Bull. Natn. Sci. Mus., Tokyo, Ser. C, 11 (4), December 22, 1985

Fossil Plant Remains from Taltung Formation, Palpa District, Nepal Lesser Himalaya

By

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(Communicated by Ikuwo OBATA)

Abstract Fossil plant remains from the Taltung Formation form the subject matter of this paper. The fossiliferous beds are supposed to range in age from Upper Jurassic to Lower Cretaceous. The assemblage comprises *Cladophlebis indica* (OLDHAM & MORRIS) SAHNI & RAO, ? *Sphenopteris* sp., *Pachypteris* sp., *Pterophyllum* sp. A, *Pterophyllum* sp. B, ? *Taeniopteris* sp./*Pterophyllum* sp., *Ptilophyllum* cf. *P. cutchense* MORRIS, *Weltrichia* sp. and *Elatocladus tenerrimus* (FEISTMANTEL) SAHNI, and resembles some of the assemblages known from the Upper Jurassic of India.

Introduction and Geological Outline (by SAKAI)

Plant fossils here described were collected by Sakai from the Taltung Formation of the Tansen Group (SAKAI, 1983, 1984) in the Nepal Lesser Himalaya (Fig. 1). The fossil localities are distributed in the southern flank of the Tansen Synclinorium that lies between the middle reaches of the Kali Gandaki and the Main Boundary Thrust (Fig. 1), which is about 60 km long in the eastwest direction.

The Taltung Formation (250 m thick) is unconformably underlain by the Sisne Formation of Permian age comprising diamictites and is unconformably overlain by the Amile Formation which is comparable to the Tal Formation in having the same lithology and occupying the same stratigraphic position (Fig. 2). Basaltic lava flows named Aulis Basalt, are intercalated in the basal part of the Taltung Formation and are comparable with the Rajmahal Traps in the eastern Indian Peninsula (SAKAI, 1983).

The Taltung Formation is composed of upward-fining fluvial sediments consisting of conglomerate, sandstone and silty shale. The detrital grains of the formation are quartzite and volcanic detritus that were derived from the Aulis Basalt; thus the beds assume an olive-green colour.

Fossil leaves under impression-state were received from several localities along the Badahare (T1), Amile (T2) and Tinau (T3) Rivers (Fig. 1), in addition fragmentary plant remains were commonly found throughout the sequence in every section of the Taltung Formation. All these fossil horizons are within 60 m thickness from the base

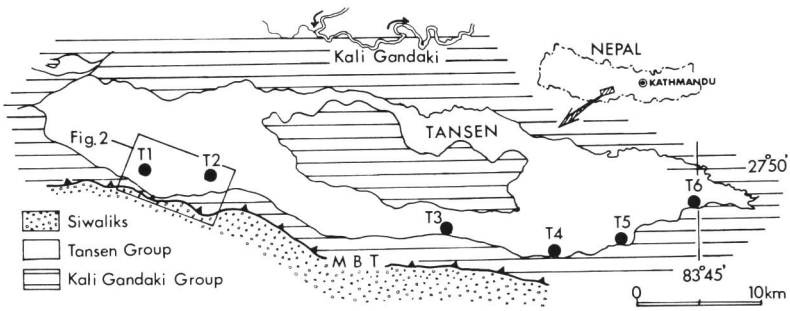


Fig. 1.

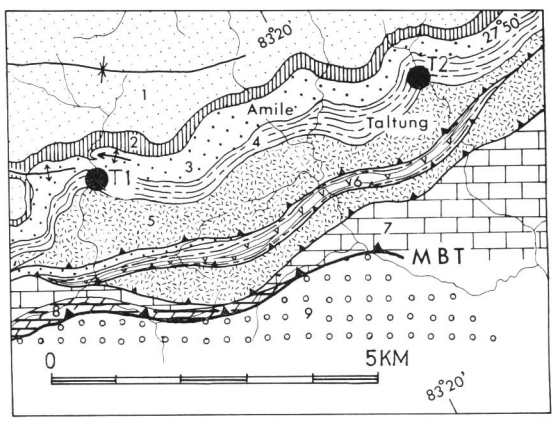


Fig. 2.

Fig. 1. Geological sketch-map showing the distribution of the Tansen Group and plant-fossil localities (T1 ~ T6) of the Taltung Formation. (MBT; main boundary thrust)

Fig. 2. Geological map indicating plant-fossil localities in the Taltung area. Location of the map is shown on Fig. 1. 1; Dumri Formation. 2; Bhainskati Formation. 3; Amile Formation. 4; Taltung Formation. 5; Sisne Formation. 6; Aulis Basalt. 7; Kerabari Formation. 8; Angha Khola Formation. 9; Siwaliks.

of the Taltung Formation (Fig. 3). The fossil leaves are embedded in the parallel laminated silty sandstone or carbonaceous silty beds which are interpreted as natural levee and overbank deposits (SAKAI, 1983). Many carbonized leaves overlap and form black laminae; at places several black laminae of leaves were observed within 1 m thick sequence (Fig. 4). These fossiliferous fine-grained sediments are overlain by conglomerate of channel filing deposits in which fragmentary fossil woods are commonly met with. Some of the larger trunks with diameter ranging up to 40 cm and length up to 60 cm occur sporadically in the lower part of the Taltung Formation (T4, T5, T6, see Fig. 1). Among these, a few specimens show anatomical details and they are either calcified or silicified.

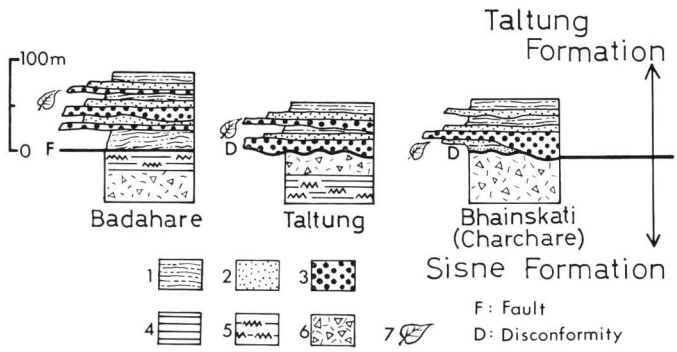


Fig. 3. Stratigraphic sections showing horizons of plant-fossils. 1; silty sandstone. 2; sandstone. 3; conglomerate. 4; black slate. 5; bioturbated sandy banded mudstone. 6; diamictite. 7; plant-fossil horizon.

Description (by KIMURA and BOSE)

All specimens here described are kept in the National Science Museum, Tokyo.

Cladophlebis indica (OLDHAM & MORRIS) SAHNI & RAO (Pl. 1, *5*; Fig. 5A)

Material: NSM-PP 7666.

Main rachis of largest specimen measuring 8.5 cm in length and 1.5 mm in width, surface smooth, bearing 6 alternately arranged pinnae (on one side fragments of 4 more pinnae are present, but not attached to main rachis). Pinnae arising at an angle of 60–65 degrees. Pinna rachis about 0.5–1 mm wide, showing a faint median groove. Apical ends of pinnae incomplete, largest pinna 5.8 cm long and 2.2 cm wide. Pinnules attached to secondary rachis by entire base at an angle of 60 degrees, catadromic, contiguous, bases of adjacent pinnae joining each other, closely set, 0.7–1.1 cm long, 0.3–0.5 cm wide; margin entire, rarely in some at places slightly wavy or near extreme apex showing 2–3 dentations. Apex acute or sub-acute; acroscopic basal margin curving upwards, basiscopic basal margin straight or slightly curving downwards. Median vein of pinnules prominent from base to apex, lateral veins arising at an angle of 25–35 degrees, mostly forking once at different levels, or rarely near bases of pinnules lateral veins forking twice, out of these mostly both the branches forking once, rarely one branch may reach margin without forking.

Occurrence: T2, locally common.

Remarks: *Cladophlebis indica* described above resembles in gross features as well as in venation pattern the specimens of *C. indica* figured by FEISTMANTEL (1877a, pl. 26, fig. 4) and BOSE and SAH (1968, pl. 2, fig. 18).

? ***Sphenopteris*** sp. (Pl. 1, *3–4*; Fig. 5B)

Material: NSM-PP 7667

Specimen extremely fragmentary, measuring 2.3 cm in length and 2.4 cm in width (on one side pinnae incomplete). Main rachis about 2 mm wide, showing longitudinal

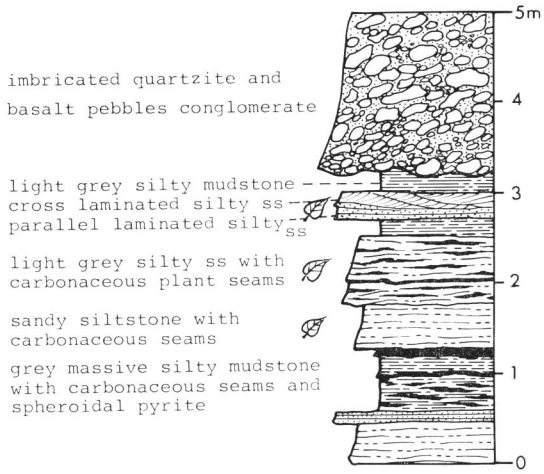


Fig. 4. Lithostratigraphic sequence of plant-fossil bearing beds at Taltung.

ridges and grooves. Pinnae sub-opposite, arising at an angle of 85–90 degrees. Pinna rachis inconspicuous, pinnules attached by their entire base, broadly oval or somewhat rhomboidal in shape; margin entire; apex obtuse; basal acroscopic margin gradually curving downwards, basal basiscopic margin decurrent. Veins arising from entire base, simple or forked, majority forking once.

Occurrence: T3, rare.

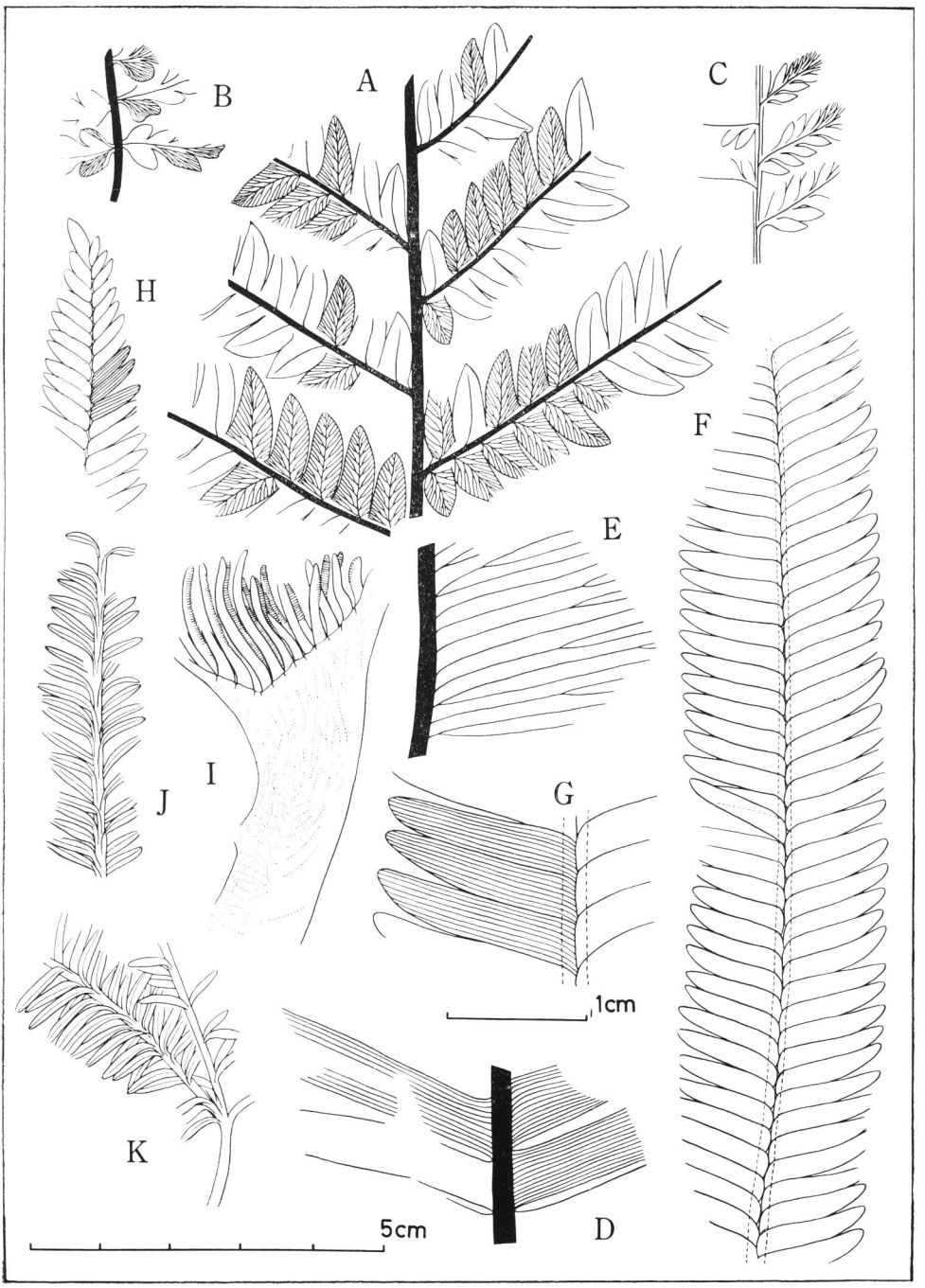
Remarks: Due to the fragmentary nature of the specimen it has been doubtfully referred to the genus *Sphenopteris* (BRONGNIART) STERNBERG.

Pachypteris sp. (Pl. 1, *4–5*; Fig. 5C)

Material: NSM-PP 7668, 7669.

Frond bipinnate, 2.9 cm long and 3.3 cm wide (pinnae incomplete towards apex); principal rachis about 1.5 mm wide; at places showing a narrow median groove. Largest pinna measuring 1.9 cm in length, alternately arranged at an angle of about 60 degrees, rachis less than 1 mm in width, showing a median groove. Pinnules arising at an angle of 55–60 degrees, somewhat lanceolate in shape, 3–6 mm long and 1.5–2 mm wide; apex sub-acute, rarely acute; margin entire; basal acroscopic margin straight

Fig. 5. (A ~ K). (All natural size except Fig. 5G)
A; *Cladophlebis indica* (OLDHAM & MORRIS) SAHNI & RAO (NSM-PP 7666), drawn from Pl. 1, fig. 1. B; ? *Sphenopteris* sp. (NSM-PP 7667), drawn from Pl. 1, fig. 2. C; *Pachypteris* sp. (NSM-PP 7668), drawn from Pl. 1, fig. 4. D; *Pterophyllum* sp. A (NSM-PP 7671) drawn partly from Pl. 1, fig. 7. E; ? *Taeniopteris* sp./*Pterophyllum* sp. (NSM-PP 7701), showing venation. F; *Ptilophyllum* cf. *cutchense* Morris (NSM-PP 7680), drawn from Pl. 3, fig. 1. G; a portion from Fig. 5F magnified to show the veins. H; apical portion of a leaf of *Ptilophyllum* cf. *P. cutchense* MORRIS (NSM-PP 7685), drawn from Pl. 2, fig. 4. I; *Weltrichia* sp. (NSM-PP 7691), drawn from Pl. 3, fig. 2. J–K; *Elatocladus tenerrimus* (FEISTMANTEL) SAHNI (NSM-PP 7696), drawn from Pl. 3, figs. 4–5.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or slightly curving downwards, basal basiscopic margin distinctly decurrent, joining the basal acroscopic margin of the pinnule lying below. Veins mostly obscure, at places midvein visible with one or two lateral veins arising at narrow angles.

Occurrence: T3, rare.

Comparison: *Pachypteris* sp. resembles most *P. elegans* ARCHANGELSKY (1966, pl. 1, fig. 1) in gross features. It also matches some of the specimens of *P. haburensis* BOSE *et al.* (1982, pl. 1, fig. 11; text-fig. 1A). The latter species differs in having pinnae which arise at narrower angles. Moreover the majority of pinnules in *P. haburensis* have acute apices.

Pterophyllum sp. A (Pl. 1, *6–7*; Fig. 5D)

Material: NSM-PP 7670–7672.

Rachis 1.5–3 mm wide, showing prominent longitudinal ridges and grooves, largest specimen measuring 2.8 cm in length and 5 cm in width. Pinnae 0.5–0.9 mm wide, laterally attached at an angle of about 80–85 degrees, margin parallel, entire; apical ends incomplete; both acroscopic and basiscopic basal margins curving upwards and downwards respectively. Bases of adjacent pinnae joining each other. Veins simple, parallel, 7–8 veins per 0.5 cm.

Occurrence: T3, rather rare.

Comparison: In general shape and venation pattern *Pterophyllum* sp. A looks more like *P. rajmahalense* MORRIS described by BOSE & BANERJI (1981, pl. 7, fig. 35; pl. 8, fig. 38). *Pterophyllum morrisianum* OLDHAM described by BOSE and BANERJI (1981) differs from *P.* sp. A in having much longer and broader pinnae.

Pterophyllum sp. B (Pl. 2, *1*)

Material: NSM-PP 7675.

The specimen shows only two incomplete pinnae attached to a wide rachis (8 mm). Of these the larger pinna (3.1 × 1.7 cm) shows 17 veins. Veins are fairly coarse.

Occurrence: T1, rare.

Remarks: The specimen is too incomplete to be compared with any of the existing species of *Pterophyllum* BRONGNIART.

? ***Taeniopteris*** sp./***Pterophyllum*** sp. (Pl. 2, *2–3*; Fig. 5E)

Material: NSM-PP 7673, 7674, 7676, 7701, 7702.

Leaves fragmentary, largest specimen 14.5 cm long (margin incomplete on both sides; available width about 8 cm); midrib about 7 mm wide, longitudinally striated. Surface of lamina seems to be thin, lateral veins arising at an angle of about 76–80 degrees, simple or forked, forking at different levels, 4–10 per cm,

Occurrence: T1, locally common.

Remarks: The specimens look very much like the specimens of ? *Taeniopteris* sp./*Pterophyllum* sp. figured by BOSE and BANERJI (1981, text-fig. 30) both in gross feature as well as in venation pattern. These specimens from Badahare could be apical segments of leaves like *Pterophyllum princeps* OLDHAM & MORRIS described by BOSE and BANERJI (1981, pl. 12, fig. 47; pl. 10, fig. 42; text-fig. 23).

It is also quite likely these fragments may be apical segments of the type of frond

described above as *Pterophyllum* sp. B (Pl. 2, *1*).

Ptilophyllum cf. ***P. cutchense*** MORRIS (Pl. 2, *4*; Pl. 3, *1*; Figs. 5F–H)

Material: NSM-PP 7666, 7677–7690.

Leaves imparipinnate, largest leaf measuring 13.6 cm in length and 2.9 cm in width, gradually tapering towards apex. Rachis partially or completely concealed by pinnae, 1–2.5 mm wide. Pinnae mostly closely set on upper surface of rachis, normally 1.2–1.4 cm long (towards apex 3–4 mm long), 2.5–3 mm wide, attached at an angle of 65–75 degrees (less towards apex); margin parallel, sometimes margin of adjacent pinnae touching each other, rarely overlapping; apex mostly obtuse, rarely sub-acute; basal acroscopic margin somewhat rounded or gradually curving downwards, basal basiscopic margin slightly decurrent. Veins mostly obscure, rarely visible at places.

Occurrence: T2, locally abundant.

Remarks: *Ptilophyllum* cf. *P. cutchense* is extremely common in the Taltung Formation. Some of the specimens resemble the specimens of *Ptilophyllum* sp. cf. *P. cutchense* described by BARALE *et al.* (1978, pl. 1, fig. 4) from Kagbeni-Muktinath. They also resemble the specimens of *Ptilophyllum cutchense* figured by BOSE and KASAT (1972, pl. 1, fig. 10; pl. 2, fig. 14). In gross features they may also be compared with some of the specimens of *Ptilophyllum jabalpurense* JACOB & JACOB figured by BOSE and KASAT (1972, pl. 9, figs. 80–81).

As all our specimens lack cuticle so we have provisionally referred them to the species *cutchense*.

Weltrichia sp. (Pl. 3, *2–3*; Fig. 5I)

Material: NSM-PP 7691.

Microsporophyll incomplete at base, measuring 6.7 cm in length and 1.8 cm in width near middle region and 3.5 cm in width near apical region; substance seems to be very thick, surface showing prominent wrinkles forming irregular patterns (mostly polygonal or rhomboidal in shape), on one side marginal region slightly depressed (about 3–4 mm wide) and showing discontinuous longitudinal striations. Apical part of microsporophyll boat-shaped, bearing on either side finger-like appendages, largest appendage measuring 1.6 cm in length and about 3 mm in width, bases of appendages slightly swollen, surface showing a slightly depressed median region, on either side of median region surface showing narrow elongated chambers (perhaps representing pollen chambers).

Occurrence: T2, rare.

Comparison: The above description is based on a single laterally compressed detached microsporophyll. In this specimen the finger-like appendages are attached at the apical end and somewhat like the ones in *Weltrichia hirsuta* SCHWEITZER (1977) and *W. harrisiana* BOSE & BANERJI (1984). The finger-like appendages resemble the fertile appendages of *Weltrichia santalensis* (SITHOLEY & BOSE) BOSE described by SITHOLEY and BOSE (1971). *Weltrichia santalensis* differs in having microsporophylls whose distal ends are more or less lance-shaped.

Elatocladus tenerrimus (FEISTMANTEL) SAHNI (Pl. 2, *5*; Pl. 3, *4–6*; Figs. 5J–K)

Material NSM-PP 7673, 7674, 7692–7698, 7702.

Branched leafy twigs, branching at an angle of 40–50 degrees; stem about 1 mm wide. Leaves spirally arranged, dorsiventrally flattened, attached at an angle of 60–85 degrees, sometimes curving downwards, linear-lanceolate, normally 5–8 mm long and 0.5–1.8 mm wide, margin entire; apex mostly obtuse, sometimes sub-acute; basal acroscopic margin straight; basal basiscopic margin decurrent. Midrib mostly obscure.

Occurrence: T1, locally abundant.

Remarks: The specimens from Badahare match the specimens of *Elatocladus tenerrimus* (FEISTMANTEL) SAHNI described by FEISTMANTEL (1877a, pl. 10, figs. 6–11) and SAHNI (1928, pl. 1, fig. 11) from Sehora (Sher River) and the specimens of *E.* cf. *E. tenerrimus* figured by BOSE and BANERJI (1984).

Discussion

From Kagbeni-Muktinath, Nepal, Mesozoic fossil plants were first reported by BORDET *et al.* (1964). A detailed description of some of these plants viz., ? *Taeniopteris* sp. cf. *T. spathulata* MCCLELLAND, *Ptilophyllum acutifolium* MORRIS, *P.* sp. cf. *P. cutchense* MORRIS and *Araucarioxylon nepalensis* BARALE *et al.* was given by BARALE *et al.* (1978). The assemblage from the Taltung Formation is more diversified and the presence of *Cladophlebis indica* and species of *Pterophyllum* along with a large number of *Ptilophyllum* leaves indicates a more closer affinity with the Rajmahal flora, especially the one met with at Bindaban. BARALE *et al.* (1978), too, had suggested that the fossiliferous beds of Kagbeni-Muktinath were also of somewhat similar age as the Rajmahal Hills. Besides the assemblages from the Rajmahal Hills, the overall assemblage from the Taltung Formation resembles the one described by FEISTMANTEL (1877a) and BOSE and BANERJI (1984) from Sehora (Sher River) and Kachchh (Kakadbhit, Kurbi etc.) respectively.

At Sehora species of *Pagiophyllum* HEER and *Brachyphyllum* BRONGNIART are fairly common, whereas, in the Taltung Formation these two genera have not been found so far. Besides the assemblages from the Upper Gondwana, the Taltung assemblage also shows similarity with the one described by GANESAN and BOSE (1982) from Lingshi Basin, Bhutan.

The present work further supports the view that the Upper Gondwana extended right up to the Lesser Himalaya, east of Thakkhola Valley, Nepal.

Acknowledgements

The last author (SAKAI) is grateful to Dr. M. P. SHARMA, Chairman of the Department of Geology, Tribhuvan University and Mr. J. M. TATER, Deupty Director General of the Department of Mines and Geology, Ministry of Industry and Commerce,

Kathmondu, Nepal for their kind help and valuable suggestions. The field work of present study has been carried out by Sakai as a part of J. O. C. V. (Japan Overseas Cooperation Volunteers) activities in Nepal. The expenses of this work were supported mainly by J. O. C. V. for which we would like to express our sincere thanks. We also give our thanks to Miss T. OHANA for her help in drawing the fossil-figures.

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Explanation of Plates 1–3

Plate 1

1. *Cladophlebis indica* (OLDHAM & MORRIS) SAHNI & RAO, NSM-PP 7666, ×1.
2. ? *Sphenopteris* sp., NSM-PP 7667, ×1.
3. The above magnified, ×2.
4. *Pachypteris* sp., NSM-PP 7668, ×1.
5. The above magnified, ×2.

6–7. *Pterophyllum* sp. A, NSM-PP 7670 and NSM-PP 7671, ×1.

Plate 2

1. *Pterophyllum* sp. B, NSM-PP 7675, ×1.

2–3. ? *Taeniopteris* sp./*Pterophyllum* sp., NSM-PP 7695 and NSM-PP 7673, ×1.

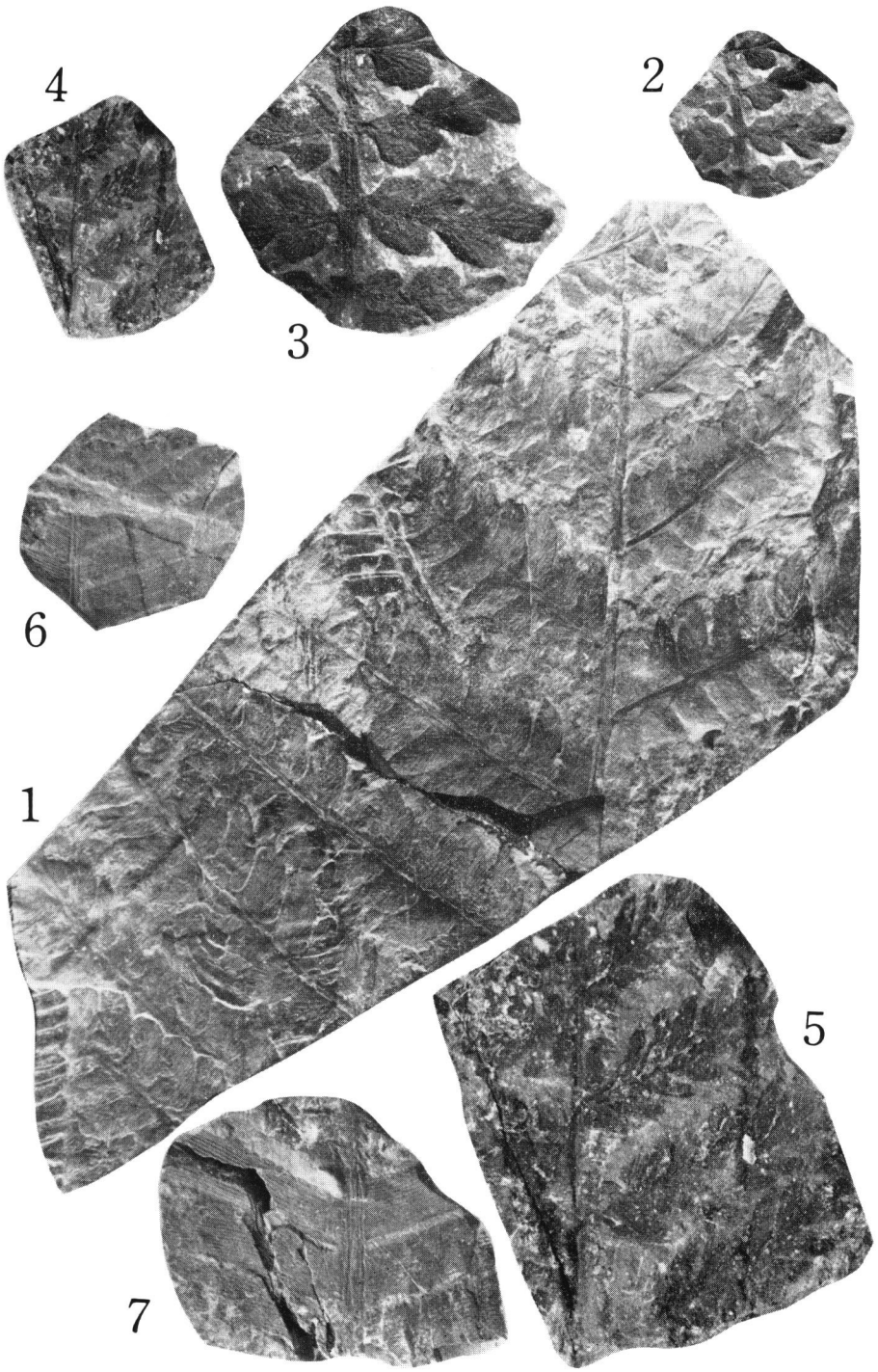
4. *Ptilophyllum* cf. *cutchense* MORRIS, NSM-PP 7685, ×1.
5. *Elatocladus tenerrimus* (FEISTMANTEL) SAHNI, NSM-PP 7702, ×1.

Plate 3

1. *Ptilophyllum* cf. *P. cutchense* MORRIS, NSM-PP 7680, ×1.
2. *Weltrichia* sp., NSM-PP 7691, ×1.

4–5. *Elatocladus tenerrimus* (FEISTMANTEL) SAHNI, NSM-PP 7696, ×1.

6. The above magnified from NSM-PP 7692, ×2.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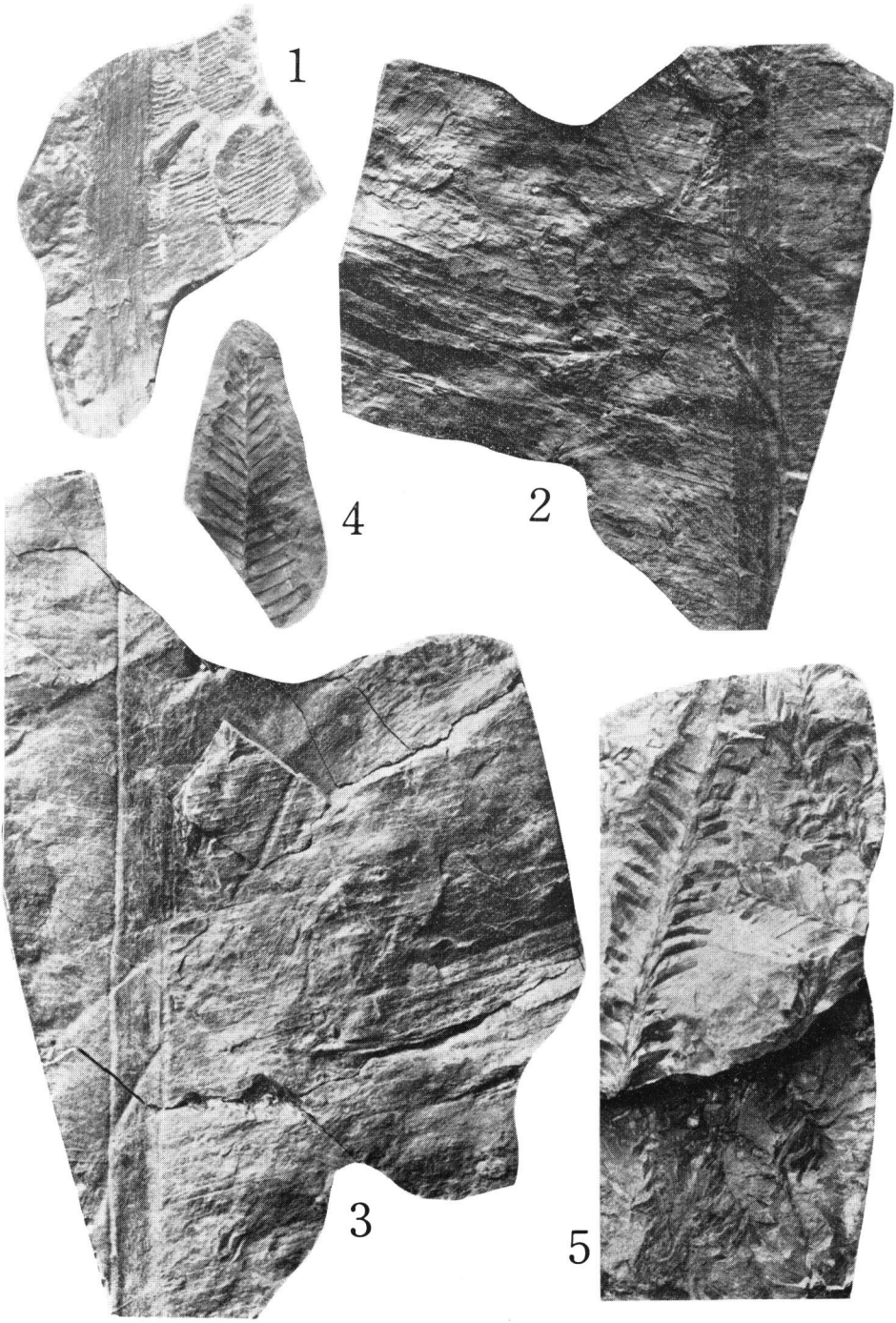
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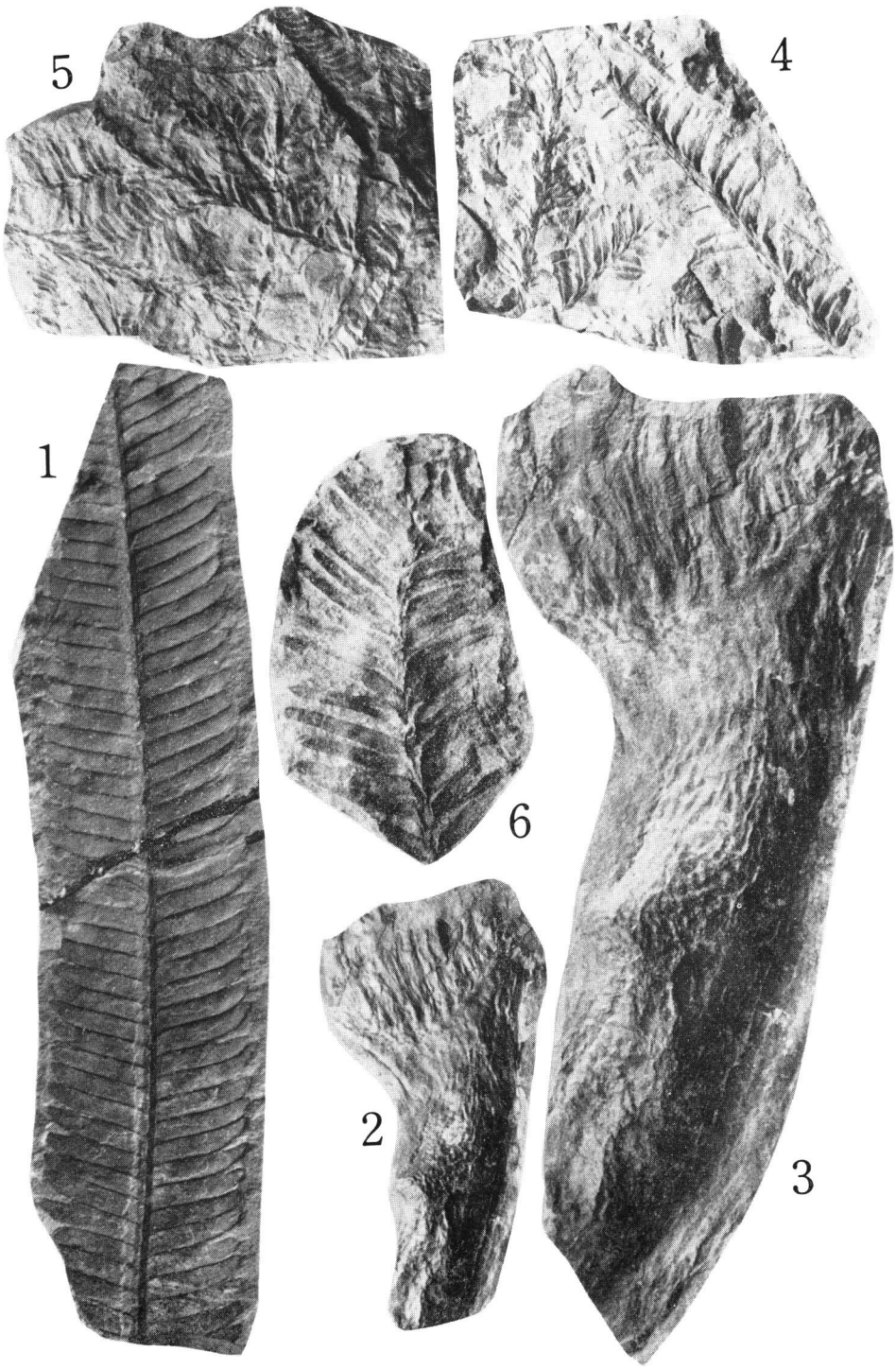
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