

# LYCOPSID, SPHENOPSISID AND CYCADACEOUS REMAINS FROM THE LOWER GONDWANA OF HANDAPPA, ORISSA

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## ABSTRACT

Some plant remains from the Kamthi Formation, Handappa, Orissa are described. Specimens of *Cyclodendron lesliei*, *Stellotheca robusta*, and *Pseudoctenis balli* increase their range and distribution. Seven articulate species are represented by leaf remains. Specimens of *Senia reticulata* are also reported.

## INTRODUCTION

The fossil flora of Handappa is rich, and important too, as it has yielded several types of fertile specimens belonging to different genera. KHAN (1969) described a new plant—*Senia reticulata*, as well as enlisted occurrence of several other plant remains from this locality.

A new collection made by K. R. SURANGE AND ANIL CHANDRA has yielded some interesting plant remains, not reported earlier from the locality. Besides, there is a large number of *Glossopteris* species comprising 70 per cent of the total specimens. In the remaining 30 per cent we have 20 per cent of different kinds of fructifications, five per cent of filicales and five per cent of lycopods, articulates and cycads which are described in the present paper. The fossils are found as impressions, coloured pinkish-brown to maroon on hard, compact, buff-coloured clayey shales. The fossiliferous beds are exposed in the Hinjrida Ghati Section (20°58' : 84°437') in Dhenkanal District of Orissa.

## DESCRIPTION

Genus **Cyclodendron** Kräusel

**Cyclodendron lesliei** (Seward) Kräusel, 1928

Pl. 1, Figs. 3 & 10

Two bigger specimens, one specimen 57 mm long by 12 mm wide (Pl. 1, Fig. 3) and a few small fragments were found in the collection. One of the small fragments (Pl. 1, Fig. 10) has one typical *Cyclodendron* scar.

Records of lycopod stems in the Lower Gondwana of India are few. KAR (1968) has recorded *C. lesliei* from the Ironstone Shale of Jharia Coalfield. Other workers have recorded doubtful specimens of *Cyclodendron*. MAITHY (1965) included a stem fragment from Karharbari Formation in "cf. *Cyclodendron* sp." BUNBURY (1861, pl. 12, fig. 2) identified a stem fragment as "*Stigmaria?* (portion of the rhizome of a fern?)" found in the Kamthi shale. He discussed a possible lycopodiaceous relationship of the specimen but because of the lack of identifiable features, he was unable to identify it satisfactorily.

There is always a problem in identifying poorly preserved or decorticated lycopod stems. In the case of the Gondwana Permian genera *Cyclodendron* and *Lycopodiopsis* even slight decortication usually results in unidentifiable stems. Some stems that are

readily identifiable have at least part of the outer cortex layer preserved where features of leaf cushion architecture are still clearly preserved. *Cyclodendron* is recorded from Africa, besides few specimens from India and one from Australia (RIGBY, 1966). KRÄUSEL has figured some well-preserved examples from Namibia (1928, pl. 1, figs. 4, 6, 9, 10), HØEG AND BOSE have also figured typical, diagnostic specimens from Zaire (1960, pl. 5, figs. 2-5).

*Lycopodiopsis* has a distinctive cushion architecture and also a clear but very small ligule pit (KRÄUSEL, 1961, pl. XX, fig. XX). The figured specimen is from north of Porangaba, Sao Paulo State, Brazil in the Passa Dois Series. The ligule pit including the rim is 0.4 mm × 0.25 mm. Some specimens figured by KRÄUSEL (1961) show protuberance at the position of the pit, although he ignored this feature.

Well-preserved specimens showing cushion architecture have been figured from Brazil by MAACK (1947, pl. 82, fig. 19a) and KRÄUSEL (1961, pl. 32, figs. 1, 2). Poorly preserved specimens have also been recorded from Argentina (KURTZ, 1921) and Bolivia (CHAMOT, 1965). The well-preserved anatomical specimen described as *Eligodendron branisae* by ARCHANGELSKY AND DE LA SOTA (1966) is seen by us to be an anatomical variant of *Lycopodiopsis derbyi* as described by RAO (1940). The differences in inner cortex distribution, used to separate these genera, are not valid, as MANIERO (1950, fig. 5) has figured a specimen showing the necessary intermediate characters to link the two genera.

It is evident that lycopod-like plants are known only from the Ironstone Shale and Kamthi formations in India. It is difficult to explain the reasons why the lycopods which usually grow in moist climate should be found as fossils in the sediments generally supposed to be deposited in arid climatic conditions.

Genus **Phyllothea** Brongniart

**Phyllothea indica** Bunbury, 1861

Pl. 1, Fig. 5

This genus is represented by only one species in this collection, i.e. *Phyllothea indica* Bunbury (1861). Our specimens compare well with type specimen of BUNBURY described by TOWNROW (1955). *Phyllothea indica* is mostly confined to the Raniganj Formation and is reported from Madhya Pradesh, Bihar and Bengal. The species is based upon impressions of stems and leaf sheaths. There are quite a few well-preserved specimens in the collection but none shows detached leaf sheath.

Genus **Stellothea** Surange & Prakash

**Stellothea robusta** Surange & Prakash, 1962 *sensu* Maithy & Mandal, 1978

Pl. 1, Fig. 2

In India, this genus is represented by only one species. So far this plant was known only from the Rajmahal Hills; ours is a second record in India. RIGBY (1966) reported *Stellothea* in organic connection with *Paracalamites* from New South Wales, Australia. BOUREAU (1964) transferred Angara species *Phyllothea schtschurovskii* to *Stellothea*. In 1969, RIGBY commented that *Annularia americana* reported from Brazil was possibly a *Stellothea*. LACEY AND HUARD-MOINE (1966) reported *Annularia* sp. from Rhodesia and commented that though the specimen is tentatively assigned to *Annularia* compares very well with *Stellothea*. All these records confirm the existence of this genus in other Gondwana countries and elsewhere. It is quite strange that in India this genus was so far not found in other localities. The presence of this genus in

Handappa flora also proves that this plant flourished only during Raniganj and equivalent times.

Genus **Sphenophyllum** Koenig

In our collection we have recorded two species of the genus *Sphenophyllum*, recently instituted by SRIVASTAVA and RIGBY from the Raniganj Coalfield.

*Sphenophyllum churulianum* Srivastava & Rigby (in press) ; *Sphenophyllum cranulatum* Srivastava & Rigby (in press) ; Pl. 2, Fig. 9

Genus **Trizygia** Royle

**Trizygia speciosa** Royle, 1839

Pl. 2, Fig. 8

As compared to *Sphenophyllum*, we have fewer specimens of *Trizygia speciosa* in our collection. Our specimens compare well with the specimens described by MAITHY (1978) from the Raniganj Formation of Raniganj Coalfield. Our specimens also resemble the specimens described by ROYLE, FEISTMANTEL and RIGBY.

Genus **Raniganjia** Rigby *emend.* Pant & Nautiyal

The genus is represented by two species :

*Raniganjia bengalensis* Rigby *emend.* Pant & Nautiyal, 1967 ; Pl. 1, Fig. 12.

*Raniganjia etheridgei* Arber *emend.* Pant & Nautiyal, 1967 ; Pl. 1, Fig. 6

This genus is of rare occurrence and is so far known only from the Raniganj Formation. Presence of two species together in Handappa collection is significant in correlation of these fossiliferous beds with other formations.

Genus **Schizoneura** Schimper & Mougeot

**Schizoneura gondwanensis** Feistmantel

The genus is represented by its well-known species—*Schizoneura gondwanensis* Feistmantel. Some of the specimens are very big and show branching as well. In India this species is widely distributed having long vertical range—from Barakar Formation to the Panchets or even in younger horizon.

Genus **Pseudoctenis** Seward

**Pseudoctenis balli** (Feistmantel) Seward

Pl. 1, Figs. 1 & 4

*Synonymy*

1881 *Anomozamites balli* Feistmantel, p. 256.

1886 *Platypterygium balli* Feistmantel, p. 37, pl. 2A, figs. 4-8; pl. 3A, fig. 2.

1902 *Pterophyllum balli* Zeiller

1917 *Pseudoctenis balli* (Feistmantel) Seward, pp. 586-587.

1920 *Pseudoctenis balli* (Feist.) Seward & Sahni, pp. 14-15, pl. 4, fig. 41.

1962 *Pseudoctenis balli* (Feist.) Sew., in Lele, p. 72, pl. 3, figs. 24-26; text-fig. 8.

1971 *Pseudoctenis balli*, Maithy, p. 72, pl. 1, figs. 7, 8.

FEISTMANTEL (1881) originally assigned this fossil from the Barakar Formation to the genus *Anomozamites*, and later transferred it to *Platypterygium*. ZEILLER (1902) transferred it to *Pterophyllum balli*. SEWARD (1907), and SEWARD AND SAHNI (1920) described this fossil under *Pseudoctenis balli*. LELE (1962) described some fronds of *P. balli* from Triassic sediments of South Rewa Gondwana Basin.

MAITHY (1971) also described some specimens of *P. balli* from Barakar Formation of Auranga Coalfield and designated lectotype for *P. balli* from Feistmantel's collection (5505, G.S.I., Calcutta). PANT AND MEHRA (1963) instituted *Pteronilssonina gopalii* for some pinnate fronds from Raniganj Formation of Raniganj Coalfield describing epidermal characters of their fronds as well. To us they look similar to *Pseudoctenis* and the distinguishing characters which they have described can, at the most, institute a new species for *Pseudoctenis*. Since we have not seen the type specimens of *Pteronilssonina*, it will not be proper to include them in *Pseudoctenis*.

In Handappa collection, we have five specimens which are very similar to *Pseudoctenis balli*. In our specimens the lower pinnae are smaller, gradually becoming bigger towards middle and then again becoming smaller towards apex. Presence of *P. balli* in Handappa shows that this species is more widespread than believed earlier.

Genus **Senia** Khan

**Senia reticulata** Khan, 1969

Pl. 1, Figs. 7-11

KHAN (1969) described a petiolate and pinnate frond from this locality under a new name *Senia reticulata*. The rachis is quite wide and the pinnae are laterally attached to it by their broad base. Each pinna has veins arising from the base and anastomose to form polygonal meshes of more or less uniform size. On the contrary, SURANGE (1974) thought that *Senia reticulata* was a peculiarly folded *Glossopteris* leaf. In our collection, although we do not have a complete frond of this species, we have several detached scattered pinnae showing same type of reticulate venation as *Senia reticulata*. We confirm the observations of KHAN (*l. c.*) and recognize the validity of the genus with its only species in Handappa locality.

#### DISCUSSION

As has been said in the introduction, the flora contains prolific glossopterid remains (70%) and fructifications (20%); the rest (10%); shows following variety :

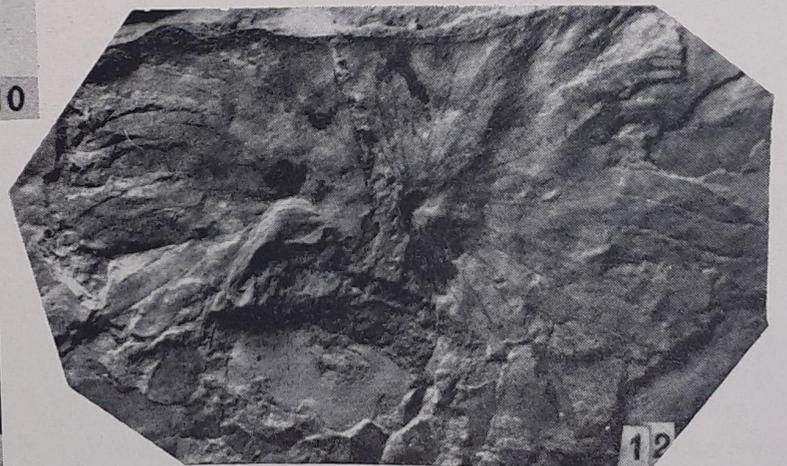
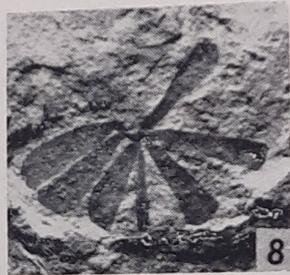
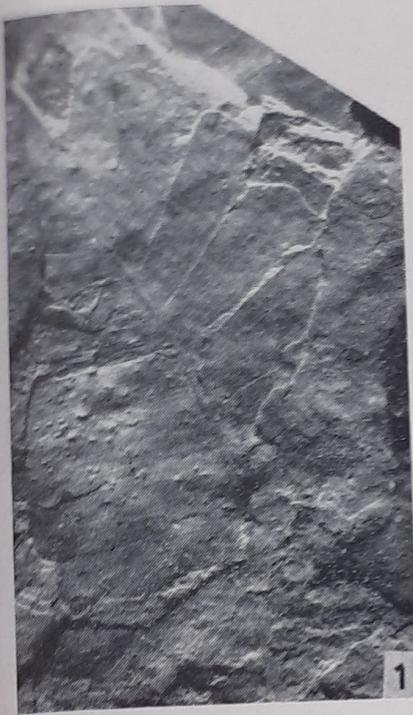
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|-------------|----|--|
| Ferns       | .. | <i>Dizeigotheca phegopteroides</i> (Feistm.) Maithy                      |
|             |    | <i>Neomariopteris hughesi</i> (Zeiller) Maithy                           |
|             |    | <i>Neomariopteris khanii</i> Maithy                                      |
|             |    | <i>Pantopteris major</i> Chandra & Rigby                                 |
| Lycopod     | .. | <i>Cyclodendron lesliei</i> (Seward) Kräusel                             |
| Articulates | .. | <i>Phyllothea indica</i> Bunbury   |
|             |    | <i>Stellothea robusta</i> Surange & Prakash <i>sensu</i> Maithy & Mandal |
|             |    | <i>Sphenophyllum crenulatum</i> Srivastava & Rigby                       |
|             |    | <i>Sphenophyllum churulianum</i> Srivastava & Rigby                      |
|             |    | <i>Trizygia speciosa</i> Royle   |
|             |    | <i>Raniganjia bengalensis</i> (Rigby) Pant & Nautiyal                    |
|             |    | <i>Raniganjia etheridgei</i> (Arber) Pant & Nautiyal                     |
|             |    | <i>Schizoneura gondwanensis</i> Feistmantel                              |
| Seed plants | .. | <i>Pseudoctenis balli</i> (Feistm.) Seward                               |
|             |    | <i>Senia reticulata</i> Khan   |

KHAN (1969) reported several *Glossopteris* species, leaves and fructifications, besides *Phyllothea indica*, *Schizoneura gondwanensis*, *Sphenophyllum speciosum*, *Sphenopteris polymorpha*, *S. hughesi*, *Vertebraria indica* and *Senia reticulata*. SURANGE AND MAHESHWARI AND SURANGE AND CHANDRA described several male and female fructifications and scale leaves belonging

to *Glossopteris*. The rich flora comprising of different genera with their species compares well with Raniganj flora. So far, no Triassic form has been recorded by any of the mentioned workers. We also agree with KHAN (*l. c.*) that this fossiliferous horizon of Handappa belongs to the Lower Gondwana sequence rather than the Panchet as was thought earlier. SURANGE AND MAHESHWARI (1970) have put their specimens under ? Kamthi (Raniganj) but did not discuss or comment further. However, in later years SURANGE AND CHANDRA in a series of papers always mentioned these beds to be of Raniganj age. The lithology of the rocks is similar to that of Kamthi Formation and the flora as a whole also compares well with that of BUNBURY (1861). Now, since we know the flora so well, we feel it appropriate to place these beds to Kamthi Formation—equivalent to Raniganj in age, as was already done by SURANGE AND MAHESHWARI (1970).

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#### EXPLANATION OF PLATE 1

(All the specimens are deposited at B. S. I. P. Museum, statement No. 474)

1. *Pseudoctenis balli* (Feistm.) Seward, B. S. I. P. specimen no. 35454, middle portion of the frond. × 1.
2. *Stellotheca robusta* Surange & Gyan Prakash, B. S. I. P. specimen no. 35455. × 1.
3. *Cyclodendron lesliei* (Seward) Kräusel, B. S. I. P. specimen no. 35456. × 1.
4. *Pseudoctenis balli* (Feistm.) Seward, B. S. I. P. specimen no. 35457. × 1.
5. *Phyllothea indica* Bunbury, B. S. I. P. specimen no. 35458. × 1.
6. *Raniganjia etheridgei* (Arber) Pant & Nautiyal, B. S. I. P. specimen no. 35460. × 1.
7. *Senia reticulata* Khan, B. S. I. P. specimen no. 35461; pinnule enlarged to show reticulation. × 4.
8. *Trizygia speciosa* Royle, B. S. I. P. specimen no. 35462. × 1.
9. *Sphenophyllum crenulatum* Srivastava & Rigby, B. S. I. P. specimen no. 35463. × 1.
10. *Cyclodendron lesliei* (Seward) Kräusel, B. S. I. P. specimen no. 35464. × 1.
11. *Senia reticulata* Khan, B. S. I. P. specimen no. 35461. × 1.
12. *Raniganjia bengalensis* Rigby, Pant & Nautiyal, B. S. I. P. specimen no. 35465. × 1.