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New Record of *Ptilophyllum* and related leaf fossils from Kimmeridgian sediments of the Kachchh Basin, western India

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Several well-preserved impressions of *Ptilophyllum* and *Cladophlebis* from the Upper Kimmeridgian part of the Jhuran Formation at the Jhuran River are described and illustrated. The presence of well-preserved leaf fossils and plant debris suggest an increasing terrestrial influence during the filling of the Kachchh Basin in the Late Jurassic. A lone ammonite collected from a bed below the plant fossil-bearing horizon and identified as *Metagravesia* cf. *decipiens* Spath suggests a Late Kimmeridgian age. The cyclically alternating fine-grained, bioturbated, often ferruginous sandstone, and medium- to coarse grained, trough cross-bedded sandstone, suggests shallowing-deepening cycles of a delta lobe with environments ranging from the lower to the upper delta front.

Keywords: *Ptilophyllum*, Kimmeridgian, shallowing-deepening cycles, Kachchh.

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INTRODUCTION

Non-marine Jurassic sediments of the Indian subcontinent have not been given as much attention as marine Jurassic deposits for the simple reason that the significance of terrestrial fossils for palaeoenvironmental reconstructions and stratigraphic correlations was not adequately understood. This lack of research resulted in a comparatively poor documentation of terrestrial fossils (Moser *et al*., 2006; Pieńkowski *et al*., 2015; Jana and Hilton, 2007; Mathur, 1972; Rai *et al*., 2016a, b; Fürsich *et al*., 2013, 2017, 2020, etc.). It is therefore important to place a higher emphasis on the identification and documentation of terrestrial fossils within marine and non-marine strata to increase our knowledge of the fossil record (e.g., Rai *et al*., 2016a).

Ptilophyllum and *Cladophlebis* are Upper Gondwana compound leaf fossils characterised by small, closely set or imbricating pinnules, sub-oppositely fully attached to the rachis. The pinnules show a simple margin, acute apex, prominent mid-rib with lateral veins and parallel to sub-parallel venation pattern. In India, they have been recorded from all the marine and non-marine Jurassic formations (e.g., Bose and Kasat, 1972; Bose and Banerji, 1984; Arora *et al.,* 2015).

GEOLOGICAL SETTING

The Kachchh Basin at the western margin of the Indian subcontinent (Fig. 1) is known for its marine Jurassic succession formed along the southern margin of the Tethys Sea. The strata contain a very rich and highly diverse fauna and flora. The good preservation of the fossils have attracted scientists for more than a century and established the Kachchh Basin as one of the best places to study the Jurassic strata of the southern Tethys at the margin of the Malagasy Gulf (Fürsich *et al.,* 2013, 2020). Litho- and biostratigraphic classifications have been developed and refined over the last decades (e.g., Biswas, 1980; Fürsich *et al.,* 2001, 2013, 2020). Lithostratigraphically, the Upper Jurassic rocks of the Kachchh Basin have been divided into Jumara, Jhuran, and Bhuj formations with a considerable depositional time gap between the Jumara and Jhuran formations (Fig. 2; e.g., comp. Alberti *et al*., 2013).

The leaf fossils *Ptilophyllum* and *Cladophlebis* are common in the Middle to Late Jurassic and Early Cretaceous sediments of the Kachchh Basin and neighbouring areas of Gujarat (Table 1). In the present study, both taxa are recorded from a horizon in the bed of the Jhuran River, north of the

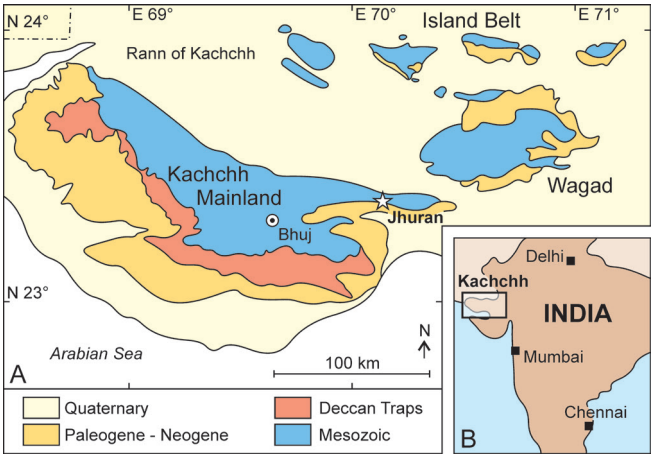

Fig. 1. A. Schematic geological map of the Kachchh Basin with the study locality. B. Map illustrating the position of the Kachchh Basin in western India (modified after Fürsich *et al*., 2013).

road between Jawahar Nagar and Modsar, in the eastern part of the Kachchh Mainland (coordinates: 23°21'05.0"N, 69°59'24.4"E). The unit containing the plant fossils is about 5 m thick and consists of a whitish, argillaceous, fine-grained sandstone (Fig. 3). The succession forms the upper part of the Jhuran Formation exposed along the Jhuran River. In general, the upper part of the succession exposed along the Jhuran River consists of an alternation of fine-grained, bioturbated, often ferruginous sandstones and medium- to coarse grained, trough cross-bedded sandstones.

The most plausible environmental interpretation of these strata is their deposition in a delta lobe fluctuating between the lower to the upper delta front thus corresponding to shallowing-deepening cycles. The fine-grained bioturbated sediments represent transgressive events, whereas the cross-bedded sandstones were deposited during regression. Towards the top of the cycles, the the basin shallowed and terrestrial elements, such as land-derived iron became concentrated. Most of the fine-grained sediments contain plant debris. The bed with the leaf fossils was deposited during the early part of a sea-level highstand.

A single fragmentary ammonite (Fig. 4), from the Middle Member of the Jhuran Formation, collected from a bed about 220 m below the plant fossil-bearing horizon, exposed along the road-cut section between Jawahar Nagar and Modsar (coordinates: 23°21'19"N, 69°59'49"E), has been identified as *Metagravesia* cf. *decipiens* Spath (1931, p. 504, pl. 94, fig. 3a, b). *Metagravesia decipiens* Spath is characterised by blunt and distant primary ribs, virgatotome with long rursiradiate secondary ribs and free secondary ribs and shallow constrictions. *Metagravesia* cf. *decipiens* Spath suggests a middle Late Kimmeridgian age (Grant-Mackie. 1988, Spath 1931, p. 504).

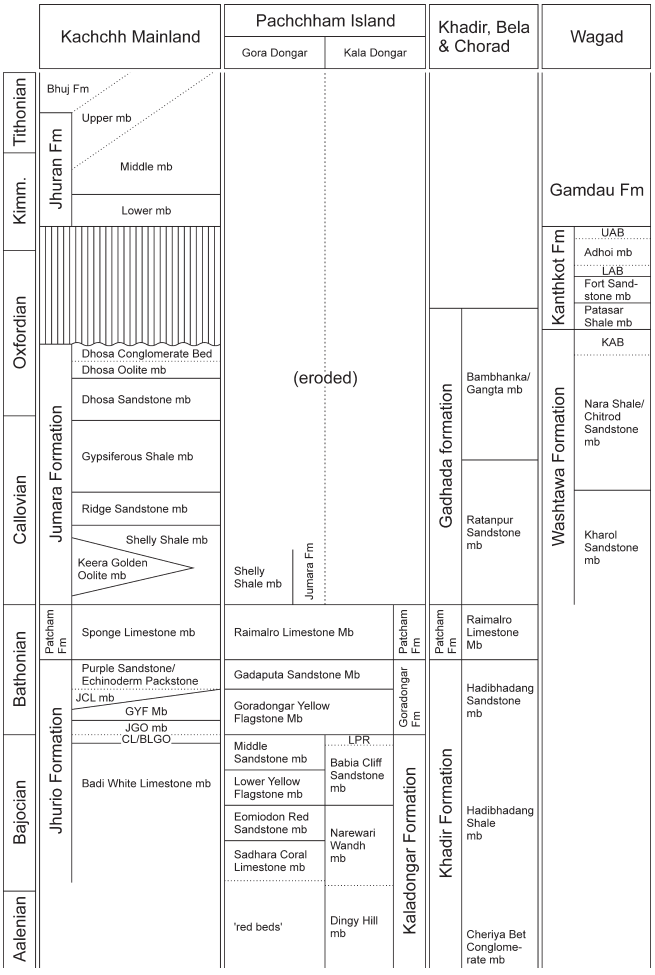

Fig. 2. Lithostratigraphy of the Upper Jurassic strata of the Kachchh Basin (modified after Fürsich *et al*., 2020).

SYSTEMATICS

While measuring a section through the Jhuran Formation at the Jhuran River, a bed containing a series of well-preserved leaf impressions was found. They were studied in the field with the help of a hand lens and photographed for further identifications. All the collected samples are lodged in the Department of Earth and Environmental Science, K.S.K.V. Kachchh University, Bhuj (Gujarat, India) and numbered as KSKV2020/Kachchh/JH-1-17. They belong to two taxa, which will be described briefly in the following.

Division **Cycadophyta** Bessey, 1907
Class **Cycadopsida** Foster and Gifford, 1974
Order **Bennettitales** Engler, 1892
Family **Williamsoniaceae** Carruthers, 1870
Genus ***Ptilophyllum*** Morris, 1840

Ptilophyllum cutchense (Morris) Bose & Kasat, 1972
(Figs. 5A, C, 6B)

Material: Several leaf impressions (field photographs) were observed in a 140-cm thick bed of whitish, argillaceous, fine-sandy siltstone in the upper part of the Jhuran Formation, exposed on the northern side of the road between Jawahar

Table 1. Previous records of *Ptilophyllum* and *Cladophlebis* from different localities in the Kachchh Basin and neighboring areas.

Taxonomy	Authors	Age	Localities
***Ptilophyllum* Morris**			
P. acutifolium Morris	Mehra *et al*., 1979	early Early Cretaceous	Jag Temple, Bhuj, Kachchh Basin
P. acutifolium Morris	Bose & Banerji, 1984	middle Late Jurassic	Loharia, Bhajori, Manzal and Kakadbhit, Kachchh Basin
Ptilophyllum sp. cf. *P. amarjolense* Morris	Bose & Banerji,1984	middle Late Jurassic	Chawad River, Kachchh Basin
P. cutchense Morris	Mehra *et al*., 1979	early Early Cretaceous	Jag Temple, Bhuj, Kachchh Basin
P. cutchense Morris	Bose & Banerji, 1984	middle Late Jurassic	Loharia, Trambau, Bhajori, Kera, Sukhpar, Jamthara, Kurbi, Gadhsisa, Manzal, Kakadbhit, Dauda Mota, Chawad River, Walka Mota, Lakhapar, Ghuneri and Dharesi, Kachchh Basin
P. cutchense type 1	Bose & Banerji, 1984	middle Late Jurassic	Kurbi, Kachchh Basin
P. cutchense type 2	Bose & Banerji, 1984	middle Late Jurassic	Kurbi, Kachchh Basin
P. distance (Feistmantel)	Bose & Banerji, 1984	middle Late Jurassic	Trambau and Sukhpar, Kachchh Basin
P. horridum Roy	Bose & Banerji, 1984	middle Late Jurassic	Trambau, Sukhpar and Dharesi, Kachchh Basin
P. indicum Jacob & Jacob	Bose & Banerji, 1984	middle Late Jurassic	Trambau & Sukhpar, Kachchh Basin
P. institacallum Bose	Bose & Banerji, 1984	middle-Late Jurassic	Trambau, Sukhpar,and Chawad River, Kachchh Basin
P. oldhamii Jacob & Jacob	Bose & Banerji, 1984	middle Late Jurassic	Trambau, Kachchh Basin
P. sakrigaliensis Sah	Bose & Banerji, 1984	middle Late Jurassic	Khari River near Bhuj and Chawad River, Kachchh Basin
Ptilophyllum sp.	Bose & Banerji, 1984	middle Late Jurassic	Walka Mota, Kachchh Basin
***Cladophlebis* Brongniart**			
C. daradensis Bose & Banerji	Bose & Banerji, 1984	middle Late Jurassic	Trambau, Khari River (Rudra Mata Dam site), Sukhpar, Mankua, Daisara, Kurbi, Gadhsisa, Kakadbhit, DaudaMota, Chawad River, Bhuki Nala near Meghpar, Walka Mota, Lakhapar and Dharesi, Kachchh Basin
C. denticulata (Brongniart)	Mehra *et al*., 1979	early Early Cretaceous	Jag Temple, Bhuj, Kachchh Basin
C. indica (Oldham & Morris) Feistmantel	Banerji *et al*., 1984	Early Cretaceous	Himmatnagar, Sabar Kantha District, Gujarat
C. kakadbhitensis Mehra &Verma	Mehra &Verma, 1982	Early Cretaceous	Kakadbhit, Kachchh Basin
C. kathiawarensis Roy	Kumaran *et al*., 1984	Early Cretaceous	Near Tarnetar Temple, Saurashtra, Gujarat
Cladophlebis sp. cf. *C. kathiawarensis* Roy	Bose & Banerji, 1984	middle Late Cretaceous	Dudhai, Trambau, Sukhpar, Jamthara, Kakadbhit and Kurabi, Kachchh Basin
Cladophlebis sp. cf. *C. longipennis* Seward	Kumaran *et al*., 1984	Early Cretaceous	Near Tarnetar Temple, Saurashtra, Gujarat
Cladophlebis sp.	Banerji *et al*., 1984	Early Cretaceous	Himmatnagar, Sabar Kantha District, Gujarat
Cladophlebis sp. A	Bose & Banerji, 1984	middle Late Jurassic	Khari River (Rudra Mata Dam site), Kachchh Basin
Cladophlebis sp. B	Bose & Banerji, 1984	middle Late Jurassic	Dharesi & Chawad River, Kachchh District, Gujarat
Cladophlebis sp. C	Bose & Banerji, 1984	middle Late Jurassic	Khari River (Rudra Mata Dam site), Kachchh Basin
Cladophlebis sp.	Bose *et al*., 1984	Early Cretaceous	Gardeshwar, Gujarat

Nagar and Modsar in the eastern part of the Kachchh Mainland.

Description: Lamina/leaf incomplete, pinnate, measuring more than 23 cm in length and approximately 2 cm in width at widest point. Lamina linear lanceolate. Rachis fully or partially concealed. Pinnae attached adaxially on upper surface of rachis, often attached by entire base, arising at an angle of 60º - 65º, closely set touching each other or imbricate. Pinnae linear-lanceolate or elongate measuring 2.5 cm in length and 0.3 cm in width, margin straight or falcate. Apex acute or obtuse. Acroscopic margin slightly contracted and rounded, whereas basiscopic margin decurrent. Veins not discernable.

Remarks: *Ptilophyllum cutchense* is the most commonly found leaf fossil in the Jurassic-Cretaceous sedimentary deposits of India (Bose and Banerji 1984; also see Table 1).

Unclassified Ferns

Genus ***Cladophlebis*** Brongniart, 1849

Cladophlebis sp.
(Figs. 5B, 6A)

Material: Some leaf impressions (field photographs)

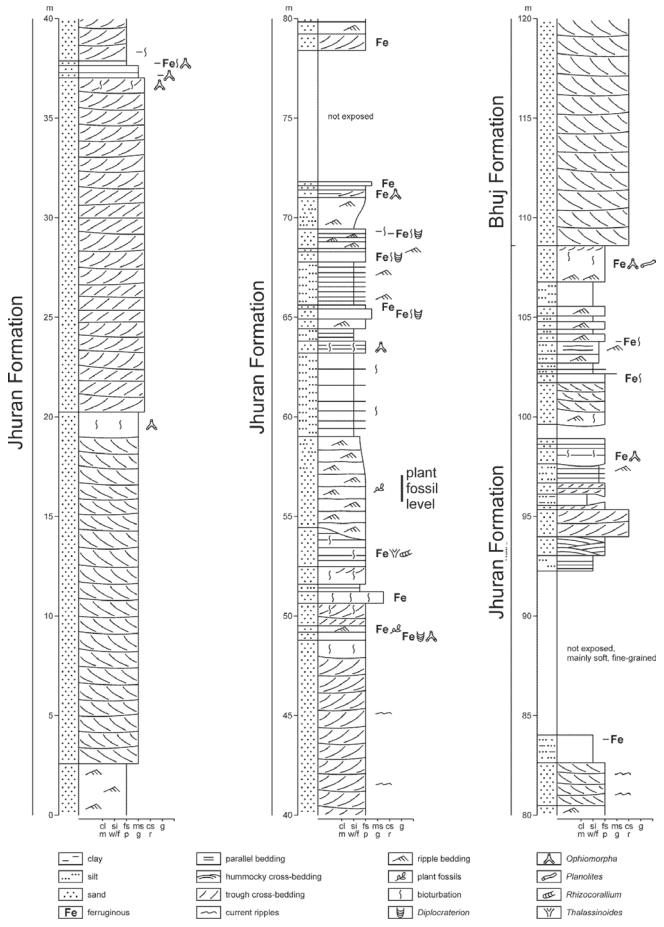

Fig. 3. Section through the upper part of the Jhuran Formation exposed in the Jhuran River north of the road between Jawahar Nagar and Modsar in the eastern part of the Kachchh Mainland. The bed with leaf fossils is marked.

were observed in a 140-cm thick bed of whitish, argillaceous, fine-sandy siltstone in the upper part of the Jhuran Formation, exposed on the northern side of the road between Jawahar Nagar and Modsar in the eastern part of the Kachchh Mainland.

Description: Pinnae incomplete, linear lanceolate in shape, available length 6.7 cm and width 3 cm at widest point. Rachis 0.2 cm wide, mesially grooved. Pinnules incomplete, linear or falcate, arising mostly at an angle of 50º, alternate or sub-oppositely set, measuring up to 2 cm in length and 0.5 cm in width, attached by broad whole base, sometimes attached to each other by decurrent bases. Margin straight, occasionally undulate. Apex not clearly discernible, mid-rib prominent, secondary vein not visible.

Remarks: In overall morphology *Cladophlebis* sp. closely resembles *Cladophlebis kathiyawarensis* Roy (1968) from Songad, Gujarat, and *Todites indicus* (Oldham and Morris) Bose and Sah (1968) from Rajmahal Hills, Bihar. However, since the lateral veins are not clearly discernable, an assignment to species level is not possible.

TAPHONOMIC REMARKS AND DEPOSITIONAL SETTING

The occurrence of *Ptilophyllum* and *Cladophlebis* fronds within the Late Kimmeridgian succession of the Jhuran Formation of the Kachchh Basin suggests terrestrial influx. During this time interval, the biomass of the floral assemblage was overwhelmingly dominated by *Ptilophyllum* fronds over other palaeo-floristic components such as pteridophytes and conifers. The floral assemblage corresponds to Floristic zone No. 8 of Sukh-Dev (1987), i.e. the *Dictyozamites* – *Pterophyllum* – *Anomozamites* Assemblage zone, where cycadophytes dominate over pteridophytes and conifers, indicating a Late Jurassic – Early Cretaceous age. Globally, bennettitales were at their zenith during the Jurassic period

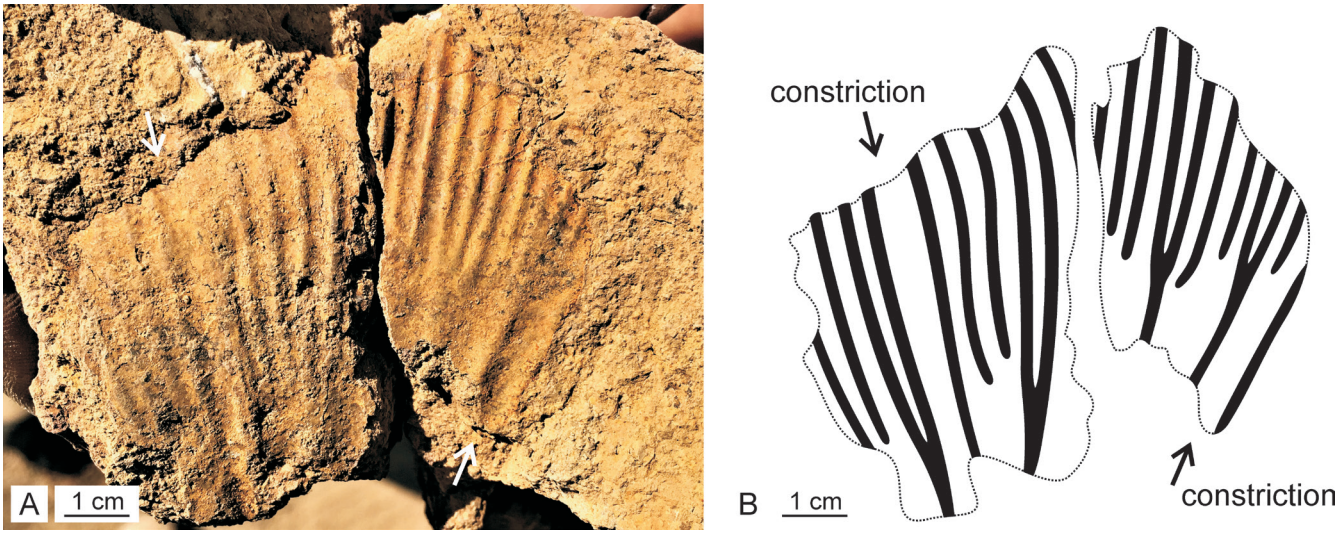

Fig. 4. *Metagravesia* cf. *decipiens* Spath (KSKV2016IIJH 50) from the Middle Member of the Jhuran Formation, exposed along the road cut between Jawahar Nagar and Modsar in the eastern part of the Kachchh Mainland. A. Lateral view showing blunt and distant virgatotome ribs with long rursiradiate secondary ribs and free secondary ribs. Note two shallow constrictions. B. Sketch of the ornamentation.

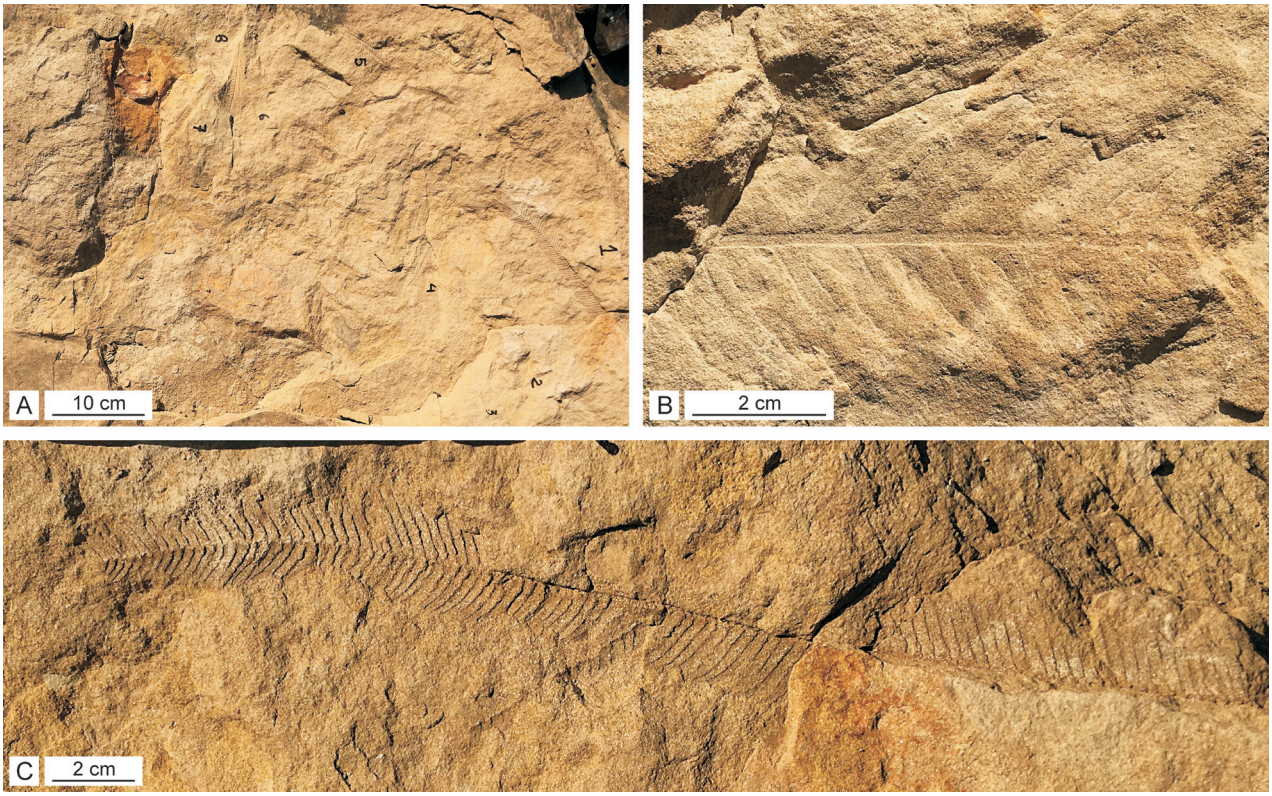

Fig. 5. Field photographs of leaf fossils from the Jhuran River. A. Assemblage of leaf fossils on a bedding surface. B. Close-up view of a compound leaf fossil (*Cladophlebis* sp.). C. Close-up view of a long compound leaf fossil (*Ptilophyllum cutchense* (Morris). These are field photographs. The other specimens have been numbered as KSKV/Kachchh/JH-1-17.

which was also named as the 'Age of Bennittitales' by McLoughlin and Pott (2009).

Long-sized pinnate bennettitalean fronds with their morphological and anatomical features suggest a xeromorphic adaptability and strategy to minimize water loss in subtropical to tropical climatic conditions. This probably indicates growth in a lowland or near-coastal region (Villar de Seoane, 2001; Chinnappa *et al.,* 2015).

Preservation of abundant large-sized compound leaves with well-preserved rachis, pinnae, leaflets, etc. depends upon the nature of transport, sedimentation rate, water chemistry, and biological agents. Hence, the well-preserved floral assemblage suggests that the leaf litters were not subjected to long distance transport (Ferguson, 1985; Burnham *et al.,* 1992; Greenwood, 1991; Burnham, 1993, 1994; Krassilov, 1978). Several well-preserved fossil impressions suggest low water-energy and a low rate of sedimentation not far from a channel levee.

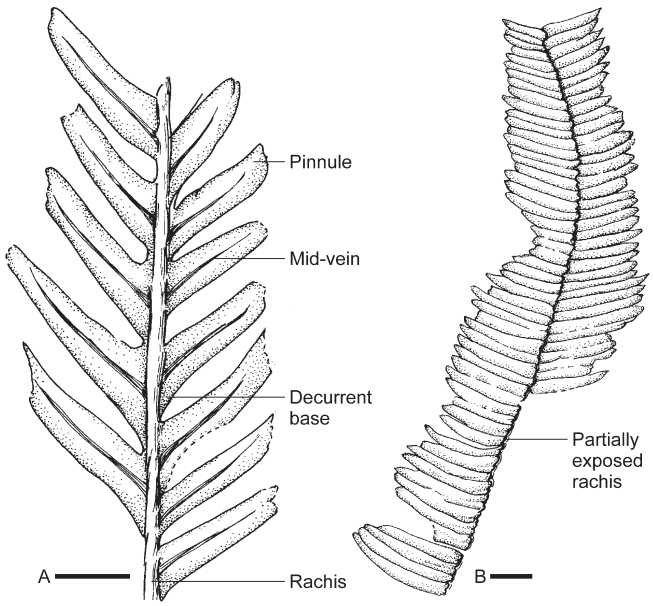

Fig. 6. Schematic sketches of leaf fossils from the Jhuran River. A. *Cladophlebis* sp., a fragmentary frond showing falcate pinnules attached on rachis. B. *Ptilophyllum cutchense* (Morris), pinnae linear-lanceolate attached adaxially on the rachis.

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REFERENCES

Alberti, M., Fürsich, F. T. and Pandey, D. K. 2013. Deciphering condensed sequences: A case study from the Oxfordian (Upper Jurassic) Dhosa Oolite member of the Kachchh Basin, western India. Sedimentology, 60: 574–598.

Arora, A., Banerjee, S. and Dutta, S. 2015. Black Shale in late Jurassic Jhuran Formation of Kutch: Possible indicator of oceanic anoxic event? Journal of the Geological Society of India, 85: 265–278.

Banerji, J., Jana, B. N. and Bose, M. N. 1984. On a collection of fossil plants from Himmatnagar, Gujarat, p. 463-473. In: Proceedings of the Symposium on Evolutionary Botany and Biostratigrphy. A.K. Ghosh Commemoration Volume, Current Trends in Life Sciences, 10. (Eds. Sharma, A.K., Mitra, G.C., and Banerjee, M.), Botany Department, Calcutta University, India.

Biswas, S. K. 1980. Mesozoic rock-stratigraphy of Kutch, Gujarat. Quarterly Journal of the Geological, Mineralogical and Metallurgical Society of India, 49: 1–51.

Bose, M. N. and Banerji, J. 1984. The fossil floras of Kachchh. I – Mesozoic megafossils. Palaeobotanist, 33: 1–189.

Bose, M. N. and Kasat, M. L. 1972. The genus *Ptilophyllum* in India. Palaeobotanist, 19: 115–145.

Bose, M. N. and Sah, S. C. D. 1968. Some pteridophytic remains from Rajmahal Hills, Bihar. Palaeobotanist, 16(1): 12–28.

Brongniart, A. 1849. Tableau des genre de végétaux fossils considérés sous le point de vue de leur classification botanique et de leur distribution géologique. 127 pp. Extrait du Dictionnaire d' Histoire naturelle, Paris.

Burnham, R. J. 1993. Reconstructing richness in the plant fossil record. Palaios, 8: 376–384.

Burnham, R. J. 1994. Patterns in tropical leaf litter and implications for angiosperm paleobotany. Review of Palaeobotany and Palynology, 81: 99–113.

Burnham, R. J., Wing, S. L., and Parker, G. G. 1992. The reflection of deciduous forest communities in leaf litter: implications for autochthonous litter assemblages from the fossil record. Paleobiology, 18: 30–49.

Carruthers, W. 1870. On fossil cycadean stem from the secondary rocks of Britain. Transections of the Linnean Society of London, 26: 675–708.

Chinnappa, C. H., Rajanikanth, A. and Rao, Y. V. 2015. Early Cretaceous plant diversity and ecology in the Krishna-Godavari Basin, East Coast. Journal of the Palaeontological Society of India, 61: 73–96.

Engler, A. 1892. Syllabus der Vorlesungen über spezielle und medizinisch-pharmaceutische Botanik. Eine Übersicht über das gesamte Pflanzensystem mit Berücksichtigung der Medicinal- und Nutzpflanzen. Large Edition., xxiii + 184 pp. [small Edition, xi + 143 pp.] Borntraeger, Berlin.

Ferguson, D. K. 1985. The origin of leaf-assemblages – new light on an old problem. Review of Palaeobotany and Palynology, 46: 117–188.

Fürsich F. T., Alberti, M., Pandey, D. K. and Rai, J. 2017. Event beds or condensed unit? Analysis of a wood-log concentration in the upper Jurassic of the Kachchh Basin, western India. Palaeogeography, Palaeoclimatology, Palaeoecology, 466, 406-415.

Fürsich, F. T., Alberti, M., and Pandey, D. K. 2013. Stratigraphy and palaeoenvironments of the Jurassic rocks of Kachchh. Field guide. Beringeria, Special Issue, 7: 1–174.

Fürsich, F. T., Pandey, D. K., Callomon, J. H., Jaitly, A. K. and Singh, I. B. 2001. Marker beds in the Jurassic of the Kachchh Basin, Western India: their depositional environment and sequence-stratigraphic significance. Journal of the Palaeontological Society of India, 46: 173–198.

Fürsich, F.T., Pandey, D.K., Alberti, M., Mukherjee, D. and Chauhan, G. 2020: Stratigraphic architecture and palaeoenvironments in the Kachchh Rift Basin during the Jurassic, 36th International Geological Congress, Field Trip Guide. 36th International Geological Congress, Delhi (NCR), 146.

Grant-Mackie, J.A. 1988. Upper Jurassic and Lower Cretaceous Buchia (Bivalvia) from southern Tibet, and some wider considerations, Alcheringia, 12:4, 249-268.

Greenwood, D. R. 1991. The taphonomy of plant macrofossils, p. 141–169. In: The Processes of Fossilization (Ed. Donovan, S. K.), Belhaven Press, London.

Pieńkowski, G., Brański, P., Pandey, D. K., Schlögl, J., Alberti, M. and Fürsich, F. T. 2015. Dinosaur footprints from the Thaiat ridge and their palaeoenvironmental background, Jaisalmer Basin, Rajastan, India. Volumina Jurassica XIII 1: 17–26.

Jana, B.N. and Hilton, J. 2007. Resolving the age of the Mesozoic Kuar Bet beds (Kachchh, Gujarat, India): A reinvestigation of palaeobotanical and palynological assemblages. Journal of Asian Earth Sciences 30: 457–463.

Krassilov, V. A. 1978. Araucariaceae as indicator of climate and paleo-latitudes. Review of Palaeobotany and Palynology, 26: 113–124.

Kumaran, K. P. N., Banerji, J. and Jana, B. N. 1984. Some fossil plant remains from Tarnetar (Saurashtra), W. India, p. 475–482. In: Proceedings of the Symposium on Evolutionary Botany and Biostratigraphy. A.K. Ghosh Commemoration Volume, Current Trends in Life Sciences, 10. (Eds. Sharma, A. K., Mitra, G. C. and Banerjee, M.), Botany Department, Calcutta University, India.

Mathur, Y. K. 1972. The plant fosils from the Kuar Bet, Patcham Island, Kutch. Current Science, 41: 488–489.

McLoughlin, S. and Pott, C. 2009. The Jurassic flora of Western Australia. Geologiska Föreningens Förhandlingar (GFF), 131: 113–136.

Mehra, S. and Verma, K. K. 1982. Two plant fossils from Mesozoic Gondwana of Kutch, Gujarat. Records of the Geological Survey of India, 112(7): 20–22.

Mehra, S., Verma, K. K. and Srivastava, S. 1979. Contribution to the study of upper Gondwana of Kutch, Gujarat: India, p. 491–501. In: Proceedings of 4th International Gondwana Symposium, Calcutta (1977) (2), (Eds. Laskar, B. and Raja Rao, C. S.), Hindustan Publication Corporation, Delhi.

Morris, J. 1840. Memoire to illustrate a Geological Map of Cutch. Transactions of the Geological Society of London (B), 5: 289–330.

Moser, M., Mathur, U.B., Fürsich, F.T., Pandey, D.K. and Mathur, N. 2006. Oldest camarosauromorph sauropod (Dinosauria) discovered in the Middle Jurassic (Bajocian) of the Khadir Island, Kachchh, western India. Paläontologische Zeitschrift 80: 34–51.

Rai, J., Prakash, N., Pandey, D. K., Fürsich, F. T., Alberti, M., Singh, A., Garg, S. and Swami, N. 2016a. A Middle Oxfordian flora from the Kachchh Basin, western India with the earliest record of bennettitaleans from the subcontinent. Geophytology, 46 (2): 133-146.

Rai, J., Prasad, M., Prakash, N., Singh, A., Garg, S., Gupta, M., Pandey, D. K. 2016b. Gymnospermous fossil woods from Gangta Bet, Eastern Kachchh, western India. Journal of the Palaeontological Society of India, 61(1), 111-122.

Roy, S. K. 1968. Pteridophytic remains from Kutch and Kathiyawar, India. Palaeobotanist, 16: 108–114.

Sukh-Dev. 1987. Floristic zones in the Mesozoic Formations and their relative age. Palaeobotanist, 36: 161–167.

Villar de Seoane, L. 2001. Cuticular study of Bennettitales from the Springhill Formation, Lower Cretaceous of Patagonia, Argentina. Cretaceous Research, 22: 461–479.