation (at Shimamura=nowadays Kuwashima or Kuwajima), Itoshiro Group in the Tetori Basin in the Inner Zone of Japan. The type species *Onychiopsis elongata* is very abundant in occurrence in the Tetori Supergroup consisting of the Upper Jurassic Kuzuryu and Lower Cretaceous Itoshiro Groups.

The name of *Onychiopsis elongata* has since been applied to the fern-fronds found from the Upper Jurassic and Lower Cretaceous plant-beds extensively distributed in the Outer Zone of Japan. However, our recent reexamination on these fern-fronds revealed that they were distinct from *Onychiopsis elongata* and belonged to *O. yokoyamai* (YABE) comb. nov.

This paper deals with the description of *Onychiopsis yokoyamai* and with its comparison with other *Onychiopsis* species hitherto described.

We express our sincere gratitude to Dr. Ikuo OBATA, director of Department of





Text-figs. 1–13. *Onychiopsis yokoyamai* (YABE) KIMURA et AIBA comb. nov.: 1. A leaf with sterile and fertile pinnules, possibly representing the distal part of a leaf. HIRATA's collection, no. 7900, collected from Yokoyama-Ikku, Kochi City, Nagashiba Formation. An arrow points the fertile part. 2–3. Sterile leaves, possibly representing the middle parts of leaves. NSM-PP 7784, 7786, collected from Todai, Todai Formation. 4–7. Sterile leaves representing the distal portions of leaves (NSM-PP 7789, 7785, 7787; NSM-PP 7790), collected from Todai, Todai Formation. 8. A sterile leaf, redrawn from KIMURA, 1976, pl. 6, fig. 2 (NSM-PP 7116) regarded formerly as *Sphenopteris yokoyamai* YABE. Yatsushiro Formation (Albian). 9. Apical part of a sterile leaf, redrawn from OISHI, 1931, pl. 1, fig. 7 regarded formerly as *Onychiopsis psilotoides* (STOKES et WEBB), collected from Takata, Yuasa Formation (Lower Neocomian). 10. Apical part of a sterile leaf, redrawn from YABE, 1927b, pl. 13, fig. 2 regarded by Yabe as *Sphenopteris yokoyamai*, collected from Furuke, Hoji (or Boji) Formation (Aptian). 11–12. Proximal portions of leaves; pinnules are elliptic or oblong in form, mostly with entire margins (NSM-PP 7791, 7788), collected from Todai, Todai Formation. 13. A pinnule enlarged from Text-fig. 2, showing the venation.

Geology, National Science Museum, Tokyo for giving us the facilities to publish this paper. Our thanks are extended to the staff of the MAKINO Botanical Garden, Kochi City for their kind help in our reexamination of HIRATA's collection kept in the garden.

Description

Unclassified fern

Genus *Onychiopsis* YOKOYAMA, 1889: 27

Type species: Thyrsopteris elongata GEYLER, 1877 [*Onychiopsis elongata* (GEYLER) YOKOYAMA, 1889].

Onychiopsis yokoyamai (YABE) KIMURA et AIBA comb. nov.

(Pls. 1–2; Text-figs. 1–13, 14a)

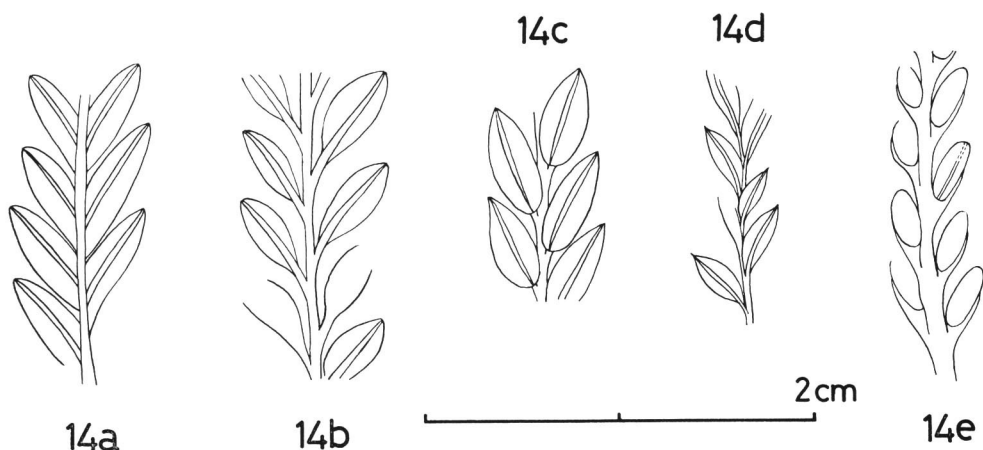
Sphenopteris yokoyamai YABE: YABE, 1927b, p. 223, pl. 23, figs. 1–2 (sterile leaf) (Furuke, Tokushima); KIMURA, 1976, p. 195, pl. 6, figs. 1–3; fig. 9a, b (Yatsushiro).

Onychiopsis elongata (GEYLER) YOKOYAMA: NATHORST, 1890, pp. 4, 8, 10, 11, pl. 5, fig. 3 (sterile leaf) (Yakyo near Kochi City); p. 12, pl. 2, fig. 6 (sterile leaf) (Haginotani near Kochi City); pp. 13, 14, pl. 6, fig. 5 (sterile leaf) (locality uncertain); YOKOYAMA, 1894, p. 215, pl. 20, fig. 8 (sterile pinna) (Hachimanzawa, Gumma); pl. 21, figs. 1, 4 (sterile leaves) (Yuasa, Wakayama): YABE, 1913, p. 3, pl. 1, figs. 1–5 (sterile leaves) (Omoto, Iwate): KIMURA, 1976, p. 196, pl. 5, fig. 1 (sterile leaf) (Yatsushiro, Kumamoto): KIMURA and KANSHA, 1978, p. 168 (Yuasa, Wakayama): KIMURA and MATSUKAWA, 1979, p. 102, pl. 1, fig. 2; pl. 2, fig. 1; pl. 3, fig. 1; pl. 3, fig. 1 (sterile leaves) (Hachimanzawa, Gumma).

Onychiopsis psilotoides (STOKES et WEBB): OISHI, 1931, p. 4, pl. 1, figs. 6–10 (sterile leaves) (Takata, Wakayama).

Material: Holotype: YABE, 1927b, pl. 23, fig. 1. Other specimens: 7900 (HIRATA's collection, kept in the Makino Botanical Garden). NSM-PP 7784–7874 (Todai Formation), *Stratum typicum*: Lower Cretaceous Hoji Formation (=Lower Monobegawa Formation). *Locus typicus*: Furuke, Katsura-gawa district, Tokushima Prefecture. *Derivatio nominis*: After Prof. YOKOYAMA, a great pioneer of Japanese palaeontology.

Diagnosis: Frond bipinnate. Rachis thick, 5–6 mm wide at base and with a median furrow on the upper surface. Pinnae closely set, overlapping each other laterally, alternate or subopposite, linear or elongate-lanceolate in outline, gradually narrowing towards the acutely pointed apex, more than 12 cm long and 1.5–2 cm wide; basal pinnae attached to the rachis at wide angle and sometimes bending downwards distally and distal ones directed forwards at an angle of 40–50 degrees. Pinnules katadromic in order, varied in form according to their position on a frond; proximal or full-grown ones rhombic or rhomboidal in form and attached to the pinna axis at wide angle, typically 1.7 cm long and up to 3.5 mm wide; distal ones lanceolate or elongate-lanceolate but occasionally rhomboidal in form, with markedly contracted acroscopic base and decurrent basicopic base and attached to the pinna axis at an



Text-figs. 14 (a–e). Fertile pinnae of *Onychiopsis* species.

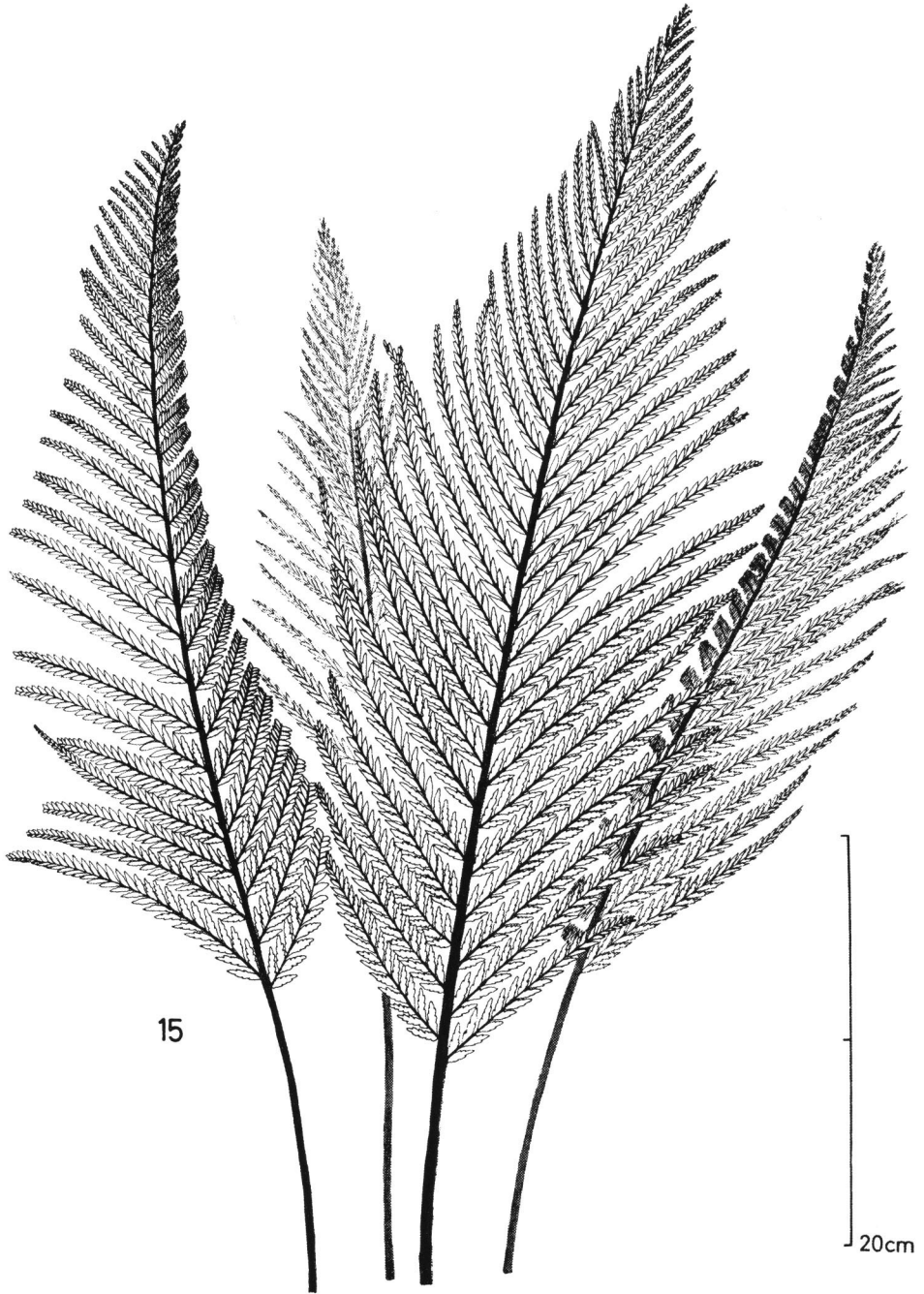
- 14a. *Onychiopsis yokoyamai* (YABE) KIMURA et AIBA comb. nov., drawn from HIRATA's collection, no. 7900.
- 14b. *Onychiopsis elongata* (GEYLER) YOKOYAMA, drawn from KM-009 (Mekkodani, Lower Cretaceous Oguchi Formation, kept in the Komatsu City Museum, Ishikawa Prefecture).
- 14c. *Onychiopsis tenuiloba* LORCH, redrawn from Q-60 (LORCH, 1967, pl. 8, fig. f).
- 14d. *Onychiopsis psilotoides* (STOKES et WEBB) WARD, redrawn from V-2159a (TATTERSALL, 1961, pl. 12, fig. 2a).
- 14e. *Onychiopsis paradoxus* BOSE et SUKH-DEV, redrawn from 30071 (BOSE and SUKH-DEV, 1961, text-fig. 3B).

angle of 30–40 degrees, typically 7 mm long and up to 2 mm wide. Margins entire in distal pinnules but lobed in proximal ones; lobes 5–7 pairs and directed forwards. Venation typical *Sphenopteris*-type and delicate; the first dichotomy occurring very near the base, then dichotomously forking twice or thrice and entering every lobe and apex.

Fertile pinnules occurring distal part of a pinna but without any fixed order as regards their position alternate, similar in form to sterile pinnules with entire margins but reduced in size, sessile, typically 0.5 cm long and 1.5 mm wide, and traversed by a strong simple keel. (Sporangium and spore not known.)

Distribution and occurrence: At the Todai locality, sterile leaves of this fern are crowded and sometimes thickly massed and appressed on the bedding plane. Similar sterile leaves have been known from the Upper Jurassic (KIMURA *et al.*, MS) and Lower Cretaceous plant-beds in the Outer Zone of Japan. A single leaf partly with fertile pinnules are found in HIRATA's collection kept in the MAKINO Botanical Garden, Kochi City.

Discussion and comparison: Our sterile leaves agree fully with that of *Sphenopteris yokoyamai* originally described by YABE (1927b) based on a single leaf from the Aptian Hoji Formation (at Furuke, Tokushima Prefecture).



Text-fig. 15. Reconstruction of *Onychiopsis yokoyamai* (YABE) KIMURA et AIBA comb. nov., based on a number of specimens kept in the MAKINO Botanical Garden and on those collected from the Lower Cretaceous Todai Formation.



Text-fig. 16. Reconstruction of *Onychiopsis elongata* (GEYLER) YOKOYAMA, based on a number of specimens collected from the Lower Cretaceous Oguchi and Akaiwa Formations (Itoshiro Group).

The leaf shown in Pl. 1 and Text-fig. 1 derived from the Upper Neocomian Nagashiba Formation (HIRATA, 1972) (=Lower Monobegawa Formation) has both sterile and fertile pinnules. Its sterile pinnules agree also fully with those of *Sphenopteris yokoyamai* and its fertile pinnules are none other than those of *Onychiopsis*-type. Thus we here propose *Onychiopsis yokoyamai* (YABE) comb. nov.

Onychiopsis yokoyamai is characterized by its bipinnate leaf with thick rachis, rhomboidal or elongate-lanceolate sterile pinnules and sessile and elliptical fertile pinnules traversed by a strong median keel on the adaxial surface.

Recently one of us (AIBA) collected a number of sterile leaves referable to *Onychiopsis yokoyamai* from the Lower Cretaceous Todai Formation in the Outer Zone of Southwest Japan.

The sterile leaves known from the Lower Cretaceous plant-beds in the Outer Zone of Japan regarded formerly as *Onychiopsis elongata* and *O. psilotoides* by the previous authors as listed above agree well with those of *O. yokoyamai*.

Onychiopsis yokoyamai is clearly distinguished from *O. elongata* known abundantly from the Middle Jurassic Utano Formation, Upper Jurassic Kiyosué Formation and Kuzuryu Group and the Lower Cretaceous Itoshiro Group (Oguchi and Akaiwa Formations) in the Inner Zone of Japan by the following:

- 1) In *Onychiopsis yokoyamai*, leaves are unexceptionally bipinnate and with thick rachis, but in *O. elongata* they are usually tripinnate and with thin rachis and very long petiole.
- 2) In *O. yokoyamai*, pinnules are rhomboidal or elongate-lanceolate in outline, but in *O. elongata* they are lanceolate or elongate-lanceolate and usually narrower than those of *O. yokoyamai*.
- 3) In *O. elongata*, margins of pinnules are sometimes deeply lobed and pinnatifid, but in *O. yokoyamai* margins are not pinnatifid.
- 4) In *O. yokoyamai*, pinnae are attached to the rachis at rather wide angle, but in *O. elongata* most pinnae are attached to the rachis at narrow angle and markedly directed forwards.
- 5) The fertile pinnule of *O. elongata* is quite different in form from its sterile one; its 'elliptical body' is terminated on the slender stalk. But the fertile pinnule of *O. yokoyamai* is sessile and similar in form to small-sized and entire sterile one but is traversed by a strong median keel on the adaxial surface.

Onychiopsis yokoyamai is distinguished from *O. psilotoides* (Stokes et Webb) Ward and *O. mantelli* (BRONGNIART) NATHORST by its broader sterile pinnule with crowded veins and its fertile pinnule without a short awn-like prolongation at its tip.

Onychiopsis yokoyamai is also distinguished from *O. paradoxus* BOSE et SUKHDEV (1961) by its rhomboidal-lanceolate sterile pinnule with crowded veins, instead of wedge-shaped one with less crowded veins, and by its fertile pinnule not differentiated between an 'elliptical body' and a stalk, instead of consisting of a basal sterile saucer-shaped lamina or stalk and an 'elliptical body' closely fitting into the saucer-shaped concave prolongation.

Onychiopsis tenuiloba described by LORCH (1967) from the Middle Jurassic of Israel has similar sessile or very short-stalked fertile pinnules, but its sterile pinnules are mostly anadromic in order and quite different in form and venation from those of *O. yokoyamai*.

We at present reserve the comparison with many American *Onychiopsis* species rearranged by BERRY (1911) because they are all represented by sterile leaves.

Onychiopsis ovata described by TAN and ZHU (1982) from the Lower Cretaceous Guyang Formation, Inner Mongolia is only represented by an incomplete sterile tripinnate frond. So it is difficult to make detailed comparison with *O. yokoyamai*.

The systematic position of *Onychiopsis* has been discussed by such earlier workers as NATHORST (1890), YOKOYAMA (1889), SEWARD (1894) and YABE (1905) and later by TATTERSALL (1961), BOSE and SUKH-DEV (1961), SURANGE (1966), KRASSILOV (1967) and LORCH (1967) based on its reproductive organs, but as pointed out by WATSON (1969) it has still been uncertain.

In Japan, *Onychiopsis elongata* is restricted in distribution in the Inner Zone successively from the Middle Jurassic Utano Formation (TAKAHASI, 1973a) to the Lower Cretaceous Akaiwa Formation. *Onychiopsis elongata* is also known from the Lower Cretaceous Nagdong Formation (YABE, 1905), lower part of the Gyeongsang Group, Korea. On the other hand, *Onychiopsis yokoyamai* is restricted in distribution in the Outer Zone of Japan successively from the Upper Jurassic to the uppermost of Lower Cretaceous plant-beds.

According to TAKAHASI's list (1973b, table 2), *Onychiopsis elongata* is said to occur from the Upper Liassic Nishinakayama Formation [*Fontanelliceras* (ammonite) Zone], but he did make neither description nor illustration.

Text-fig. 14 shows fertile parts of five *Onychiopsis* species for comparison.

Specimens here described are all kept in the National Science Museum, Tokyo except 7622 and 7900.

References

- BERRY, E. W., 1911. Section on fossil plants. *In: Maryland Geol. Surv., Lower Cretaceous*. 99–172, 213–508, pls. 22–97.
- BOSE, M. N. & SUKH-DEV, 1961. Studies on the fossil flora of the Jabalpur Series from the South Rewa Gondwana Basin. 2. *Onychiopsis paradoxus* n. sp. *Palaeobotanist*, **8** (1–2): 55–64, pls. 1–2.
- GEYLER, T., 1877. Ueber fossil Pflanzen aus der Juraformation Japans. *Palaeontographica*, **24**: 221–232, pls. 30–34.
- HIRATA, M., 1972. Fossil List and Illustration of the Specimens kept in the MAKINO Botanical Garden. Vol. 1: Ryoseki-type Plants obtained from Kochi Prefecture. 81 pp., incl. 21 pls. HIRATA Inst. Geol. (In Japanese.)
- KIMURA, T., 1976. Mesozoic plants from the Yatsushiro Formation (Albian), Kumamoto Prefecture, Kyushu, Southwest Japan. *Bull. Natn. Sci. Mus.*, Tokyo, ser. C, **2**: 179–208, pls. 1–6.
- KIMURA, T. & KANSHA, Y., 1978. Early Cretaceous plants from the Yuasa District and the Aridagawa Valley, Wakayama Prefecture, in the Outer Zone of Japan. Part 1. *Ibid.*, **4**: 99–116, pls. 1–4.
- KIMURA, T. & MATSUKAWA, M., 1979. Mesozoic plants from the Kwanto Mountainland, Gumma

- Prefecture, in the Outer Zone of Japan. *Ibid.*, **5**: 89–112, pls. 1–6.
- KRASSILOV, V. A., 1967. Early Cretaceous Flora of Southern Primorye and its Significance for Stratigraphy. Siberian Branch, Far East Geol. Inst., Acad. Sci. USSR. 364 pp., 93 pls. Moscow (In Russian.)
- LORCH, J., 1967. A Jurassic flora of Makhtesh Ramon, Israel. *Israel J. Bot.*, **16**: 131–165, pls. 1–14.
- NATHORST, A. G., 1890. Beiträge zur mesozoischen Flora Japans. *Denks. Math.-Nat. Cl. Kaiser. Akad. Wiss. Wien*, **57**: 4–60, pls. 1–6.
- OISHI, S., 1931. Fossil plants from Japan and Korea. *Sci. Rep., Tohoku Imp. Univ.*, 2nd. ser., **14**: 107–118, pl. 36.
- SEWARD, A. C., 1894. The Wealden Flora, I. Thallophyta-Pteridophyta. Catalogue of the Mesozoic Plants in the Department of Geology, British Museum (Natural History). xxxviii+179 pp., 11 pls. London.
- SURANGE, K. R., 1966. Indian Fossil Pteridophytes. viii+209 pp. Council of Scientific & Industrial Research, New Delhi.
- TAKAHASI, E., 1973a. Some Triassic and Jurassic plants from Prov. Nagato (Yamaguchi Pref.), Japan. *Sci. Rep., Yamaguchi Univ.*, **20**: 7–13, incl. pls. 1–2.
- , 1973b. Stratigraphic distribution of the Miné-type and the Toyora-type floras. *Ibid.*, 15–28 (In Japanese.)
- TAN, L. & ZHU, J. N., 1982. Palaeobotany. In: The Mesozoic Stratigraphy and Palaeontology of Guyang Coal-Bearing Basin, Neimenggol Autonomous Region, China. Geol. Publ. House, Beijing, pp. 137–160, pls. 33–41. (In Chinese.)
- TATTERSALL, J. A., 1961. Notes on *Onychiopsis psilotoides* (STOKES & WEBB). *Ann. Mag. Nat. Hist.*, ser. 13, **4**: 349–352, pl. 12.
- YABE, H., 1905. Mesozoic plants from Korea. *J. Coll. Sci., Imp. Univ. Tokyo*, **20** (8): 1–59, pls. 1–4.
- , 1913. Mesozoische Pflanzen von Omoto. *Sci. Rep., Tohoku Imp. Univ.*, 2nd. ser., **1** (4): 57–64, pl. 10.
- , 1927a. Cretaceous stratigraphy of the Japanese Islands. *Ibid.*, **11** (1): 27–100, pls. 3–9.
- , 1927b. A new species of *Sphenopteris* from the Lower Cretaceous of Japan. *Japan. J. Geol. Geogr.*, **5**: 223–224, pl. 23.
- YOKOYAMA, M., 1889. Jurassic plants from Kaga, Hida, and Echizen. *J. Coll. Sci., Imp. Univ. Japan*, **3** (1): 1–66, pls. 1–14.
- , 1894. Mesozoic plants from Kozuke, Kii, Awa, and Tosa. *Ibid.*, **7** (3): 201–231, pls. 20–28.
- WATSON, J., 1969. A revision of the English Wealden flora, I. Charales-Ginkgoales. *Bull. Brit. Mus. (Nat. Hist.)*, Geol., **17**: 207–254, pls. 1–6.

Explanation of plates 1–2

Plate 1

Onychiopsis yokoyamai (YABE) KIMURA et AIBA comb. nov.: HIRATA's collection, no. 7900, kept in the MAKINO Botanical Garden, Kochi City. A leaf with fertile part. ft; fertile part, st; sterile part. Collected from Kb-6 point of HIRATA (1972), Nagashiba Formation (Lower Monobegawa Formation).

Plate 2

Onychiopsis yokoyamai (YABE) KIMURA et AIBA comb. nov.: HIRATA's collection, no. 7622, kept in the MAKINO Botanical Garden, Kochi City. Two sterile leaves. Collected from Gb-5 point of HIRATA (1972), Ryoseki Formation.

