

ON SOME FOSSIL CYCADEAN FRONDS FROM INDIA

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ABSTRACT

The present paper deals with the description of some of the fossil cycadean fronds collected from the Rajmahal Hills, India. The author has also tried to redefine the systematic positions of certain doubtful species and has suggested a key for the identification of different species of the genus *Nilssonia* from India.

INTRODUCTION

Fossil cycadean fronds are quite common in the Mesozoic strata of India and particularly in the Jurassic rocks of the Rajmahal Hills, Bihar (Gupta 1966). Oldham and Morris (1863) described nineteen species of such fronds in their fossil flora of the Rajmahal Hills. Schimper (1869) and Feistmantel (1877) accepted in main the findings of Oldham and Morris and added some more species to their record. Feistmantel (1877-79) described in all forty species of the cycadean fronds from India. However, his list included both the true cycadean and the bennettitalean frond genera, as he was unaware of the vast differences exist between the fronds of these two groups of plants. Seward and Sahni (1920) revised the previous works on fossil plants from India and in this work they redefined the systematic positions of the then known cycadean fronds. Since then enough work has been done on the Mesozoic plants of India, but none of the worker has paid a special attention towards the study of fossil cycadean fronds. In the present paper the author has not only tried to redefine the systematic positions of some of these fronds, but has also given critical remarks on the known species. Author's investigations are based on the study of the materials available in Geological Survey of India, Calcutta; Birbal Sahni Institute of Palaeobotany, Lucknow; Prof. K. M. Gupta's collections, Jodhpur and his personal collections.

The fossil cycadean frond genera which have been described from the various Mesozoic rocks of India are given below :

1. *Cycadites* Sternb.
2. *Morrisia* Bose
3. *Nilssonia* Brongt.
4. *Pseudecten* Sew.
5. *Stangerites* Mac Cl.
6. *Taeniopteris* Brongt.

DESCRIPTION

NILSSONIA Brongt.

In 1917, Seward for the first time used the name *Nilssonia* for the Indian cycadean fronds and he adopted the name *Nilssonia princeps* for the fronds which were previously described as *Pterophyllum princeps* by Oldham and Morris (1863) and Feistmantel (1877). Later, Seward and Sahni (1920) transferred many of the fronds then described as *Pterophyllum*, *Cycadites* and *Anomozamites* from India into the genus *Nilssonia*. They identified the following species of the genus *Nilssonia* from India :

1. *Nilssonia princeps* (O. and M.) Sew.
2. *N. morrisiana* (Oldh.) Sew. and Sahni
3. *N. medlicottiana* (Morr.) Sew. and Sahni
4. *N. bindrabunensis* Sew. and Sahni
5. *N. rajmahalensis* (Oldh.) Sew.
6. *N. fissa* (Fst.) Sew. and Sahni

Since then, almost no work has been done on the fronds of the genus *Nilssonia* from India, except the discovery of a new species *Nilssonia sahnii* from the Rajmahal Hills, published recently by Prof. K. M. Gupta (Gupta 1968). In the present paper the author has tried to redefine the systematic positions of some of these fronds and has given a key for their identification.

Nilssonia distans (Morr.) comb. nov. Sharma (Text fig. 3 ; Pl. I, fig. 3).

Pterophyllum distans Morr. (Oldh. and Morr. 1863, P. 18, Pl. IX, fig. 3).

P. hislopianum Oldh. (Schimper 1869, P. 136).

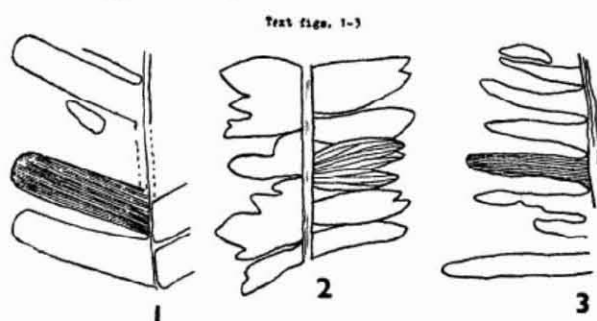
P. distans Morr. (Feist. 1876, P. 40).

P. distans Morr. (Feist. 1877a, P. 176 ; Pl. V, fig. 1, Pl. VI, fig. 1).

P. hislopianum Oldh. (Feist. 1877, P. 109 ; Pl. IX, fig. 1).

Diagnosis : Frond pinnate, length unknown, breadth 15-22 cm ; pinnae coriaceous, long, more or

less unequal, 10-11 × 0.8-1 cm straight, apex acuminate, opposite or sub-opposite, sparse, attached at right angles on the upper surface of rachis by little expanded continuous bases; veins 14-15 per cm, strong, parallel with bifurcations; rachis 0.5 cm thick, longitudinally striated.



Text figs. 1-3: Showing shape, size, attachment and venation of the different species of *Nilssonia* and *Anomozamites* described in the present paper: 1. *Nilssonia crassum*. 2. *Anomozamites fissa*. 3. *Nilssonia distanse*.

External morphology: A number of specimens are present in author's collection representing this species (Specimen No. K.45/Raj.DHO; Text fig. 3; Pl. I, fig. 3). All the specimens are similar except showing some minor differences in their quantitative measurements. None of the frond is complete. They vary in breadth from 15-22 cm. Pinnae are long, straight, unequal in their breadth and are attached by their little expanded bases at right angles on the upper surface of rachis, leaving 0.4 cm portion of its upper surface exposed. The pinnae taper gradually and form acuminate apices. The veins are well developed, parallel with a number of bifurcations. In the marginal veins, however, vein connections have also been seen.

Comparison: The above description fits in well with the description of *Pterophyllum distans* of Morris (Oldham and Morris 1863), who defined it as follows: "Frond elongate, pinnae distant, linear elongate entire, very gradually diminishing towards the apex, attached by their whole base and slightly expanded or occasionally decurrent; either opposite or sub-alternate and very slightly oblique to the rachis; veins few, four or five, in each pinnule, parallel and distinctly marked, stem slightly furrowed." Schimper (1869) considered it to be a distinct species and merged *Pterophyllum hislopianum* Oldh. in it. Feistmantel (1877a) agreed with Schimper and figured some more specimens of *Pterophyllum distanse* in his fossil flora of Golapilli area. Seward and Sahni (1920) did not mentioned any

thing about this species in their revision of the Indian fossil plants. The study of the specimens present in author's collection of this species leave no doubt about their Nilssonian nature. The pinnae are attached on the upper surface of rachis and not on the lateral sides, unlike *Pterophyllum* and thus *Pterophyllum distans* of Morris should be called as *Nilssonia distanse*.

Nilssonia crassum comb. nov. Sharma (Text fig. 1; Pl. I, fig. 1).

Pterophyllum crassum Morr. (Oldh. and Morr. 1863, P. 24; Pl. XVI, fig. 2).

P. crassum Morr. (Schimper 1869, P. 137).

P. crassum Morr. (Feistmantel 1877, P. 109; Pl. XVI, fig. 2).

Nilssonia princeps (Sew. and Sahni, 1920, P. 29; Pl. IV, fig. 38).

Diagnosis: Frond pinnate, length unknown, breadth 8-9 cm; pinnae coriaceous, medium, equal, 4.2 × 1.1 cm, straight, apex truncate-round, opposite, or sub-opposite, little sparse, oblique, attached on

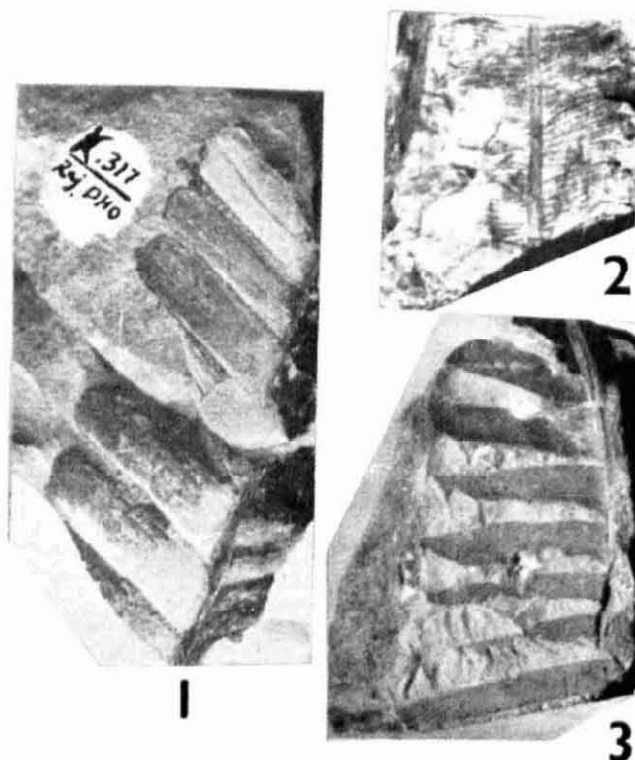


Plate I: Figs. 1-3: 1. *Nilssonia crassum*. Specimen No. K. 317/Raj. DHO. showing shape, size, attachment and venation of the pinnae of the frond. × ca. '75. 2. *Anomozamites fissa*. Specimen No. K. 171/Raj. C. showing a few incised, unequal pinnae attached on the lateral sides of the rachis. × ca. '75. 3. *Nilssonia distanse*. Specimen No. K. 45/Raj. DHO. showing sparsely placed, linear, straight pinnae attached on the upper surface of rachis. × ca. '75.

the upper surface of rachis by unexpanded, continuous bases; veins 18-20 per cm, fine, parallel with bifurcations; rachis 0.5 cm thick with a median groove.

External morphology: Specimen No. K.317/Raj.DHO (Text fig. 1; Pl. I, fig. 1) has been collected from the fossiliferous locality Dhokuti, situated about two and a half miles south of the village Mirzachowki. This specimen represents an incomplete, middle part of the frond containing four complete pinnae. The pinnae are more or less, equal, straight, sparse and attached on the upper surface of rachis by their unexpanded, continuous bases. The upper surface of rachis is almost entirely covered over by the bases of the pinnae. Veins are fine, 18-20 per cm, parallel, with bifurcations and without vein connections.

Comparison: The description of the specimen given above compares well with the diagnosis of *Pterophyllum crassum* given by Morris as below: "Frond pinnate; pinnae long, pinnules broad, obtusely rounded at the apex, somewhat distant from each other, nearly at right angles to the stem, slightly recurved along the margins; veins prominent, numerous, about 20-24 in larger pinnules; stem broad, strong, furrowed or channelled." "The pinnules had an average length of about $2\frac{1}{2}$ ", were slightly thickened and recurved at the margins, nearly at right angles to the petioles with ovately or obtusely rounded apices." In 1920, Seward and Sahni transferred *Pterophyllum crassum* of Morris into *Nilssonina princeps* (Oldh. and Morr.) Sew. However, the present study has revealed that the two forms, *Pterophyllum crassum* and *Nilssonina princeps* are quite distinct and should not be merged into one species. The present investigation has also shown that *Pterophyllum crassum* of

Morris is a Nilssonian frond and should be called as *Nilssonina crassum* (Morr.) Sharma. It can be differentiated from *Nilssonina princeps* and other species of Indian Nilssonias on the characters of its veins. It has the finest and largest number of veins among the Indian species and they are bifurcated frequently (Table I).

Anomozamites fissa Fst. (*Nilssonina fissa* Sew. and Sahni) (Text fig. 2; Pl. I, fig. 2).

Pterophyllum sp. (Oldh. and Morr. 1863, P. 25 and 28; Pl. XII, figs. 2-5).

P. fissum Fst. (Feist, 1877, P. 113; Pl. XXXIX, figs. 2-4).

Anomozamites fissum Fst. (Feist, 1879, P. 208; Pl. VII, figs. 11-13).

A. fissum Fst. (Feist, 1886, P. 36; Pl. IV, fig. 2).

Nilssonina fissa Sew. and Sahni (Sew. and Sahni 1920, P. 32; Pl. IV, fig. 39).

N. (?) Anomozamites fissa (Sahni and Rao 1931 P. 198, Pl. XV, figs. 27-29).

Diagnosis: Frond pinnate or deeply lobed, length unknown, breadth 1.2-2 cm; lobes unequal, 0.5-0.9 × 0.2-0.4 cm, base and apex contracted, subopposite, attached at right angles on the lateral sides of rachis, veins 4-6 per pinna, more or less, parallel, bifurcations frequent at all levels, vein connections also present; rachis narrow, 0.1 cm thick with fine longitudinal striations.

External morphology: There are two specimens present in author's collection which represent this species. Specimen No. K. 171/Raj. C. (Text fig. 2; Pl. I, fig. 2), represents the middle part of the frond, measuring 2.2 × 1.8 cm in size. The lobes are unequal and close. The apices are irregularly bifid. Veins are thick, almost all the veins

TABLE I: Showing the variations in the venation of different species of Indian Nilssonias.

Species	No. of veins per cm	No. of vein bifurcations per cm	No. of vein connections	Position of vein connection
<i>Nilssonina princeps</i>	12-15	3-4	0-1	Middle of pinna
<i>N. medicottiana</i>	11-12	4-6	0-1	Marginal
<i>N. morrisiana</i>	14-16	4-5	2-3	Marginal
<i>N. bindrabunensis</i>	14-16	2-3	Absent	Absent
<i>N. sahnii</i>	10-12	5-8	Absent	Absent
<i>N. distans</i>	14-16	3-6	2	Marginal
<i>N. crassum</i>	18-20	6-8	Absent	Absent

show their first bifurcation near the base of the pinna. Vein connections are also present.

Comparison: The small size of the frond with unequal segments, their lateral attachment on the rachis and bifurcated path of the veins, separates out the genus *Anomozamites* from allied genera like *Nilssonia* and *Pterophyllum*. The characteristic bifid incision of the apices of the segments, separates out *Anomozamites fissa* from the other species of the genus. The characters of our specimen described here, fits in well in the diagnosis of *Anomozamites fissa* as given by Feistmantel in the year 1877. "Fronde tenera, pedunculata, maxima parte imparipinnate, pinnis una media et summe in parte differentibus; inferioribus dilatatis, brevibus, mediis oblongioribus, summis brevibus, congestioribus; omnibus apices fissis; nervis pluribus, lievibus."

Seward and Sahni (1920) and Sahni and Rao (1931) suspected the lateral attachment of pinnae in the fronds of this species. In the latter paper, the authors had expressed the opinion that the original name *Anomozamites fissa* of Feistmantel might be correct, and so they named such fronds as *Nilssonia* (? *Anomozamites*) *fissa*. Ganju (1946) also adopted this nomenclature for describing his specimens of *Nilssonia fissa*. The present study supports Feistmantel's identification and nomenclature and thus the fronds described as *Nilssonia fissa* by Seward and Sahni be transferred back to *Anomozamites fissa* of Feistmantel.

Following are the other known species of the genus *Nilssonia* from India.

Nilssonia princeps (Oldh. and Morr.) Sew.

N. medlicottiana (Oldh.) Sew. and Sahni

N. morrisiana (Oldh.) Sew. and Sahni

N. bindrabunensis Sew. and Sahni

N. sahnii Gupta

A key for the identification of different species of *Nilssonia* from India is given below:

1. Pinnae long, veins strong with bifurcations and vein connections
 - A. Pinnae at right angle to the rachis
 - (i) Pinnae sparse, acuminate; veins 14-15 per cm, vein connections marginal ... *N. distanse*
 - (ii) Pinnae more or less close, acute or obtuse; veins 11-12 per cm, vein connections marginal ... *N. medlicottiana*
 - B. Pinnae oblique to the rachis
 - (iii) Pinnae close, acute; veins 14-16 per cm, vein connections throughout the pinna ... *N. morrisiana*

2. Pinnae small, veins strong or fine, with or without vein connections

C. Pinnae at right angle to the rachis.

- (iv) Pinnae close, round; vein fine, 14-15 per cm, bifurcations rare, vein connections absent ... *N. bindrabunensis*
- (v) Pinnae close, truncate, veins fine, 12-15 per cm, vein connections throughout the pinna ... *N. princeps*
- (vi) Pinnae sparse, lanceolate; veins strong, 10-12 per cm, vein connections absent ... *N. sahnii*

D. Pinnae oblique to the rachis

- (vii) Pinnae more or less close, round, veins fine, 18-20 per cm, vein connections absent ... *N. crassum*

The genus *Nilssonia* is known since long and is widely distributed in the Mesozoic rocks throughout the world. More than eighty species of it have been described so far. Because of wide variations found in its species, the genus has generally been confused with allied genera like *Pterophyllum*, *Pseudecten*, *Taeniopteris* etc., and thus the diagnosis of the genus *Nilssonia* were modified from time to time. Recently, Prof. Harris (1964) has amended the diagnosis of this genus as follows: "Leaf as a whole linear or lanceolate, lamina gradually increasing in width from the base. Lamina attached to the upper edge of rachis and entirely concealing it from above. Lamina entire or cut transversely into segments. Veins simple, numerous, equal and ending at its distal margin, resin bodies often present between veins, guard cells slightly cutinised, exposed or sunken and surrounded and more or less protected by a more or less regular rim of subsidiary cells; subsidiary cells, unspecialised or each bearing a papilla projecting over the aperture. Unicellular trichome bases occurring on the underside, atleast on veins. Petiole base expanded, cut off by an absciss layer showing a curved group or ring of vascular strands (Halle 1913). Vascular bundle of lamina showing centripetal xylem (Stopes 1940); vernation of leaves cercinate (Nath. 1909).

Stem unknown, but the scale leaves (*Deltolepis*), the male cone (*Androstrobus*), female cone (*Beamia*) including details of the seed are known".

None of the Indian frond of the genus *Nilssonia* agree in *toto* with the above diagnosis. The fronds of the Indian species are mostly segmented or pinnate; the pinnae are equal or unequal and are attached on the upper surface of rachis. In some of the species like *Nilssonia crassum* the rachis is almost hidden over by the bases of the pinnae, while in others, a part of the upper surface of rachis remains exposed as in *N. bindrabunensis* and

Nilssonia sahnii. Veins are parallel with bifurcations. Taking these variations into consideration, Prof. K. M. Gupta (1968) has proposed a new generic name for Indian *Nilssonias* as *Nilssoniophyllum*. The present author does not agree with it. A genus which occurs so widely distributed, is bound to have some differences from the original type. The genus *Nilssonia* was originally described from HÖR in Scania. Fronds of this type occurring in different climatic conditions and at geographical distances like India, Japan and Australia must have some differences from the original forms. Indian fronds do not differ fundamentally from the type species of the genus *Nilssonia*. In all the Indian *Nilssonias*, the pinnae or the segments are attached on the upper surface of rachis and the lamina remains continuous throughout the length of the frond. Veins are parallel with or without bifurcation.

Nilssonian fronds from Japan also differ from the original type species and they resemble Indian *Nilssonias* in some of the morphological characters like the pinnate nature of the fronds and frequent bifurcations of their veins. Similarly, some of the species of *Nilssonia* like *N. pterophylloides* described by Nathorst (1909) from Sweden also resembles the Indian fronds in the nature of lamina and venation.

It shows that on the basis of morphological characters we should not segregate the Indian fronds from the genus *Nilssonia* and should continue to describe such fronds under this genus. Unfortunately, epidermal characters are not preserved in the fronds of the species of Indian *Nilssonias*, otherwise, their fate could have been decided with more certainty.

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