

# A SPOROLOGICAL STUDY OF SEAM VII (JOTE DHEMO COLLIERY) IN THE RANIGANJ COALFIELD BIHAR (INDIA)

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## ABSTRACT

The present paper deals with the sporological study, both qualitative as well as quantitative, of seam VII (Bonbahal seam) of the Raniganj coalfield, Bihar (India). The fossil spore and pollen flora of the seam consists of 40 genera and 85 species, out of which 13 species are new. The miospore assemblage of the present seam (No. VII) has also been compared with that of seam VIII (Jambad Bowlah seam) overlying it, bringing out the significant differences between them.

## INTRODUCTION

**S** SEAM VII (Bonbahal seam) is among the nine major coal seams of the East Raniganj coalfield, Bihar (India). It is located about 200 ft. below the Jambad Bowlah seam and nearly the same distance above the Toposi-Kenda seam (No. VI). In Chhora-Bonbahal area it occurs about 195 feet above the Chhora seam. Bonbahal seam is possibly the easterly continuation of the upper seam of Singaran colliery and is approximately 14 ft., in thickness at Bonbahal. The thickness of the seam at different places varies from 6'-6" to 14'-2".

## MATERIAL AND METHODS

The usual maceration procedure was adopted. For the qualitative study the macerate was sieved and concentrated, whereas for the quantitative analysis the slides were made from the unsieved and unconcentrated material.

The Bonbahal seam is 14'-2" thick and from this 15 samples have been obtained. The geological location and the sampling details along with the maceration numbers of each sample are given in Table 1.

## DESCRIPTION OF THE SPORAE DISPERSAE

The miospore genera represented here have been arranged according to the artificial system of classification which was put for-

**TABLE 1 — RANIGANJ COALFIELD, BONBAHAL SEAM (JOTE DHEMO COLLIERY)**

(Location of the place of sampling in the mine: about 400 ft, S.S.W. from the shaft, Bottom of the pit No. 1)

| <i>Section of the seam</i>                 |            |            |          |
|--|------------|------------|----------|
| DESCRIPTION OF STRATA                      | THICKNESS  | SAMPLE No. | MAC. No. |
|  | ROOF-SHALE |            |          |
| Coal with brights                          | 1'-0" }    | 15         | 343      |
| Dull coal                                  | 0'-1½" }   |            |          |
| Dull coal                                  | 0'-6" }    | 14         | 342      |
| Dull coal with thin laminations of brights | 0'-6" }    |            |          |
| Shale                                      | 0'-4"      | 13         | 341      |
| Dull coal                                  | 0'-5" }    | 12         | 340      |
| Coal with brights                          | 0'-9" }    |            |          |
| Coal with brights                          | 1'-0"      | 11         | 339      |
| Coal with brights                          | 1'-0"      | 10         | 338      |
| Coal with brights                          | 1'-0"      | 9          | 337      |
| Coal with brights                          | 0'-8" }    | 8          | 336      |
| Dull coal with thin laminations of brights | 0'-4" }    |            |          |
| Shale                                      | 0'-5"      | 7          | 335      |
| Dull coal with thin laminations of brights | 1'-1½"     | 6          | 334      |
| Dull coal with thin laminations of brights | 0'-6" }    | 5          | 333      |
| Coal with brights                          | 0'-6" }    |            |          |
| Coal with brights                          | 1'-0"      | 4          | 332      |
| Coal with brights                          | 1'-0"      | 3          | 331      |
| Coal with brights                          | 1'-0"      | 2          | 330      |
| Coal with brights                          | 1'-0"      | 1          | 329      |

ward by Potonié & Kremp (1954) and subsequently elaborated by Potonié (1956, 1958, 1960). The various genera encountered here in seam VII (Bonbahal seam) are, with few exceptions, the same as recovered out of the other seams of the Raniganj coalfield (BHARAD., 1962; BHARAD. & SALUJHA, 1964). However, the differences in the different seams appear to be in the species occurring in them, because there are some species which are present here and

absent in the others and vice versa. Thus in order to avoid repetition with the already published work of seam VIII (BHARAD. & SALUJHA, 1964) the common species are listed below:

- Leiotriletes* sp.  
 cf. *Concavisporites bankolensis* Bharad. & Salujha  
*Eupunctisporites gravus* Bharad. & Salujha  
*Calamospora aplata* Bharad. & Salujha  
*Retusotriletes diversiformis* (B. & H.) Bharad.  
*Cyclogranisporites gondwanensis* Bharad. & Salujha  
*Cyclogranisporites* sp.  
*Lophotriletes rectus* Bharad. & Salujha  
 cf. *Lophotriletes rarus* Bharad. & Salujha  
*Horriditriletes curvibaculosus* Bharad. & Salujha.  
*Horriditriletes brevis* Bharad. & Salujha  
*Horriditriletes* sp. A.  
*Cyclobaculisporites indicus* Bharad. & Salujha  
*Cyclobaculisporites minutus* Bharad. & Salujha  
*Microfoveolatispora* sp.  
*Indospora laevigata* Bharad. & Salujha  
*Indospora macula* Bharad. & Salujha  
*Indospora* sp.  
*Lycopodiumsporites* sp.  
*Gondisporites* sp.  
*Latosporites colliensis* (B. & H.) Bharad.  
*Punctatosporites* sp.  
*Verrucosporites gondwanensis* Bharad. & Salujha  
 cf. *Nuskoisporites triangularis* (MEHTA) Pot. & Lele  
 cf. *Nuskoisporites reticulatus* Bharad. & Salujha  
*Densipollenites indicus* Bharad.  
*Densipollenites invisus* Bharad. & Salujha  
*Densipollenites* sp.  
*Striomonosaccites circularis* Bharad. & Salujha  
*Platysaccus* sp.  
*Striatites notus* Bharad. & Salujha  
*Striatites rhombicus* Bharad. & Salujha  
*Striatites subtilis* Bharad. & Salujha  
*Striatites obtusus* Bharad. & Salujha  
*Striatites solitus* Bharad. & Salujha  
*Striatites communis* Bharad. & Salujha  
*Verticypollenites finitimus* Bharad. & Salujha  
*Verticypollenites subcircularis* Bharad. & Salujha  
*Verticypollenites gibbosus* Bharad.  
*Lahirites singularis* Bharad. & Salujha

- Lahirites incertus* Bharad. & Salujha  
*Lahirites rotundus* Bharad. & Salujha  
*Lahirites parvus* Bharad. & Salujha  
*Hindipollenites indicus* Bharad.  
*Lunatisporites fuscus* Bharad.  
*Lunatisporites* sp. A  
*Lunatisporites* sp. B  
*Striatopodocarpites decorus* Bharad. & Salujha  
*Striatopodocarpites magnificus* Bharad. & Salujha  
*Faunipollenites varius* Bharad.  
*Faunipollenites* sp. A.  
*Striapollenites saccatus* Bharad.  
*Striapollenites obliquus* Bharad. & Salujha  
*Distriatites insolitus* Bharad. & Salujha  
*Sulcatisporites cvatus* (B. & H.) Bharad.  
*Sulcatisporites* sp. A.  
*Sulcatisporites* sp. B.  
*Welwitschiapites tenuis* Bharad. & Salujha  
 cf. *Gnetaceapollenites* sp.  
*Decussatisporites lucifer* Bharad. & Salujha  
 Besides the above listed species, there are some others which are not so far reported from the Raniganj Stage and are described below.

- Anteturma** — *Sporites* H. Pot. 1893  
**Turma** — *Triletes* (Reinsch) Pot. & Kr. 1954  
**Subturma** — *Azonotriletes* Luber 1935  
**Infraturma** — *Laevigati* (B. & K.) Pot. 1956

***Eupunctisporites* Bharad. 1962**

*Eupunctisporites* sp.

Pl. 1, Fig. 1

**Description** — Circular, dark brown miospores; size  $\pm 92 \mu$ , Y-mark indistinct, exine 6-7  $\mu$  thick, ornamented with puncta of varying size, usually 1-2  $\mu$  broad leaving a 2-4  $\mu$  wide space in between them; puncta usually cohering with each other to give a pseudoreticulate appearance.

**Comparison** — *Eupunctisporites poniatienensis* has a clear trilete mark, puncta are 1  $\mu$  wide with a 2-3  $\mu$  wide space in between them. *E. gravus* has a hardly discernible Y-mark,  $\pm 4 \mu$  thick exine and the puncta are widely spaced. The present species distinguishes in having the thickest of all exines, an indistinct Y-mark and puncta of irregular sizes which fuse to form a pseudo-reticulum.

***Punctatisporites* (Ibr.) Pot. & Kr. 1954, 1955***Punctatisporites priscus* sp. nov.

Pl. 1, Figs. 2-4

*Holotype* — Pl. 1, Fig. 2.*Diagnosis* — Circular to subcircular; size 42-74  $\mu$ ; Y-mark prominent, rays 1/2-3/4 radius long; labra 1-2  $\mu$  thick; exine smooth, intragranulose around the trilete mark.*Description* — Golden yellow, circular to subcircular miospores with many folds; holotype 58  $\mu$ . Y-mark prominent, rays reaching 1/2-3/4 the length of the radius. Exine laevigate, appearing to be intragranulose around the trilete mark.*Comparison* — The solitary specimen of *Punctatisporites* figured by Bharadwaj (1962; Pl. 1, Fig. 8) is bigger in size and the Y-rays almost reach the spore margin. *P. gretensis* is also bigger in size and has a 4  $\mu$  thick exine. The present species distinguishes in being smaller in size, with a thin exine and the Y-rays are 1/2-3/4 radius long.*Punctatisporites* sp.

Pl. 1, Fig. 5

*Description* — Yellowish,  $\pm$  circular miospores; size  $\pm$  88  $\mu$ ; Y-mark prominent, rays reaching almost upto the equatorial margin, labra 3-4  $\mu$  thick; exine laevigate, thin because of which it gets variously folded.*Comparison* — The present species distinguishes in having a thin and laevigate exine, Y-rays as long as the radius and a very thick labra.

The present specimen is very much similar to the one figured by Bharadwaj (1962).

*Remarks* — It is of interest to note that *Punctatisporites* which is abundantly represented in the older deposits of Europe and America is very scantily found from the Raniganj coals. This record is the second to the one described by Bharadwaj (1962).***Calamospora* S.W. & B. 1944***Calamospora* sp.

Pl. 1, Figs. 6-7

*Description* — Golden yellow, circular to subcircular miospores, 28-32  $\mu$ ; Y-mark visible, sometimes open; rays almost 1/2 the length of the radius, ray-ends usually pointed. Exine laevigate.*Comparison* — *Calamospora aplata* and *C. exila* are bigger in size with infrapunctate exine. The present species distinguishes in being smaller in size and in having a smooth exine. Balme & Hennelly (1956b) describe a species of *Calamospora*, *C. diversiformis* which has been transferred to *Retusotriletes diversiformis* by Bharadwaj (1962). It is characterised in having a clearly defined, darkened contact area.***Infraturma* — Apiculati (B. & K.) Pot. 1956*****Cyclogranisporites* Pot. & Kr. 1954***Cyclogranisporites optimus* sp. nov.

Pl. 1, Fig. 8

*Holotype* — Bharad. & Salujha 1964; Pl. 1, Fig. 23.*Diagnosis* — Circular to subcircular; size 58-66  $\mu$ , Y-mark hardly discernible, rays  $\pm$  3/4 radius long; exine beset with irregular, sparsely arranged grana.*Description* — Golden yellow, circular to subcircular miospores; holotype 65  $\mu$ , Y-mark faintly seen; rays almost 3/4 radius long, ray-ends pointed; exine ornamented with sparsely arranged  $\pm$  1.5  $\mu$  broad grana; grana irregular in shape thereby fusing to form a negative reticulum; 62-70 grana can be counted on the *extrema-lineamenta*.*Comparison* — *Cyclogranisporites gondwanensis* is smaller in size with closely set grana which sometimes show coherence. The present species differs in being bigger in size and in having bigger and widely spaced grana.***Verrucosisporites* (Ibr.) Pot. & Kr. 1954***Verrucosisporites diversus* sp. nov.

Pl. 1, Figs. 9-10

*Holotype* — Pl. 1, Fig. 9.*Diagnosis* — Circular to subcircular; size 60-80  $\mu$ ; Y-mark prominent, rays 1/2-3/4 radius long, labra thick; exine verrucose.*Description* — Golden yellow, circular to subcircular miospores; holotype 70  $\mu$ , Y-mark distinct, rays 1/2-3/4 the length of radius; labra 2-3  $\mu$  thick, tapering towards the ray-ends. Exine covered with 2-3  $\mu$  broad and 1-2.5  $\mu$  long verrucae; verrucae closely set which fuse to give a pseudoreticulate appearance.

*Comparison* — *V. bullatus* B. & H., is smaller in size and the exine is ornamented with very bulbous processes. *V. trisecatus* B. & H., has an irregular outline due to the broad and hemispherical nature of the verrucae, and the trilete mark is devoid of any labra. The present species distinguishes in having a trilete mark with a thickened labra, Y-rays  $1/2-3/4$  length of the radius and closely and low set verrucae.

***Apiculatisporis* Pot. & Kr. 1956**

*Apiculatisporis weylandii* sp. nov.

Pl. 1, Figs. 11-12

*Holotype* — Pl. 1, Fig. 11.

*Diagnosis* — Circular to subcircular; size 48-56  $\mu$ ; Y-mark indistinct; exine covered with sparsely set, longer than broad coni.

*Description* — Light yellow, circular to subcircular miospores, holotype 54  $\mu$ . Y-mark indistinct; exine ornamented with sparsely arranged, 1.5-2.5  $\mu$  long and 1-1.5  $\mu$  broad, sharp to blunt tipped coni; 15-22 coni present on the *extrema-lineamenta*.

*Comparison* — One of the species of *Apiculatisporis* described and illustrated by Balme & Hennelly (1956b), that compares well with the present species is *A. levis*. It differs from the specimens illustrated here in being smaller in size and in having a prominent trilete mark whose rays extend upto the periphery of the spore. *A. apertus* Leschik, has longer ornament elements and a strongly developed trilete mark.

***Horriditriletes* Bharad. & Salujha 1964**

*Horriditriletes elegans* sp. nov.

Pl. 1, Figs. 14-15

*Holotype* — Pl. 1, Fig. 14.

*Diagnosis* — Triangular, size 34-42  $\mu$ . Y-mark prominent, rays  $1/2-3/4$  radius long; inter-ray area thickened; exine baculate.

*Description* — Golden yellow, triangular miospores with rounded angles; holotype 40  $\mu$ . Trilete mark distinct, its rays being  $1/2-3/4$  radius long, ray-ends usually tapering with a thickened inter-ray area. Exine ornamented with bacula; bacula 3-5  $\mu$  long and 1.5-2  $\mu$  broad with blunt tips; 9-14 bacula observed on the *extrema-lineamenta*.

*Comparison* — The present species differs from all the hitherto known species of

*Horriditriletes* in having a distinct inter-radial thickening. Spore  $D_1$  described by Ghosh & Sen (1948; PL. 4, FIG. 25) may probably belong to this species.

***Horriditriletes brevis* Bharad. & Salujha 1964**

Pl. 1, Fig. 16

*Remarks* — In the description of *Horriditriletes brevis* Bharad. and Salujha, it is stated that the Y-rays reach right upto the equatorial margin and that the bacula are about 2  $\mu$  long. But in the specimen figured here the Y-rays are nearly  $2/3$  the radius length and the bacula are upto 4  $\mu$  long. This variation be noted while assigning any other specimen to this species.

***Horriditriletes splendidus* sp. nov.**

Pl. 1, Figs. 17-18

*Holotype* — Pl. 1, Fig. 17.

*Diagnosis* — Triangular; size 50-60  $\mu$ ; Y-mark present, rays  $3/4$  radius or more long; exine baculate, bacula very sparse, blunt to round tipped.

*Description* — Golden yellow, triangular miospores with rounded angles and almost straight sides; holotype 60  $\mu$ . Y-mark faintly discernible to distinct, rays  $3/4$  radius or more long. Exine ornamented with up to 2.5  $\mu$  long and upto 2  $\mu$  broad, blunt to round tipped bacula; bacula very sparsely arranged such that only 6-14 bacula protrude out at the *extrema-lineamenta*.

*Comparison* — *Horriditriletes curvibaculosus* and *H. sp. A*, are smaller in size with Y-rays  $2/3$  radius long and the exine is ornamented with big bacula. *H. brevis* is much smaller in size, with the Y-rays  $2/3$  the spore radius to almost reaching the equatorial margin. The present species distinguishes in being bigger in size, Y-rays  $3/4$  radius or more long with small, blunt to round tipped bacula.

***Anapiculatisporites* Pot. & Kr. 1954**

Cf. *Anapiculatisporites longispinosus* sp. nov.

Pl. 1, Figs. 13, 19-20

*Holotype* — Pl. 1, Fig. 19.

*Diagnosis* — Roundly triangular; size 46-70  $\mu$  (excl. spinae); Y-mark prominent, rays reaching almost upto the equator; exine covered with 3-5  $\mu$  long, sharp to blunt tipped spinae.

*Description* — Golden yellow, triangular with broadly rounded angles and straight to slightly convex sides; holotype 70  $\mu$  (excl. spinae). Y-mark distinct, rays usually as long as the spore radius; labra thin. Exine beset with 3-5  $\mu$  long, 1.5-2  $\mu$  broad, sharp to blunt tipped spinae; 48-70 spinae present on the *extrema-lineamenta*.

*Comparison* — *Anapiculatisporites ericianus* (B. & H.) Bharad., is comparatively smaller in size, has sparsely arranged and smaller spinae.

*Remarks* — *Anapiculatisporites* is a spore genus from the northern hemisphere to which a number of species have been referred by Bharadwaj (1962). There is no doubt that these species from Lower Gondwana sediments show agreement with *Anapiculatisporites* in the progressive reduction of sculpture from equator to the pole proximally, longer polar axis and triangular shape in polar view. The only difference noticeable in the species from Lower Gondwana is the elevation in the region of trilete rays resulting into characteristic folds along the rays whereas in northern *Anapiculatisporites* the trilete rays are not accompanied with folds. Organisationally, *Anapiculatisporites* and chiefly its southern species are very close to *Microbaculispora* Bharad., and *Microfoveolatispora* Bharad.

#### **Cyclobaculisporites Bhard. 1955**

*Cyclobaculisporites proprius* sp. nov.

Pl. 1, Figs. 21-22

*Holotype* — Pl. 1, Fig. 21.

*Diagnosis* — Circular to subcircular; size 52-90  $\mu$ ; Y-mark hardly discernible; exine covered with irregular, sparsely arranged, round-tipped or truncate bacula.

*Description* — Golden yellow, circular to subcircular miospores; holotype 65  $\mu$ . Trilete mark almost indistinct. Exine ornamented with 2-3  $\mu$  broad and equally long, loosely arranged, round-tipped or truncate bacula; bacula irregular in shape which sometimes fuse to give a pseudoreticulate appearance. 40-68 bacula seen on the *extrema-lineamenta*.

*Comparison* — *Cyclobaculisporites indicus* Bharad. & Salujha, is bigger in size and is ornamented with more closely placed bacula. *C. minutus* Bharad. & Salujha, has a prominent Y-mark and the exine is beset with small, more closely placed bacula. The

present species distinguishes in having an indistinct trilete mark and the exine being covered with large and sparsely arranged bacula which are irregular in shape.

#### **Microfoveolatispora Bharad. 1962**

*Microfoveolatispora directa* (B. & H.) Bharad. 1962.

Pl. 1, Fig. 23

*Remarks* — In the specimens observed here the exine ornamentation is almost laevigate in contrast to the distinct microfoveolate ornamentation in the specimens studied and illustrated by Bharadwaj (1962). In all his types a graded microfoveolation is seen with the biggest in *Microfoveolatispora raniganjensis*, medium in *M. pseudoreticulata* to fine in *M. directa*. May be the specimens studied here represent the finest type of microfoveolation which is not clearly seen under oil. But all these specimens conform to the genus *Microfoveolatispora* in the nature of their overall shape and the Y-mark.

#### **Indospora Bharad. 1962**

*Indospora clara* Bharad. 1962.

Pl. 1, Fig. 24

*Remarks* — In the description of *Indospora clara*, Bharadwaj (1962) has given the size of the bacula as upto 6  $\mu$  long while in some of the specimens studied here the bacula are upto 10  $\mu$  long and are usually curved.

**Turma** — *Monoletes* Ibr. 1933

**Subturma** — *Azonomonoletes* Luber 1935

**Infraturma** — *Laevigatomoletti* Dybova and Jachowitz 1957

#### **Latosporites Pot. & Kr. 1954**

*Latosporites* sp.

Pl. 1, Figs. 25-26

*Description* — Golden yellow, circular to subcircular miospores, size 30-35  $\mu$ . Monoletic mark distinct, open, running over 3/4 the length of the spore. Exine 1.5-2  $\mu$  thick, laevigate, usually with one or two folds.

*Comparison* — *Latosporites colliensis* is bigger in size, the monoletic mark being 1/2-2/3 the spore length and the exine has an intrapunctate structure. *L. striatus* has the

typical striations usually running parallel to the monolete mark. The present species distinguishes in being much smaller in size with its monolete mark running over 3/4 length of the spore.

Spore type 10 of Virkki (1946; PL. 3, FIG. 34) resembles in most of the characters with the present species and may be included here.

**Infraturma — *Sculptatomonoleti* Dybova & Jackowitz 1957**

***Spinoporites* Alpern 1958**

*Remarks* — In the generic diagnosis of *Spinoporites*, Alpern (1958) states that the spores are regularly covered with small, closely placed spinae. But by a careful look at the specimen figured by him (ALPERN, 1958) it appears that the ornamentation is conical and not spinae. Such is also the view of Potonié (1960). Since the specimens recovered here in the present study, also bear conical for their ornamentation, they are being included in this genus.

*Spinoporites* sp.

Pl. 1, Figs. 27-28

*Description* — Golden yellow, oval to subcircular miospores, 35-50  $\mu$ . Monolete mark prominent, sometimes open, running over 1/2-3/4 radius length. Exine ornamented with sparsely arranged  $\pm 2 \mu$  long and  $\pm 1.5 \mu$  broad (at the base) conical; 12-18 conical present on the *extrema-lineamenta*.

*Comparison* — The present species differs from the genotype *S. spinosus*, in bearing sparsely arranged conical and a prominent monolete mark.

*Remarks* — This is the first record of *Spinoporites* from Indian Gondwanas.

**Turma — *Saccites* Erdtm. 1947**  
**Subturma — *Disaccites* Cookson 1947**  
**Infraturma — *Disaccitrileti* Leschik 1955**

***Limitisporites* Leschik 1956**

*Limitisporites disectus* (Hart) comb. nov.

Pl. 1, Figs. 29-31

*Description* — The specimens studied here are bilateral, bisaccate pollen grains with an oval to subcircular central body measuring 40-55  $\mu \times 45-56 \mu$ ; overall size 54-80  $\mu$ . Body exine intragranulate, proximally bearing a monolete mark, running

over 1/2-3/4 the horizontal length of the central body. Bladders crescentic in shape, finely intrareticulate; distal saccus attachment convex leaving a 30-46  $\mu$  wide, thin area in the centre.

*Remarks* — Specimens put under *Vestigisporites* spm. "A" by Balme & Hennelly (1955, PL. 6, FIGS. 59-64) appear to be similar to the specimens figured here and those by Hart (loc. cit.) in many of the characters and thus, probably belong to this species.

**Subturma — *Disaccites* Cookson 1947**  
**Infraturma — *Striatiti* Pant 1952**

***Lahirites* Bharad. 1960**

*Lahirites lepidus* sp. nov.

Pl. 2, Figs. 32-33

*Holotype* — Pl. 2, Fig. 32.

*Diagnosis* — Size 132-140  $\mu$ ; central body thick, vertically oval to rhomboidal, marginal ridge prominent; horizontal striations 6-9 without vertical partitions; exine uniformly and coarsely intrapunctate; bladder intrareticulation medium to coarse, sulcus 24-28  $\mu$  broad.

*Description* — Bisaccate, bilateral, golden yellow pollengrains with a dark brown, vertically oval to rhomboidal central body; holotype 136  $\mu$ . Body exine uniformly and coarsely intrapunctate, proximally bearing 6-9 horizontal striations devoid of any vertical partitions. Bladders subspherical, with medium to coarse intrareticulation; distal saccus attachment full length, leaving a 24-28  $\mu$  wide, thin bladder free area.

*Comparison* — *Lahirites raniganjensis* the genotype, *L. singularis*, *L. incertus* and *L. rotundus* differ in having vertical partitions in between the horizontal striations. *L. rarus* differs in being smaller in size and the distal bladder free area is 8-14  $\mu$  wide. *L. parvus* has a circular to subcircular central body with restrictedly intrapunctate exine and a 7-10  $\mu$  wide gap between the bladders distally. The present species distinguishes in having striations devoid of any vertical partitions, central body exine uniformly and coarsely intrapunctate and the widest (24-28  $\mu$ ) bladder free area distally.

***Lahirites* sp.**

Pl. 2, Fig. 34

*Description* — Bisaccate, bilateral pollen grains measuring  $\pm 73 \mu$ . Central body

thin, subcircular with a broad marginal ridge. Horizontal striations  $\pm 6$ , faintly seen and without any vertical partitions inbetween them; exine intrapunctate. Bladders subspherical, finely intrareticulate; distal saccus attachment full length, leaving a  $\pm 18 \mu$  broad area free from the bladders.

*Comparison* — Out of the already known species only one described as *Lahirites* sp., by Bharad. & Salujha, has the fine intrareticulation of the bladders. The specimen figured here, though having a fine bladder intrareticulation, differs in having a thin, subcircular central body and few vertical partitions inbetween the horizontal striations.

***Lunatisporites* (Lesch.) Bharad. 1962**

*Lunatisporites latisulcatus* sp. nov.

Pl. 2, Figs. 35-36

*Holotype* — Pl. 2, Fig. 35.

*Diagnosis* — Size 108-130  $\mu$ ; central body vertically oval to subcircular, marginal ridge distinct, horizontal striations 6-9; distal sulcus 25-35  $\mu$  broad.

*Description* — Bisaccate, bilateral, golden yellow pollengrains; holotype 130  $\mu$ . Central body vertically oval to subcircular, 48-66  $\mu \times 62-70 \mu$ , as high as the bladders, with a distinct marginal ridge and 6-9 horizontal striations proximally; vertical partitions absent. Bladders hemispherical with medium to big sized intrareticulation; bladders attaching distally thereby leaving a 25-35  $\mu$  wide thin area free from the bladders.

*Comparison* — The present species differs from all the hitherto known species of *Lunatisporites* in having the widest bladder free area distally.

***Striatopodocarpites* (Soritsch. & Sedowa) Bharad. 1962**

*Striatopodocarpites venustus* sp. nov.

Pl. 2, Figs. 37-38

*Holotype* — Pl. 2, Fig. 37.

*Diagnosis* — Size 66-74  $\mu$ ; central body vertically oval to subcircular, exine intramicroreticulate, horizontal striations 5-8; bladders finely intrareticulate, distal sulcus 12-17  $\mu$  broad.

*Description* — Bisaccate, bilateral and yellow pollengrains; holotype 68  $\mu$ . Central

body vertically oval to subcircular, 30-40  $\mu \times 40-46 \mu$ , marginal ridge distinct; exine intramicroreticulate, proximally bearing 5-8 horizontal striations without any vertical partitions inbetween them. Bladders subspherical, finely intrareticulate, attaching distally and leaving a 12-17  $\mu$  wide, thin area free from the bladders.

*Comparison* — *Striatopodocarpites decorus* has a rhomboidal central body with truncate ends, a uniformly broad bladder free area distally and a medium sized intrareticulation of the bladders. *S. magnificus* has a circular to subcircular central body, proximally bearing 8-10 horizontal striations with a  $\pm 25 \mu$  wide distal sulcus and the bladder intrareticulation is medium to big sized. *S. diffusus* has a hexagonal, dark brown and diffused central body with medium to big sized bladder intrareticulation. The present species distinguishes in having a oval to subcircular central body with only 5-8 horizontal striations, a slightly convex 12-17  $\mu$  wide bladder free area and a small sized mesh work of the bladders.

Two of the specimens referred as *Lueckisporites* spm., by Balme & Hennelly (1955, Pl. 4, Figs. 41, 42) may probably belong to this species.

***Striatopodocarpites* sp.**

Pl. 2, Fig. 39

*Description* — Bisaccate, bilateral and golden yellow pollengrains; 70-104  $\mu$ . Central body vertically oval; exine intramicroreticulate with 5-7 horizontal striations proximally. Bladders subspherical, intrareticulation with sparse, small lumina; distal attachment of the sacchi straight to slightly convex, 11-13  $\mu$  apart in the centre.

*Comparison* — The present specimens are small in size and have a vertically oval central body with bladders having sparsely meshed intrareticulation. These are not comparable to any other species of *Striatopodocarpites* described from Raniganj Stage.

***Faunipollenites* Bharad. 1962**

*Faunipollenites copiosus* sp. nov.

Pl. 2, Figs. 40-41

*Holotype* — Pl. 2, Fig. 40.

*Diagnosis* — Size 148-162  $\mu$ ; central body vertically oval, outline hardly discernible,

exine intramicroreticulate, horizontal striations 9-11; bladders coarsely intrareticulate, 25-32  $\mu$  apart distally.

*Description* — Bisaccate, bilateral, golden yellow pollengrains; holotype 162  $\mu$ . Central body vertically oval, 70-76  $\mu \times$  88-98  $\mu$ , slightly bigger in height than the bladders, outline hardly discernible, being made out by striation ends; exine intramicroreticulate proximally bearing 9-11 horizontal striations without any vertical partitions. Bladders subspherical, coarsely intrareticulate, attaching distally and leaving a 25-32  $\mu$  wide thin bladder free area.

*Comparison* — *Faunipollenites varius* Bhadr., is smaller in size bearing only 6-8 horizontal striations on the central body. *F. sp. A*, too is smaller in size with a roundly bilateral shape. The present species distinguishes in being bigger in size, distinctly bilateral in shape, having 9-11 horizontal striation and big-sized intrareticulation in the bladders.

*Faunipollenites perexiguus* sp. nov.

Pl. 2, Figs 42-44

*Holotype* — Pl. 2, Fig. 42.

*Diagnosis* — Over all shape subcircular, size 54-74  $\mu$ ; central body outline indistinct, horizontal striations 6-9; bladders with fine to medium intrareticulation, almost touching each other distally.

*Description* — Bisaccate, subcircular and golden yellow pollengrains; holotype 54  $\mu$ . Central body indistinct, its outline can be made out by striation ends; exine intramicroreticulate, proximally bearing 6-9 horizontal striations devoid of any vertical partitions. Bladders small, hemispherical with fine to medium sized meshes, distally bladders very close often touching each other.

*Comparison* — *Faunipollenites varius* the genotype, is bigger in size, and longish bilateral in shape. *F. sp. A*, too is bigger in size, horizontal striations on the central body number 9-12 and the distal bladder free area 20-30  $\mu$  wide.

*Faunipollenites* sp.

Pl. 2, Fig. 45

*Description* — Bisaccate, bilateral, golden yellow pollengrain; size  $\pm$  99  $\mu$ . Central

body outline indistinct, can be made out by the edges of the thickened central body, shorter in height than the bladders, vertically oval,  $\pm$  46  $\times$  56  $\mu$ ; horizontal striations  $\pm$  6, usually bifurcating; exine intramicroreticulate. Bladders hemispherical with medium sized mesh work, distal bladder free area convex, 24  $\times$  4  $\mu$  wide.

*Comparison* — All the hitherto known species of this genus have an indistinct central body which is as much as or bigger than the bladders in height and the distal bladder free area is straight to slightly convex. The present specimen, though having an indistinct central body outline, differs in having a thick body which is shorter in height than the bladders and the distal sulcus is distinctly convex.

### MIOFLORAL DISTRIBUTION

The fossil spore and pollen flora of the Bonbahal seam from Jote Dhemmo colliery consists of 40 genera with 85 species. The distribution of the various genera in each of the samples is represented in the distribution chart (TEXT-FIG. 1). The quantitatively important genera are the following:

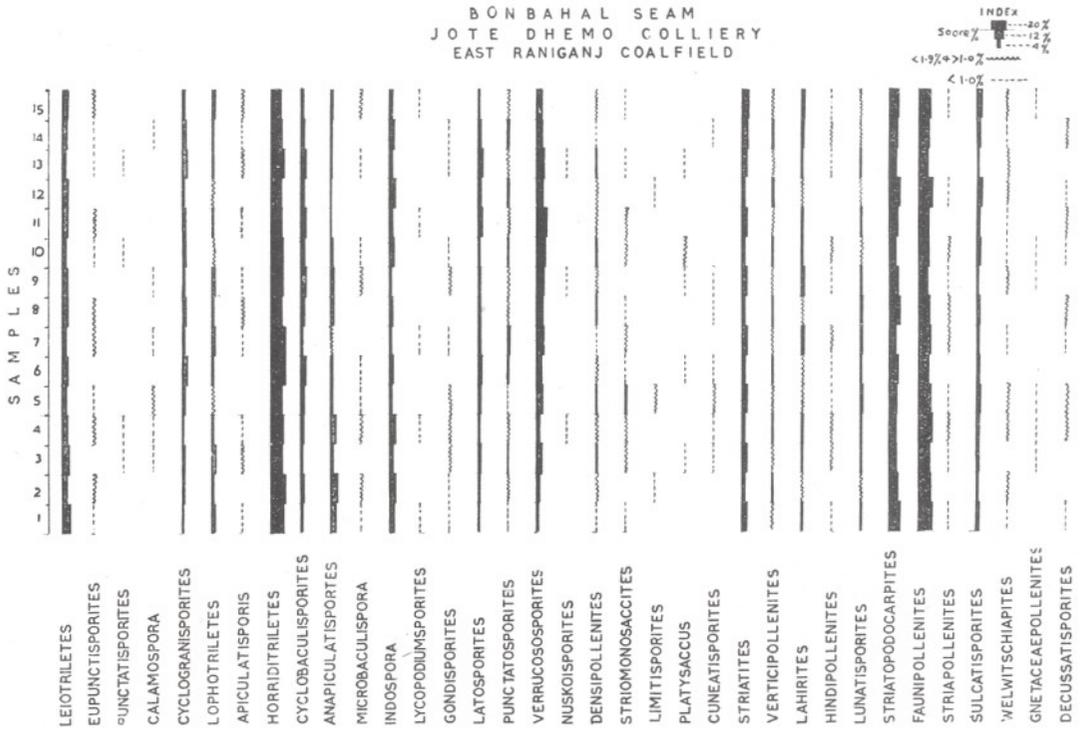
*Leiotriletes*, represented by a single species *L. sp.*, has the distribution range from 2.0 to 8.5 per cent.

*Cyclogranisporites* has abundant distribution in all the samples of the colliery and ranges from 2.0 to 5.5 per cent. It is represented by two species, *C. gondwanensis* and *C. optimus*.

*Lophotriletes* has a range in its distribution percentage from 1.0 to 4.0 per cent and is represented by two species, *L. rectus* and cf. *L. rarus*. The later species has a poorer occurrence as compared to the former species.

*Horriditriletes* shows considerable richness in its distribution. It is represented by five species, *H. curvibaculosus*, *H. brevis*, *H. elegans*, *H. splendidus* and *H. sp.* The average percentage of the genus is 16.2 per cent, *H. curvibaculosus* and *H. brevis* being the most frequently encountered species.

*Cyclobaculisporites* is fairly represented in all the samples of the colliery, the average frequency being 3.7 per cent. The species met with are *C. indicus*, *C. minutus* and *C. proprius*. A bulk of the average percentage is constituted by *C. indicus*, the other two species being poorly represented.



TEXT-FIG. 1 — Showing the distribution of the various genera in each of the samples of the seam.

*Microfoveolatispora*, with two species *M. directa* and *M. sp.*, has the average frequency of 4.3 per cent.

*Indospora* has an average frequency of 4.8 per cent and is represented by three species, *I. clara*, *I. laevigata* and *I. macula*. A bulk of the distribution percentage is contributed by *I. laevigata* and *I. macula*, *I. clara* showing a meagre occurrence.

*Latosporites*, with two species *L. colliensis* and *L. sp.*, is abundantly distributed throughout the colliery with an average percentage of 3.9 per cent.

*Punctatosporites* and *Verrucososporites*, each with a single species, *P. sp.*, and *V. gondwanensis* have the average frequencies of 1.5 and 7.0 per cent respectively.

*Densipollenites* has the average frequency of 1.3 per cent and is represented by three species, *D. indicus*, *D. invisus* and *D. sp.* *D. invisus* and *D. sp.* are comparatively more commonly encountered than *D. indicus*.

*Striomonosaccites*, with its single species *S. circularis*, has a very meagre distribution ranging from 0.5 to 2.0 per cent.

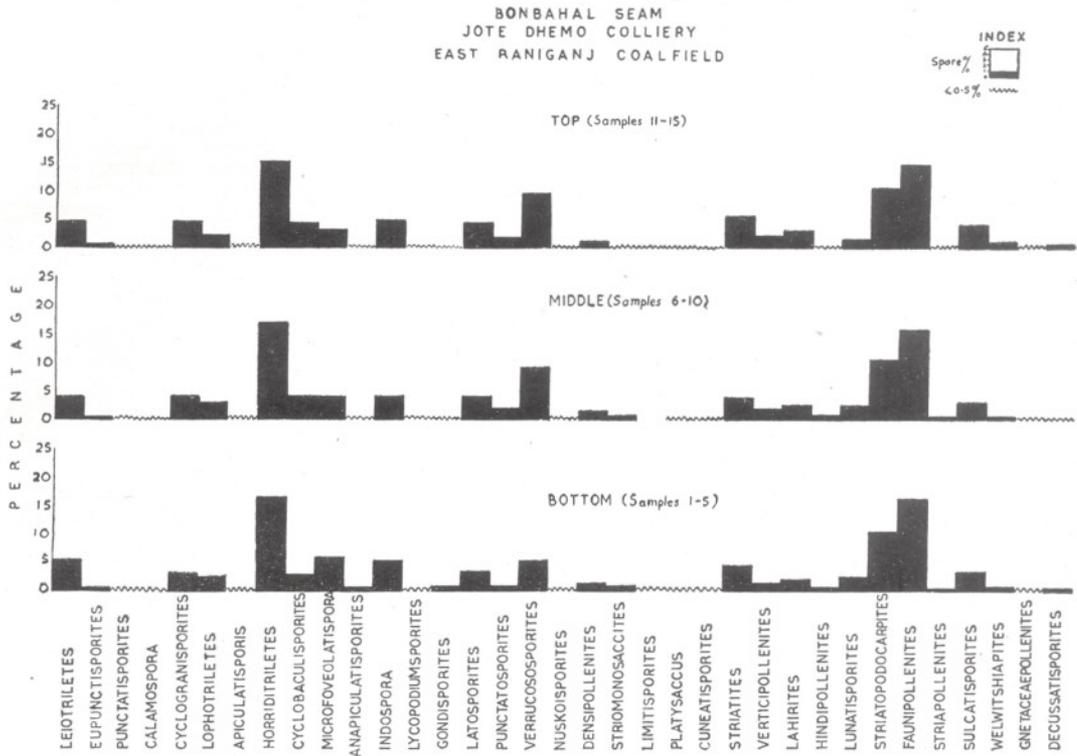
*Striatites* is fairly and almost uniformly represented throughout the vertical length of the seam. The average frequency being 4.5 per cent and the species encountered are *S. notus*, *S. rhombicus*, *S. subtilis*, *S. obtusus*, *S. solitus* and *S. communis*.

*Verticipollenites* has the average percentage of 1.7 per cent and is represented by three species, *V. finitimus*, *V. subcircularis* and *V. gibbosus*. All these species are almost equally distributed.

*Lahirites* is fairly represented with the average frequency of 2.5 per cent. The species represented are, *L. singularis*, *L. incertus*, *L. rotundus*, *L. parvus*, *L. lepidus* and *L. sp.* Out of these *L. singularis*, *L. incertus* and *L. parvus* contribute mostly to the average percentage of the genus.

*Lunatisporites* has the frequency range from 1.0 to 4.0 per cent. It is represented by the species, *L. fuscus*, *L. sp. A*, *L. sp. B*, and *L. latisulcatus*. *L. sp. A* and *L. sp. B* are abundantly represented as compared to the remaining two species.

*Striatopodocarpites* shows an abundant distribution and has the frequency range from



TEXT-FIG. 2 — Showing the representation of the various genera from the top, middle and bottom sectors of the seam.

8.0 to 14.5 per cent. Out of the four species of the genus represented here, *S. decorus* and *S. venustus* are common and others like *S. magnificus* and *S. sp.*, are rare.

*Faunipollenites* has the maximum distribution averaging to 15.5 per cent. It is represented by four species which are, *F. varius*, *F. sp. A*, *F. copiosus* and *F. perexiguus*. The first two species are comparatively abundantly represented.

*Sulcatissporites* has the distribution range from 2.0 to 6.5 per cent, being comparatively more in the top samples than the bottom ones. The genus is represented by three species, *S. ovatus*, *S. sp. A*, and *S. sp. B*. The first species constitutes the bulk of the percentage.

The poorly or very poorly represented genera are cf. *Concavissporites*, *Eupunctisporites*, *Punctatissporites*, *Calamospora*, *Apiculatissporis*, *Retusotrilletes*, *Anapiculatissporites*, *Lycopodiumsporites*, *Gondisporites*, *Spinisporites*, *Platysaccus*, *Cuneatisporites*,

*Limitisporites*, *Hindipollenites*, *Striapollenites*, *Welwitschiapites*, *Gnetaceapollenites* and *Decussatisporites*.

The average percentages of all the genera from 3 different sectors i.e., top, middle and bottom have been plotted in the form of a histogram (TEXT-FIG. 2).

#### MIOFLORAL COMPARISON OF BONBAHAL SEAM WITH THAT OF JAMBAD BOWLAH SEAM

A comparison of the miospore assemblages of the Bonbahal and Jambad Bowlah seams (TABLE 2) shows that they differ from each other both qualitatively and quantitatively.

In the above table (—) indicates total absence, (+) indicates presence but not encountered in the countings. A look at it shows that most of the genera are common to both the seams. However, there are some genera which are present in

TABLE 2

| SPORE GENERA               | AVERAGE PERCENTAGES |                    |
|----------------------------|---------------------|--------------------|
|                            | Bonbahal seam       | Jambad Bowlah seam |
| <i>Leiotriletes</i>        | 4.5                 | 2.45               |
| cf. <i>Concavisporites</i> | +                   | 0.1                |
| <i>Eupunctisporites</i>    | 0.6                 | 0.35               |
| <i>Ricaspora</i>           | —                   | +                  |
| <i>Punctatisporites</i>    | 0.13                | —                  |
| <i>Calamospora</i>         | 0.23                | 0.37               |
| <i>Retusotriletes</i>      | 0.02                | +                  |
| <i>Cyclogranisporites</i>  | 3.8                 | 7.66               |
| <i>Verrucosiporites</i>    | +                   | +                  |
| <i>Lophotriletes</i>       | 2.5                 | 2.6                |
| <i>Apiculatisporis</i>     | 0.1                 | —                  |
| <i>Horriditriletes</i>     | 16.2                | 13.97              |
| <i>Anapiculatisporites</i> | 0.5                 | —                  |
| <i>Cyclobaculisporites</i> | 3.7                 | 1.67               |
| <i>Microfoveolatispora</i> | 4.3                 | 0.04               |
| <i>Indospora</i>           | 4.8                 | 2.7                |
| <i>Dictyotriletes</i>      | —                   | +                  |
| <i>Lycopodiumsporites</i>  | 0.16                | 0.02               |
| <i>Gondisporites</i>       | 0.5                 | 0.25               |
| <i>Latosporites</i>        | 3.9                 | 2.65               |
| <i>Punctatisporites</i>    | 1.5                 | 2.03               |
| <i>Verrucosiporites</i>    | 7.03                | 11.12              |
| <i>Spinisporites</i>       | 0.03                | —                  |
| <i>Densipollenites</i>     | 1.3                 | 2.0                |
| <i>Striomonosaccites</i>   | 0.7                 | 0.9                |
| <i>Platysaccus</i>         | 0.1                 | +                  |
| <i>Cuneatisporites</i>     | 0.2                 | 0.01               |
| <i>Limitisporites</i>      | 0.3                 | —                  |
| <i>Striatites</i>          | 4.5                 | 7.9                |
| <i>Verticypollenites</i>   | 1.7                 | 2.66               |
| <i>Lahirites</i>           | 2.5                 | 3.8                |
| <i>Hindipollenites</i>     | 0.6                 | 1.46               |
| <i>Lunatisporites</i>      | 2.1                 | 5.3                |
| <i>Striatopodocarpites</i> | 10.5                | 4.4                |
| <i>Faunipollenites</i>     | 15.5                | 15.7               |
| <i>Striapollenites</i>     | 0.5                 | 0.55               |
| <i>Distriatites</i>        | +                   | 0.04               |
| <i>Sulcatisporites</i>     | 3.5                 | 5.96               |
| <i>Welwitschiapites</i>    | 0.7                 | 0.7                |
| <i>Gnetaceapollenites</i>  | 0.2                 | 0.1                |
| <i>Decussatisporites</i>   | 0.5                 | 0.53               |

Bonbahal seam and absent in Jambad Bowlah seam and vice versa but these are rare in occurrence. A number of other genera show quantitative differences in their occurrence in the two seams. Such genera are:

*Leiotriletes*  
*Cyclogranisporites*  
*Microfoveolatispora*  
*Indospora*  
*Verrucosiporites*  
*Striatites*  
*Hindipollenites*  
*Lunatisporites*

*Striatopodocarpites*  
*Sulcatisporites*

Along with the qualitative and quantitative differences in the occurrence of various genera, some of the species represented in the Bonbahal seam are absent in the Jambad Bowlah seam and vice versa. The following are the quantitatively important species represented in Bonbahal seam which are not recorded from the Jambad Bowlah seam:

*Punctatisporites priscus*  
*Calamospora* sp.  
*Apiculatisporis weylandii*  
*Horriditriletes splendida*  
*Cyclobaculisporites proprius*  
*Microfoveolatispora directa*  
*Latosporites* sp.  
*Limitisporites dissectus*  
*Lahirites lepidus*  
*Lunatisporites latisulcatus*  
*Striatopodocarpites venustus*  
*Faunipollenites perexiguus*

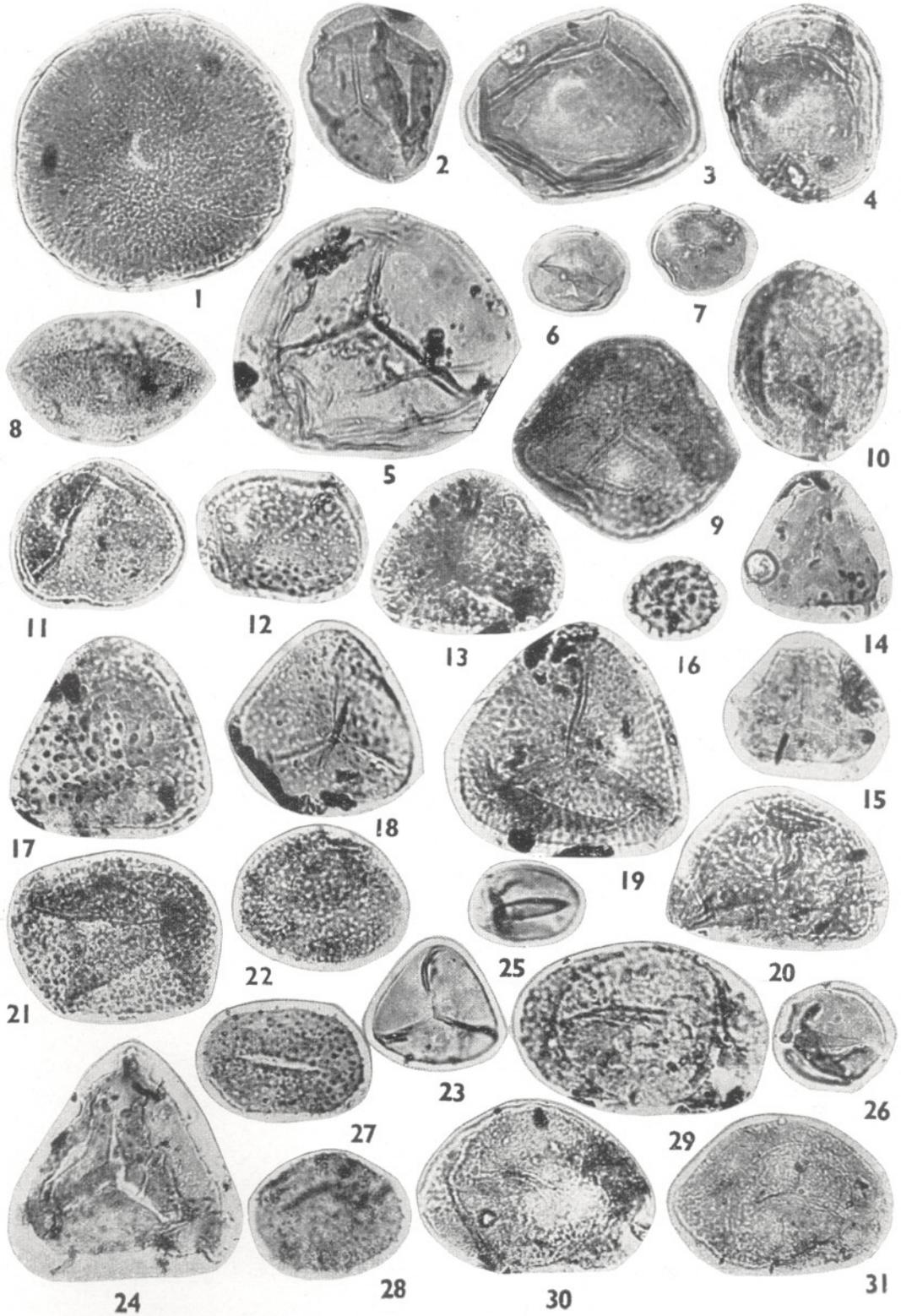
The species that are significantly represented in Jambad Bowlah seam but seem to be absent in Bonbahal seam are listed below:

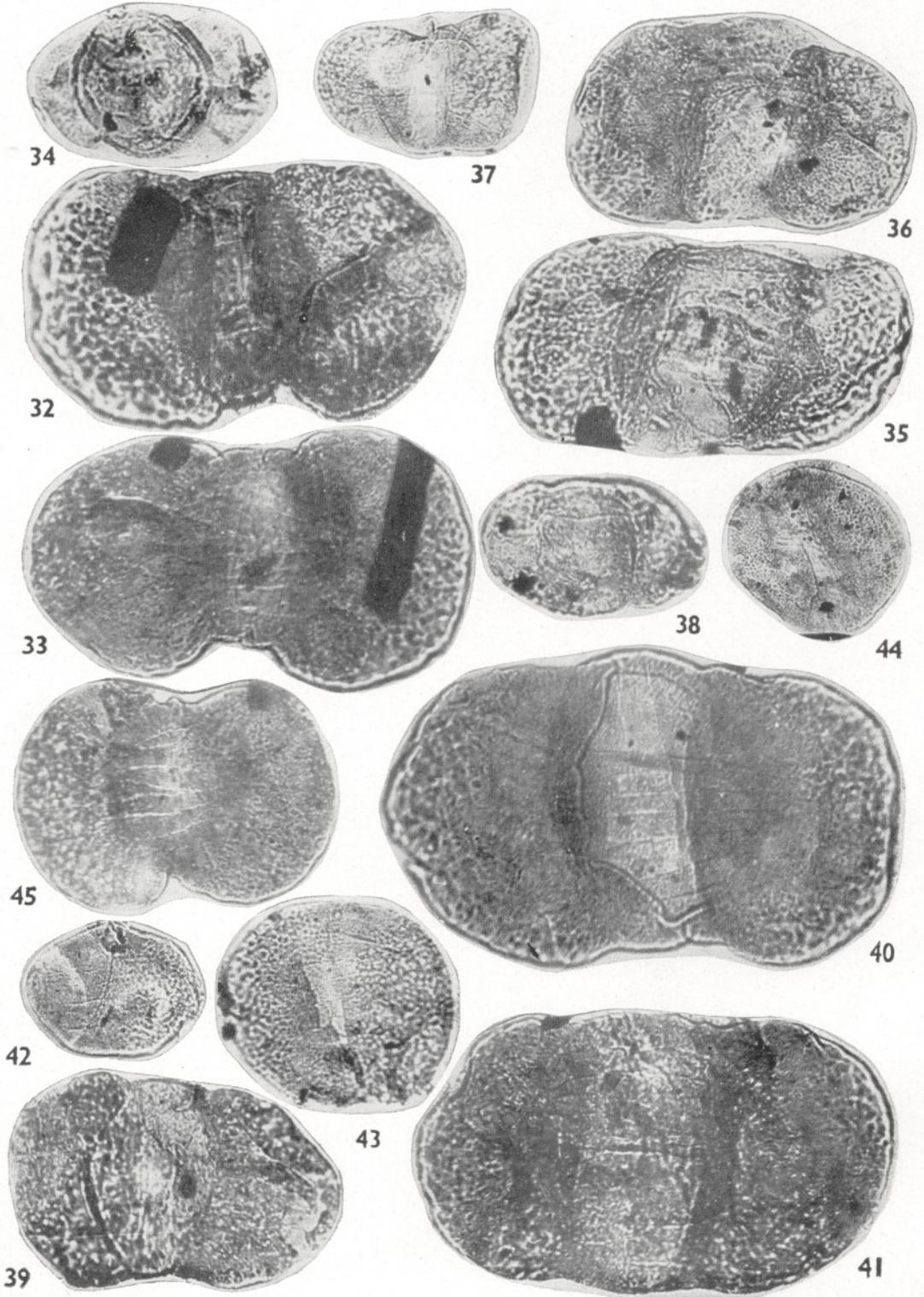
*Calamospora exila*  
cf. *Lophotriletes pseudogranus*  
*Latosporites* sp.  
cf. *Nuskosporites triangularis*  
*Lahirites rarus*  
*Hindipollenites oblongus*  
*Striatopodocarpites diffusus*  
*Vesicaspora* sp.

From the details given above it is observed that the bisaccates dominate the miofloral assemblages of each of the coal seams under comparison. But still, comparatively they are represented more in Bonbahal seam than in Jambad Bowlah seam. Triletes also, are distributed more in Bonbahal seam than in Jambad Bowlah seam. The monoletes and the monosaccates naturally show a comparatively poorer distribution in Bonbahal seam than in Jambad Bowlah seam.

## ACKNOWLEDGEMENTS

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## EXPLANATION OF PLATES

(All magnifications  $\times 500$ )

## PLATE 1

1. *Eupunctisporites* sp.; Ph. No. 377/33.
- 2-4. *Punctisporites priscus* sp. nov.; Ph. Nos. 206/14 (Slide No. 619-Bc336/3), 376/35, 351/7.
5. *Punctisporites* sp.; Ph. No. 352/32.
- 6-7. *Calamospora* sp.; Ph. Nos. 376/2, 376/9.
8. *Cyclogranisporites optimus* sp. nov.; Ph. No. 374/13 (Holotype Slide No. 620-10M/8).
- 9-10. *Verrucosisporites diversus* sp. nov.; Ph. Nos. 200/31 (Slide No. 619-331/2), 352/24.
- 11-12. *Apiculatisporis weylandii* sp. nov.; Ph. Nos. 376/8 (Slide No. 619-Bc330/2), 376/4.
13. *Acanthotriletes* sp.; Ph. No. 376/20.
- 14-15. *Horriditriletes elegans* sp. nov.; Ph. Nos. 376/40 (Slide No. 619-Bc339/1), 353/34.
16. *Horriditriletes brevis* Bharad. & Salujha; Ph. No. 352/26.
- 17-18. *Horriditriletes splendidus* sp. nov.; Ph. Nos. 354/15 (Slide No. 619-Bc332/1), 352/3.
- 19-20. *Anapiculatisporites longispinosus* sp. nov.; Ph. Nos. 376/3 (Slide No. 619-Bc329/3), 376/24.
- 21-22. *Cyclobaculisporites proprius* sp. nov.; Ph. Nos. 354/2 (Slide No. 619-Bc340/1), 352/6.

23. *Microfoveolatispora directa* (B. & H.) Bharad.; Ph. No. 375/5.
24. *Indospora clara* Bharad.; Ph. No. 352/37.
- 25-26. *Latosporites* sp.; Ph. Nos. 353/24, 376/16.
- 27-28. *Spinisporites* sp.; Ph. Nos. 352/20, 374/34.
- 29-31. *Limitisporites dissectus* Hart, 1960.; Ph. Nos. 352/28, 376/7, 352/8.

## PLATE 2

- 32-33. *Lahirites lepidus* sp. nov.; Ph. Nos. 205/15 (Slide No. 619-343/4), 202/4.
34. *Lahirites* sp.; Ph. No. 376/15.
- 35-36. *Lunatisporites latusulcatus* sp. nov.; Ph. Nos. 376/13 (Slide No. 619-Bc331/2), 376/12.
- 37-38. *Striatopodocarpites venustus* sp. nov.; Ph. Nos. 376/27 (Slide No. 619-Bc334/2), 376/36.
39. *Striatopodocarpites* sp.; Ph. No. 199/7.
- 40-41. *Faunipollenites copiosus* sp. nov.; Ph. Nos. 202/34 (Slide No. 619-334/2), 199/2.
- 42-44. *Faunipollenites perexiguus* sp. nov.; Ph. Nos. 377/15 (Slide No. 619-333/6), 352/35, 377/17.
45. *Faunipollenites* sp.; Ph. No. 204/9.