SPORAE DISPERSAE OF THE LIGNITES FROM CANNANORE BEACH ON THE MALABAR COAST OF INDIA

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ABSTRACT

In this paper sporae dispersae of the Cannanore lignites have been described. For taxonomic purposes we have made use of the rules of the International Code of Botanical Nomenclature. It was necessary to create some new genera and several species, because our forms do not agree with most of the forms which till now have been studied from the Indian Tertiaries. We suppose that the youngest Tertiary has, till now, not been studied, and that our lignite perhaps belongs more or less to the Upper Miocene or Pliocene while the forms described till now are probably of Lower Miocene.

INTRODUCTION

THE sporae dispersae described in this paper were obtained from three samples of lignites from Cannanore Beach in Kerala. The lignite was presented to the Birbal Sahni Institute of Palaeobotany in July 1953 by Dr. E. K. Janaki Ammal, Director, Central Botanical Laboratories, Allahabad. The samples were collected on the beach of Cannanore close to the old European club from some exposed cliffs near the sea. However, nothing was mentioned concerning the position of these samples in the outcrop. Further we know nothing concerning the petrographical character of the lignite deposit as a whole, whether the entire deposit consists of the same type of lignite as we have received, or if the seam was banded and contained different types of lignites. Therefore, the present account of the Sporae dispersae should be regarded as representing the three samples and not the entire deposit.

This lignite was first recorded in 1830 by General Cullen (*see* KRISHNAN, 1951, p. 162) as a deposit at the base of the cliffs on the seashore at Cannanore. In 1943 Jacob investigated this lignite deposit and states (KRISHNAN l.c.) that the lignite bed is exposed at the low tide for a length of several feet at the base of a 30 ft. high cliff on the seashore about 1 mile north of Fort St. Angelo, Cannanore. The bed was 4½ ft. thick including a 3-inch layer of clay about one foot above the base. He further states that there are records of finds in some wells a quarter of a mile inland at a depth of 30-40 ft., but he, however, is not sure if they are continuous.

In the geological map compiled by Krishnan (l.c., PLATE 12) our lignite is topographically placed in the recent deposits between the sea and the undifferentiated crystallines. About 60 miles to the south of Cannanore along the Malabar Coast there appear under the recent deposits Miocene to Pleistocene rocks.

Till now, along the Malabar Coast near the seashore three deposits of lignites have been observed. The two in the south have been placed in the Miocene.

A detailed sporology has not been done so far and we feel it is necessary to do so. It is quite likely that at least in the north the lignites belong to the Pliocene because of the great difference between its spore and pollen content and that of the Miocene lignite of Warkalli and also taking into consideration the great distance between the two deposits. But these are only suppositions to stimulate further studies.

In our preparations there are not only spores and pollen grains but chiefly leaf cuticles and fungal remains. That means perhaps that the peat was not formed in or below the level of the ground water but a little above and only sinking later under the level.

This paper deals principally with only the spores and pollen grains while the fungal spores and cuticular remains shall be dealt elsewhere.

However, we find that it is necessary to take into account the entire microflora (including fungal spores) to assess its

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relationship with the Tertiary microflora of other regions.

Sahni *et al.* (1948, pp. 262, 263) have reported some microfossils from the oil-bearing Tertiary rocks of Assam. They have given four plates (14-17) of drawings in which there is a fairly large number of fungal remains agreeing with our forms, e.g. Pl. 14, Fig. 1 (agrees); Pl. 16, Fig. 40 (agrees); Pl. 16, Fig. 43 ($\pm$); Pl. 16, Fig. 45 ($\pm$); Pl. 17, Fig. 51 ($\pm$) and others. On the other hand, there are also some distinct forms which we did not find in our lignite, e.g. Pl. 15, Figs. 21, 26, 29; Pl. 16, Fig. 44 ; Pl. 17, Fig. 47.

It is difficult to correlate these sedimentary deposits because they belong to different facies as lignites, clays and shales. Different facies have a different spore content even if they are in the same stratigraphical range. It is not only interesting but perhaps significant that many of the characteristic spore and pollen forms of the European, Australian and the Far East are missing from both these facies.

Also comparing our microflora with that of the Indian lignites, e.g. Miocene of Warkalli (RAO & VIMAL, 1952; VIMAL, 1953), we see that there is not one form which absolutely agrees with those of our lignite. We have even some forms which are completely different.

Comparing with Eocene microfossils from the Indian Palana lignites (RAO & VIMAL, 1950, 1952) we see that all the distinct forms differ from those of our forms and the same is to be said of the spores and pollen grains of the Eocene lignites of Dandot, Pakistan (VIMAL, 1952).

Among the microfossils figured by Stefen Macko (1957) from the lower Miocene of Upper Silesia three forms agree with those of ours: Pl. 72, Figs. 2-9 (*Lanomyces* ?); Pl. 74, Figs. 34-36 (*Nebela* ?, Rhizopoda); and Pl. 73, Figs. 5-7 (*Trichothyrium* ?). Another common form in our lignite has been figured by Cookson (1947, PL. 11, FIG. 5) as *Notothyrites setiferus* from the Tertiary deposits of New South Wales.

From the above perusal it seems as if the spore content of our lignite cannot be designated as Eocene or Miocene and, therefore, also not as Oligocene. This cannot be said as an absolute conclusion but as a derivative of the literature existing till now.

There is a question if it is possible to say something about the stratigraphical position in studying the petrographical features of the lignite samples. They do not look like Pleistocene peat but like a Tertiary lignite. In Europe sediments have been found, which look more like a lignite rather than peat from the interglacial humolithes of the Alps, e.g. in Rosenheim. In this case the spore content showed clearly that it was a Pleistocene humolithe, but in spite of this the question is open whether it is allowed to call a material peat only from the stratigraphical point of view. Here it must be mentioned that in Japan there exists Tertiary charcoals and in Russia in the basin of Moscow lignites are known from the Lower Carboniferous. Therefore, the terms peat, lignite and coal are petrographical ones and are not always of stratigraphical significance.

TAXONOMY

For the taxonomy of our material we have used the rules of the International Code of Botanical Nomenclature concerning form and organ genera. There it is said that for isolated parts of fossil plants such genera shall be used, and that for these genera the Type Method must be applied as well as for all other genera; further that there are to be placed as form species and organ species which are treated like the species of the other system. It is said that organ species and form species are necessary because fossil plant remains are mostly found as ' organs ' separated from one another, and that in most of the cases it is not possible to say exactly how the different organs belong together. So far the International Code only underlines the botanical point of view, but on the other hand the organ and form genera and species are of immense stratigraphical value. This occurs from the stratigraphical incongruity of the organs. Not every organ of a plant has the same diagnostical value. While with one organ we may be able to recognize exactly the species, it will not be so with other organs. They will perhaps only show the genus or the family. All these organs are put in organ genera and if even the family is not recognizable, then they are included in form genera. That means the features of these genera may belong to several families and even classes or orders and so this botanical fact will make such genera of lesser stratigraphical value. If now, for instance, a fructification containing spores is put in an organ genus and if the organ genus has a clear stratigraphical range, there may be spores in the fructification which resemble absolutely spores found in other stratigraphical conditions as sporae dispersae. So it is not possible to put these sporae dispersae together with the fructification. Then this would mean that everywhere we find such a sporae dispersae, we have the stratigraphical position of the fructification. Since this is not right, it will not be possible to make a correct stratigraphy with plant microfossils without using very carefully the organ and form genera and species.

Rao (1955) has written a paper worthy of notice concerning the pollen grains found in the Indian Tertiary Eocene and Miocene lignites. He places his forms in units which are called Sporomorpha. Such units are not accepted from the International Code of Botanical Nomenclature. Since 1st January 1953 the I.C. demands the clear indication of the rank of the Taxon. This means, of course, only such ranks which are accepted by the I.C., e.g. orders, classes, families, genera and species. The form and organ genera are treated as genera. They must be used for the sporae dispersae and are under the rules of priority, not so the Sporomorpha. The latter must be replaced by form species and organ species. It is always possible to make some of the Sporomorpha legitimate as far as they are not in collision with the organ and form species still existing. To do so the I.C. demands the use of type method.

On the other hand Rao (l.c.) determines the pollen grains more or less according to the natural system of plant families. In the plates he does this mostly with a question mark and also in the text he does not absolutely insist upon his determinations. This is very good as such and shows how much organ and form species are necessary to make the palaeontology of sporae dispersae more stable than as it is with the terminology used by Rao.

If we have types attached on the names of organ and form species, there will be an international possibility of understanding and everyone is then allowed to emphasize his own opinion concerning the relationship of the organ and form species with genera and families of the natural system, but that must not be expressed in putting our organ and form species into the common genera. They must always be placed in organ and form genera having a spore as genotype. An organ or form species should only be placed in a genus of which the same organ is the type.

What we think about the natural relationship of sporae dispersae must be said beside and will often be a matter of scientific opinion. But in spite of the changes in the opinions it will be possible to work with the types of the organ and form species stratigraphically. This would not be possible in such a manner if we work with so loose a method as with the Sporomorpha or even only with supposed relationships.

We are not absolutely sure that the pollen grains shown in Plate 1, Type number 2 (Rao, l.c.) are such as those of Palmae. The same is to be said of the ? *Quercus* (Pl. 1, Type number 4). The form mentioned as Schizaeaceae (Pl. 4, Type number 17, figure on the right) is well determined. A curious form is shown under Type number 15 (Pl. 4) but its comparison with *Carya* does not seem to be appropriate. The possibility of its belonging to *Anacolosia* should also be taken into consideration. Another interesting form is shown in Plate 3, Type number 13 (right side figure), resembling a pollen grain described by Thiergart (1940). Such forms must now be placed under the form genus *Stephanoporopollenites* Th. & Pf. (1953, p. 90). In Europe the genus only occurs in the oldest Tertiary formations. Rao has, however, found it in the Miocene rocks. The pollen grain shown in Pl. 3, Type number 11, has been supposed by Rao as belonging to the Proteaceae and indeed it would perhaps be good to place the form in the genus *Proteacidites* Cookson (1950).

It is astonishing that between all these forms mentioned by Rao there is perhaps only one which is to be placed in an organ genus not occurring in the Tertiary of Europe. Also the genera of the natural system which are mentioned by Rao are, as far as they have a little more of evidence, mostly the same as in Europe. This may be because a clear palaeontology of the sporae dispersae is only in development in India.

The same must be said of the earlier papers of Rao and Vimal (1950, 51, 52 and 53). Some clearer differences would possibly appear if the forms would have been compared carefully with those of other lands. Rao & Vimal (1952, Pl. 18, Fig. 25) show perhaps such a difference, likewise the figures in Vimal (1952, Pl. 8, Figs. 28, 30-32) which are placed in *Hexacolpites*, *Septacolpites* and *Octacolpites*. In the end mention may also be made of Vimal (1953, Pl. 9, Figs. 30-32), which shows such a discrepancy.

Stefan Macko (1957) has written a paper concerning the Lower Miocene Pollen Flora from Klodnica valley in Upper Silesia. He compares his spores and pollen grains very carefully with those of recent plants. This is the method which has been used from the first beginning of the fossil sporology, as for instance is seen in the papers of Kirchheimmer, R. Potonié, F. Thiergart, Wodehouse and others. Already in earlier papers of Tertiary, R. Potonié has put after the diagnosis of most of the fossil spores a diagnosis of recent ones which may be compared. He (1954) has also tried to compare carefully Palaeozoic sporae dispersae with those of fructifications. It could be shown that there were many clear relations. But on the other hand it appeared that it was not possible to put together the form genera of fructifications with those of the spores because that would have produced stratigraphical errors. In spite of the fact that the comparative method has made great progress, many authors continue even today to put Tertiary spores and pollen grains in organ and form genera and in organ and form species. Macko (l.c., p. 7) says, " I regard the obstinate employment of this method for analytical investigations of Tertiary pollen as irrational, since it hinders the development of the comparative method, leading to a phylogenetic and natural, hence systematological, synthesis not to be reached by conventional methods." This opinion is not as correct as it appears. The work of the last thirty years has shown that it was just the ' conventional method ' which has provided the material for the development of the comparative method. Without better morphographical studies of this method, the other method, i.e. the morphological method, is not possible. That is a botanical point of view. On the other hand, there is the question if it is possible to leave the conventional method in future after so much of progress. We do not think so, because there is the stratigraphical point of view and even this is in close relation with the botanical one. For the stratigraphy we need not only the botanical types but that our types at the same time must be clearly attached to a stratigraphical *Locus Typicus*. That is not so with the method used by Macko. It may be very good for other purposes but it does not allow a work of sufficient exactness for the stratigraphers.

Macko speaks of spore types. Firstly, it must be mentioned that these ' types ' have nothing to do with the nomenclatural types of the International Code of Botanical Nomenclature. His ' fossil types ' are designated by the generic and frequently specific names of recent plants. The author knows himself that this is not a definite designation but shall more or less change from one author to the other. With such a method it will be difficult to designate definitely whether a single spore or pollen grain found in a stratigraphical unit and with a regional range, can be applied as a nomenclatural type for all further stratigraphical and botanical comparison. The botanical opinion may change but a definite nomenclatural type has been found in certain stratigraphical position is definite. Only with this fact we can make good stratigraphical work.

Traverse (1957, p. 256) says: " Potonié (1956) has clearly condemned the use of extant generic and specific names for fossil pollen." That is not right, both are allowed and it has been indicated in several papers. But there is an important restriction. It is not suitable to use, for fossil spores and pollen grains, generic names of recent plants if we give the spores, etc., specific names whose holotypes are sporae dispersae. The moment a specific name of a fossil sporae dispersae is introduced in the genus of a recent plant, the specific name of the spore or pollen grain has no more any scientific value. In this point we agree entirely with Brown, Faegri, Firbas, Hughes, Iverson, Kirchheimer, Rudolph and Thomson.

Traverse further says (1957, p. 258): " Potonié's argument that inclusion of new organ species in an extant genus involves a broadening of the genus does not seem correct to me, because the circumscription of the genus is established by its description." Traverse would have understood if he had seen that also in his case a new organ species is only necessary *if it is believed not to fall* absolutely within the circumscription of the recent genus in question.

Another objection of Traverse (1957, p. 255) is this, that the palaeobotanists studying megafossil organs have placed the organs in extant taxa. It is true that this is not absolutely forbidden by the I.C. But it should only be used if the material is more or less complete and does not consist of a very little part of the plant which sometimes only shows characters of contested diagnostic value.

MATERIAL AND METHOD

The Cannanore lignite is compact, dull and brownish black in appearance. A shaly (laminated) texture is very well seen in this lignite quite unlike the lignites of South Arcot or Warkalli. The lignite is formed mostly of volatile matter and some moisture while only a small percentage of fixed carbon and ash is present.

Best results were obtained when the Cannanore lignite samples were treated with 50 per cent HCl or boiled in H_2O_2. With 50 per cent HNO_3 or Schultze's solution the results were not very satisfactory. After maceration the material was next treated with 10 per cent KOH for only about 20-30 minutes. The permanent mounts were made with glycerine jelly while single spore mounts were made in Canada balsam, and in certain case safranin was used to stain the grains.

SYSTEMATIC DESCRIPTION

Anteturma — *Sporites* H. Pot. 1893
Turma — *Triletes* (Reinsch 1881) Pot. & Kr. 1954
Subturma — *Azonotriletes* Luber 1935
Infraturma — *Murornati* Pot. & Kr. 1954

Lycopodiumsporites Thiergart 1938 (1937 Separatum)

Lectogenotype — *Lycopodiumsporites agathoecus* (R. Pot. 1934, Pl. 1, Fig. 25, size 87 μ) Thiergart 1938, p. 293.

Locus typicus — East Germany, Geisel valley (near Merseburg), Eocene.

Lycopodiumsporites perplexus nov. sp.

Holotype — Pl. 1, Figs. 1, 2; diameter 75 μ.

Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

Specific Diagnosis

Size varies from 67 to 82 μ; equator subtriangular to circular; Y-rays may reach equator, but not so always seen; *extrema lineamenta* notched, composed of short outgrowing bows, sometimes transforming themselves in a more bastionic form. The distal side shows a perfect reticulum; lumina ± polygonal, measuring perhaps five to ten times the breadth of the muri; height of muri unequal, sometimes showing ± conical protuberances. Therefore, if the distal side lies upside, in the higher focus we see only a system of sinuate or bent short muri which do not approach to form a perfect reticulum (Pl. 1, Fig. 4). The distal exine may be smooth or perhaps shows parts of a more reduced ornamentation.

Specific Differential Diagnosis

The species known till now of this genus do not show in such a differentiated manner the unequal height of the muri so as to allow such different views under different foci.

Analyses

Preparation 61/2 (Pl. 1, Figs. 1, 2) — Diameter 75 μ; equator clearly circular; *extrema lineamenta* notched, composed of short bows, at one place bastionic outline; rays of Y-mark not reaching equator, perhaps two-thirds of the radius; in higher focus the distal side shows a system of ± long, sinuous or bent muri which do not constitute a reticulum but end without contact with one another, and sometimes make ± conical projections; but in a lower focus these muri meet together to form a perfect reticulum; so we have a reticulum of which the muri are not of equal height; lumina polygonal having ± five to ten times the diameter of the muri; ornamentation of the proximal side not sure.

Preparation 60/1 (Pl. 1, Fig. 4) — Diameter 79 μ; *extrema lineamenta* oval, here also somewhat sinuated muri in the higher focus with shorter walls, not so much as in the first specimen; in the deeper focus perfect reticulum very well seen; Y-mark not seen.

Preparation 60/2 (Pl. 1, Fig. 3) — Diameter 77·5 μ; equator circular; Y-mark not recognizable; the proximal side seems to be upside, therefore, perfect reticulum of distal side in the high focus and highest parts of the muri in the deeper.

Preparation 59/1 — Diameter 78 μ; equator a little subtriangular, Y-mark faint reaching equator; muri of perfect reticulum do not show so much differentiation as in their heights as the first one.

Preparation 55/4 — Diameter 73 μ; outline oval, shrunken; Y-mark not seen.

Preparation 53/2 — Diameter 82 μ; folded near the equator; reticulum perfect in the lower focus.

Preparation 30/6 — Diameter 67 μ; equator subtriangular; rays of Y-mark attaining equator; muri not so high.

Anteturma — *Sporites* R. Pot. 1893
Turma — *Zonales* (Bennie & Kidst.) R. Pot. 1956
Subturma — *Zonotriletes* Waltz 1935
Infraturma — *Cingulati* Pot. & Kl. 1954

***Cyatheacidites* (Cookson) R. Pot. 1956**

Genotype — *Cyatheacidites annulatus* Cookson 1947, p. 136, Pl. 15, Fig. 53.

Locus typicus — Kerguelen Archipelago; Waterfall Gorge; Tertiary ?

***Cyatheacidites pulcher* nov. sp.**

Holotype — Pl. 1, Figs. 7, 8; Diameter 47 μ.

Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

SPECIFIC DIAGNOSIS

Diameter 47 μ; equator triangular, angles rounded showing a smooth cingulum; *extrema lineamenta* partly irregularly sinuous; Y-mark distinct, rays reaching the cingulum, being as broad at ends as at the apex. On the distal side there is, upon the line between cingulum and central body, a line of verrucae; these verrucae are not of the same shape and size, sometimes they are as broad as high, sometimes more broad. We call them verrucae because they are only seldom a little tapering, mostly rounded at the upper end or sometimes cut away. Inside this triangular line of verrucae the distal side is covered with other verrucae which are more equal in size and seem to have the shape of a broadly rounded half disc or scale; these scales are only loosely arranged; the same scales appear on the proximal side between the rays of the Y-mark but there they are much more small, their bases perhaps only one-third of the distal scale.

SPECIFIC DIFFERENTIAL DIAGNOSIS

Our form is more triangular than *Cyatheacidites annulatus* Cookson. The verrucae of *C. pulcher* greatly differ from those of *C. annulatus* mostly in being disc-shaped.

Turma — *Monoletes* Ibrahim 1933
Subturma — *Azonomonoletes* Luber 1935
Infraturma — *Psilamonoleti* V. D. Hammen 1955

***Monolites* (Erdtman 1947) ex Potonié 1956**

Genotype — *Monolites major* Cookson 1947, p. 135, Pl. 15, Fig. 56.

Locus typicus — Kerguelen Archipelago, Tertiary.

***Monolites* sp.**

Pl. 4, Fig. 5

ANALYSIS

Only one specimen observed.

Diameter 86 × 126 μ; equator oval, narrow ends broadly rounded; outline partly notched. Exine finely infrareticulate ? Upon the middle line a monolete mark as long as about one-third of the longer axis.

Infraturma — *Ornati* R. Pot. 1956

***Polypodiidites* Ross 1949**

Genotype — *Polypodiidites senonicus* Ross 1949, p. 33, Pl. 1.

Locus typicus — South Sweden, Åsen, Näsum Parish, N.E. Bay of Ivösjen lake; Cretaceous.

GENERIC DIAGNOSIS

(*See* also diagnosis in R. Pot. 1956, p. 79.)

***Polypodiidites impariter* nov. sp.**

Holotype — Pl. 1, Figs. 9, 10; Diameter 34·5 × 47·5 μ.

Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

SPECIFIC DIAGNOSIS

Size 34·5 × 47·5 μ; meridian broadly bean-shaped; distal side well rounded; proximal line ± straight; form rigid; exine completely covered with coni which sometimes are ± rounded at the points, ± 17 coni seen on the *extrema lineamenta* of the distal curve; coni mostly not higher than the breadth of their bases.

SPECIFIC DIFFERENTIAL DIAGNOSIS

The elements of the ornamentation of the species described till now in the genus are not so clearly conical as in our species.

ANALYSES

Preparation 49/2 (PL. 1, FIGS. 9, 10) — Diameter 34·5 × 47·5 μ; broadly bean-shaped; proximal line of the meridian cut straight; form rigid; exine completely covered with coni but which sometimes are ± rounded at the points, ± 17 coni seen on the *extrema lineamenta* of the distal curve.

Preparation 53/3 (PL. 1, FIG. 6) — Diameter 21·5 × 47·5 μ; broken in two halves along the meridian; 16 coni seen on the *extrema lineamenta* of the distal curve.

Anteturma — *Pollenites* R. Pot. 1931
Turma — *Saccites* Erdtman 1947
Subturma — *Monosaccites*
(Chitaley 1951) Pot. & Kr. 1954

***Cannanoropollis* nov. gen.**

Genotype — *Cannanoropollis janakii* nov. sp.; Pl. 2, Fig. 1; Diameter 112 μ.

Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

Generic Diagnosis

Equator circular, broadly oval or very rounded subtriangular; central body corresponding to the equator; equatorial velum or saccus small of more or less equal breadth, with an irregular and slightly notched, or only somewhat sinuate border; infrareticulation of the saccus with fine rounded lumina, as broad, or ± 3 times, as the muri, only sometimes the saccus seems irregularly striated in radial direction if saccus is more or less shrunken. Infrareticulation of central area often finer than in saccus. In certain cases a circular darker band is observed between central area and saccus; Y-mark present, sometimes imperfect or even perhaps a bent monolete mark.

Generic Differential Diagnosis

From the tertiary genera described till now the genus *Tsugaepollinites* must be compared. Here also occurs sometimes the darker circular band between central area and saccus. But the reticulation of central area and saccus is overwhelmed by sinuated and even more or less sculptured muri. The velum is sometimes so much shrunken that a radial structure is more clearly observed. A Y-mark is not seen in *Tsugaepollinites*.

Pastiels (1948, p. 59, Pl. 6, Figs. 33, 34) has figured a specimen from the Eocene of Belgium which agrees with our new genus in its general form and size but it does not seem to be the same as our species. A tetrad mark is not seen and the reticulation of the saccus has not been mentioned nor is it clearly seen in his figures. The central body is said to be granulate but this remark may be due to the state of preservation. The folded rim surrounding the central body has been observed.

The Permian genotype of *Nuskoisporites* (*Nuskoisporites dulhuntyi* Pot. & Kl.) has an equator which is absolutely circular, more than that of our specimen. Here we can speak no more of a velum but of a saccus. The saccus shows an equatorial limbus not seen in our specimen. The nearly circular central area is not often surrounded in our specimens by a darker circular band. But it is sure that in the genus *Nuskoisporites* have later been placed other species which show transitions to our genus. On the other hand, the genotype of the genus *Cannanoropollis* shows a shape which we would never have placed under the genus *Nuskoisporites*. Now we have the difficulty that between the two extreme forms (these are the two genotypes of both genera), we have many transitions. But forms as *Nuskoisporites dulhuntyi* do not occur in the younger rocks, and forms as *Cannanoropollis janakii* till now have not been seen in the Permo-Carboniferous. We, therefore, separate the two genera in the following way. Forms found in the older rocks and approaching more or less the younger shapes are in spite of this placed in the genus *Nuskoisporites*, while forms in the younger strata appearing like transitions to *Nuskoisporites* should be put in *Cannanoropollis*.

***Cannanoropollis janakii* nov. sp.**

Holotype — Pl. 2, Fig. 1; Equatorial diameter 112 μ.

Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

Specific Diagnosis

Size ranges from 95 to 133 μ; equator mostly circular; central area surrounded by a velum, breadth of velum ± one-third of the entire radius; mostly a distinct Y-mark, rays of Y-mark one-half to one-third of the radius of the central area, rays differing in breadth from specimen to specimen, sometimes faint and sometimes not clearly seen; lumina of the reticulum at the most two or three times broader than the muri separating them. In one case lumina greater in the velum than in the central area, velum sometimes a little shrunken with small radial folds; *extrema lineamenta* ± irregularly notched. Another circular band between circular area and velum not observed.

Specific Differential Diagnosis

This species differs from *C. malabarensis* nov. sp. in having a velum which does not so much appear as a saccus as in the latter species and also a circular band does not exist in *C. janakii* as it does in *C. malabarensis*.

From *C. medicus* nov. sp. it differs in having a more circular equator and in having a distinct Y-mark.

ANALYSES

Preparation 1/12 (PL. 2, FIG. 1) — Equatorial diameter 112 μ; outline more circular; velum showing no other circular zone inside; infrareticulation of central body with lumina 2 or 3 times broader than muri (i.e. greater than often in *C. medius*); Y-mark distinct, rays of Y-mark one-half or less than radius of central body, and of equal breadth in the entire length; *extrema lineamenta* irregularly notched.

Preparation 1/13 — Equatorial diameter 133 μ; border line circular; velum finely infrareticulate, but partly a little shrunken, and having small radial folds; central body with Y-mark, rays one-third to one-half of the radius of central body; rays more narrower than in Preparation 1/12.

Preparation 2/10 — Diameter 107·5 × 124·5 μ; outline irregularly oval; Y-mark faint, rays ± one-third of the central body.

Preparation 2/13 — Equatorial diameter 95 μ; only 2 rays of the Y-mark seen; outline circular; irregularly notched; reticulum in the central body clear, in the velum shrunken.

Preparation 3/12 (PL. 2, FIG. 2) — Equatorial diameter 119 μ; outline circular; border (not a band) between velum and central area clearly seen; lumina of reticulum in velum greater than in central body; rays of Y-mark clear and narrow, measuring one-half or a little more than the radius of central area.

***Cannanoropollis malabarensis* nov. sp.**

Holotype — Pl. 2, Fig. 5; Equatorial diameter 103 μ.

Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

SPECIFIC DIAGNOSIS

Size varies from 103 to 146 μ; equator circular or little subtriangular; *extrema lineamenta* ± irregularly notched. Between central area and saccus a darker circular band may be seen; in such cases breadth of the saccus outside the dark circle ± one-third of the radius of the entire specimen; lumina of infrareticulation mostly circular, separated by muri appearing ± as broad as lumina; infrareticulation finer in central body, chiefly in its centre; lumina very sharp and fine in L position. Y-mark faint and narrow, mostly seen but not always, rays ± one-third to a little more than one-half of the radius of the central area.

SPECIFIC DIFFERENTIAL DIAGNOSIS

These forms approach *Nuskoisporites* but it is valid what has been said in the differential diagnosis of the genus.

It is impossible that these spores are on secondary place as those of Cookson (1955, p. 6) for *Nuskoisporites* found in Cretaceous and Lower Tertiary rocks of Australia. Our spores have been found in large number by Sah together with other Tertiary spores and pollen grains and without any other elements characteristic of older formations in an autochthonous lignite.

Cannanoropollis malabarensis differs from both the other forms of this genus in having a velum approaching to a saccus.

ANALYSES

Preparation 1/16 (PL. 2, FIG. 5) — Diameter of equator 103 μ; circular; central area is separated from the monosaccus by a broad darker circle; the infrareticulation of the saccus does not show radially arranged elements. The lumina of the infrareticulation are ± circular and separated by relatively broad muri; it is a *reticulum perfectum*; the infrareticulation of the central body is finer in its centre. The exine of the body is ripped open in the form of an irregular Y-mark. The primary form of Y-mark is not seen.

Preparation 1/5 (PL. 2, FIGS. 6, 7) — Equatorial diameter 112 μ; equator circular to a little subtriangular; the darker circle surrounding the central area is not very clearly separated from the monosaccus, it is also ± dark; the infrareticulation of the central body very well developed; clear OL phenomenon is observed in the lumina, lumina in L position very sharp and fine; the muri between the lumina appearing ± as broad as the lumina. A faint but narrow Y-mark is seen; rays of Y-mark larger than one-half radius of the central area.

Preparation 1/8 — Equatorial diameter 116 μ; infrareticulation of central area good, but no L position of lumina possible; Y-mark very faint with narrower rays, seemingly not longer than half the radius of central area. *Extrema lineamenta* of saccus irregularly notched.

Preparation 1/9 (Pl. 3, Fig. 1) — Greatest equatorial diameter 129 μ; *extrema lineamenta* circular; darker circle surrounding central area well developed; breadth of the saccus outside the dark circle one-third of the radius of the entire specimen; Y-mark not seen; OL phenomenon is rather well seen in the reticulation of the saccus.

Preparation 2/1 — Equatorial diameter 112 μ; equator circular to subtriangular; *extrema lineamenta* irregularly notched; Y-mark faint; darker circle surrounding the central area sharply lined.

Preparation 2/7 — OL phenomenon to be observed in the central body and the saccus; exine ripped open in the region of Y-mark.

Preparation 2/10 (Pl. 3, Fig. 2) — Equatorial diameter 124·5 μ; rays of Y-mark only one-third of the radius of central area; dark zone between central area and saccus not clear.

Preparation 2/14 — Equatorial diameter 116 μ; *extrema lineamenta* irregularly notched; region of the Y-mark opened with a triangular rupture.

Preparation 3/1 — Equatorial diameter 107·5 μ; Y-mark very faint; breadth of saccus one-third of the total radius of the specimen.

Cannanoropollis medius nov. sp.

Holotype — Pl. 2, Fig. 3; Diameter 121 × 127·5 μ.

Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

Specific Diagnosis

Size range from 90 × 99 μ to 125 × 146 μ; equator ± circular to broadly oval; *extrema lineamenta* irregularly undulated to notched, mostly without darker circular band between saccus or velum and central area. Breadth of velum one-third to one-fourth of the longer axis of the whole grain. Lumina of infrareticulation not very much broader to about three times that of muri, ± finer reticulation in the central area. No Y-mark or monolete mark; in one case a bent line which does not appear to be clear proximal mark.

Specific Differential Diagnosis

This species differs from both the other species in having no tetrad mark and in having a smaller velum than *Cannanoropollis malabarensis*. From its form and shape it appears to occupy a position intermediate between *C. janakii* and *C. malabarensis*.

Analyses

Preparation 1/4 (Pl. 2, Fig. 3) — Diameter 121 × 127·5 μ; equator broadly oval; *extrema lineamenta* irregularly undulated; central body surrounded by a small velum, e.g. *Tsugaepollenites* Pot. & Ven. (1934). The velum may also be named a very small saccus, breadth of velum one-fourth radius of longer axis of the whole grain; infrareticulum of velum perfect, lumina not very much broader than the short and straight muri as is not seen in *Tsugaepollenites* where muri are undulated. Finer reticulum in central body; exoexine of one side of central body broken out; no Y-mark.

Preparation 1/1 — Diameter 90 × 99 μ; *extrema lineamenta* not complete; no Y-mark.

Preparation 1/2 — Diameter 94·5 × 107·5 μ; no Y-mark; infrareticulation of velum with a little broader lumina, their breadth being 3 times that of muri.

Preparation 1/7 — Diameter 120·5 × 146 μ; outline irregularly oval and notched; velum one-third of the greater radius; no Y-mark; infrareticulation as in Preparation 1/4.

Preparation 1/11 (Pl. 2, Fig. 4) — Diameter 103 × 112 μ; no Y-mark; a darker circular band around the central body; infrareticulation as in Preparation 1/4; *extrema lineamenta* notched.

Preparation 1/14 — Diameter 116 × 133 μ; darker zone inside the velum only faint; on the apex of the central body a bent line (not surely a proximal mark).

Preparation 2/6 — Diameter 121 × 138 μ; exine of central body ruptured; no Y-mark or monolete mark seen.

Preparation 2/5 — Line separating velum and central body on one side is quite well seen.

Preparation 3/11 — Diameter 107·5 μ; more circular than oval; darker zone only faint; no Y-mark.

Subturma — _Disaccites_ Cookson 1947

Limitisporites (Leschik 1956) R. Pot. 1958

Genotype — *Limitisporites rectus* Leschik 1956, p. 133; Pl. 21, Fig. 15; *ca.* 65 μ.

Locus typicus — West Germany, Neuhof (near Fulda); Salt clay of Permian.

Generic Diagnosis

(*See* also R. Potonié 1958, p. 55.)

Limitisporites **sp.**

'Pl. 3, Figs. 5, 6

ANALYSES OF 4 SPECIMENS

Size of the whole grain 86×125 μ; bisaccate; shape haploxylonoid; body ± 73 μ in diameter; monolete mark faintly seen; ± bent or straight; sacii with fine infrareticulum, breadth of lumina ± twice of the muri, less in the central body; reticulum perfect.

We only have four specimens of this form which do not show enough to allow a sufficient specific analysis, but we think it is permitted to put them in the genus *Limitisporites* characterized by a bent or straight monolete mark. The genus *Limitisporites* is a Permain one and our specimens are Tertiary, but it becomes more and more obvious that certain form genera of the Bisaccites have no value for finer stratigraphical purposes.

Turma — Aletes Ibrahim 1933
Subturma — *Azonoaletes* (Luber 1935) Pot. & Kr. 1954
Infraturma — *Psilonapiti* Erdtman 1947

Inaperturopollenites **Th. & Pf. 1953**

Genotype — Inaperturopollenites dubius (R. Pot.) Th. & Pf. 1953.

Inaperturopollenites ruptus **nov, sp.**

Holotype — Pl. 1, Fig. 11; diameter 30 μ.
Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

SPECIFIC DIAGNOSIS

Size varies from 26×30 μ; *extrema lineamenta* circular, smooth; exine hyaline, secondary folds; exine may show a triangular, ± smooth or opened area surrounded by irregular folds.

SPECIFIC DIFFERENTIAL DIAGNOSIS

The species differs from the other species of the genus in showing sometimes more clearly a triangular smooth area which we consider as the germinal region.

ANALYSES

Preparation 24/2 (PL. 1, FIG. 12) — Diameter 26 μ; outline irregularly polygonal due to many secondary folds, smooth; exine thin, very faintly and finely infragranulose.

Preparation 48/5 (PL. 1, FIG. 11) — Diameter 30 μ; equator irregularly rounded; exine thin with many secondary folds, being ± near the equator; in the centre the exine has opened with a triangular rupture; the sides of the triangular area are accompanied by irregular folds which form a ± straight ligament from equator to equator.

Preparation 50/4 — Diameter 26 μ; the triangular area in the centre of the exine surrounded by folds do not seem to be ruptured; outline of the circular *extrema lineamenta* smooth; structure in the exine not seen.

Infraturma — *Reticulonapiti* (Erdtman 1947) Vimal 1952

Bireticulasporis **nov. gen.**

Genotype — Bireticulasporis indicus nov. sp.; Pl. 3, Figs. 7, 8; diameter 120·5 μ.
Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

GENERIC DIAGNOSIS

Size varies from 77·5 to 129 μ; *extrema lineamenta* circular to irregular circular or polygonal; outline undulated to irregularly dentate, sometimes ± straight; the outline may or may not be accompanied by a ± narrow darker band which apparently results from the folding of the peripheral exine in tangential plane. The exine shows two ornamentations; a finer reticulation in the higher focus and a clear coarse reticulation in the deeper focus; the lumina of the deeper reticulation have a diameter several times as great as the diameter of the reticulation in the higher focus. In the last reticulation the lumina are ± rounded and sometimes with diameter less than the muri between them. The coarser reticulation shows greater lumina with ± polygonal shape or sometimes with muri which are a little sinuous. A tetrad mark or another germinal apparatus is not seen.

GENERIC DIFFERENTIAL DIAGNOSIS

The genus *Tsugaepollinites* differs in having around the whole exine an ornamentation of undulated muri. The darker peripheral band is, if it is seen, developed as a plain velum, while in our case we only see a tangentially shrunken exine.

The genus *Cannanoropollis* nov. gen. (*see* page 127) also shows a clear velum or even a monosaccus and does not show two different reticula in different foci.

Bireticulasporis indicus nov. sp.

Holotype — Pl. 3, Figs. 7, 8; diameter 120·5 μ.

Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

Specific Diagnosis

Size range from 77·5 to 129 μ; outline ± irregular circular, partly irregularly dentated if *exolamella* shrunken or partly disappeared; darker band along the periphery absent; muri of the coarser reticulum sometimes sinuous, mostly straight; lumina ± polygonal, often having more than ten times the breadth of the muri. The fine reticulation of the higher focus may be faint but often is clear.

Specific Differential Diagnosis

Differs from *Bireticulasporis communis* nov. sp. (*see* below) in not having a darker peripheral band.

Analyses

Preparation 35/1 — Diameter 129 μ; outline ± irregular circular; no tetrahedral mark; exine showing reticulation with great lumina, the lumina often having more than ten times the breadth of the muri, muri sinuated in large curves; in the higher focus we see a very fine and faint reticulation.

Preparation 35/2 — Diameter 77·5 μ; specimen seems to be shrunken; the coarse reticulum very irregular, the finer not seen.

Preparation 35/3 — Diameter 103 μ; surrounding irregular; not more dark than in the first; in the *extrema lineamenta* the muri of the reticulation seem to produce a relief so that the *exolamella* would not be present or very shrunken; the finer infragranulation is only partly seen in the higher plane.

Preparation 35/4 — Diameter 116 μ; imperfect preservation of reticulum. In the *extrema lineamenta*, appear on one place the muri not covered with the *exolamella* so that the surrounding appears dentated.

Preparation 36/5 (Pl. 3, Figs. 7, 8) — Diameter 120·5 μ; in the higher focus a fine reticulation, in the deeper focus the coarse infrareticulation. The uppermost reticulation must be covered by an *exolamella* which seems to be observed in the surrounding of the grain. Two ± circular perforations are seen as secondary features.

Preparation 38/2 (Pl. 3, Figs. 3, 4) — Diameter 94·5 μ; in the higher focus the fine reticulation with dark lumina, in the lower focus this fine reticulation ± disappearing and therefore the coarse reticulation with sharp dark walls but in each of this greater lumina are still to be seen several other of the little darker lumina of the first reticulation. The surrounding of the grain partly dentated.

Preparation 45/4 — Diameter 99 μ; both coarse and fine reticulation seen, coarse reticulum not perfect. In the surrounding the exine shows an *exolamella*.

Bireticulasporis communis nov. sp.

Holotype — Pl. 4, Figs. 1, 2; diameter 99·5 μ.

Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

Specific Diagnosis

Size ranges from 86 to 129 μ; outline irregular circular to roundly polygonal and dentate to faintly sinuate, the *extrema lineamenta* inside is followed by a dark ± narrow band; this band is formed by very narrow and dense tangential folds; coarser reticulum not always perfect perhaps as a result of bad preservation; the higher reticulation sometimes seen as sharp white points but in the highest focus as dark points.

Specific Differential Diagnosis

(*See* under *Bireticulasporis indicus* nov. sp.)

Analyses

Preparation 3/9 (Pl. 4, Figs. 1, 2) — Diameter 99·5 μ; fine higher focus reticulation is very good to be observed with dark lumina being less broad than the muri between them, coarse reticulation of the lower focus clear but imperfect with straight muri as in most cases of *B. indicus*. In the lower focus the lumina of the higher reticulation are seen as sharp white points inside the lumina of the coarse reticulation. No tetrahedral mark. *Extrema lineamenta* roundly polygonal, faintly sinuated to dentate, perhaps because the *exolamella* is shrunken and partly ruptured; inside the *extrema lineamenta* there is a darker band.

Preparation 4/1 — Diameter 103 μ; higher focus reticulation not seen; coarse reticulation mostly perfect; outline irregular polygonal to rounded and followed by a dark band.

Preparation 4/5 — Diameter 129 μ; lumina of fine reticulation with OL phenomenon, coarse reticulation of deeper focus only partly preserved, mostly destroyed.

Extrema lineamenta seems to show an arrangement of very sharp tangential folds ± around the entire circumference, so that it appears as a darker band consisting of ± three layers of exine.

Preparation 5/8 — Diameter 86 μ; both reticulations seen, the coarser not completely; walls here a little sinuated; outline of exine accompanied by very small and dense tangential folds, resulting in a darker circular band. It may be that this state of preservation is of diagnostic value.

Turma — *Polyplicates* Erdtman 1952

Lirasporis nov. gen.

Genotype — *Lirasporis intergranifer* nov. sp., Pl. 4, Fig. 4; diameter 82×109 μ.

Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

GENERIC DIAGNOSIS

Size varies from 69×103 μ to 116×134 μ; outline oval, longitudinal ends of oval broadly rounded or ± tapering, sometimes showing irregular protuberances which form a jumbled mass; *extrema lineamenta* ± smooth except the longitudinal ends which are always ± notched; following the longer axis exists perhaps 20-30 parallel but narrow ribs showing between them spaced grana.

GENERIC DIFFERENTIAL DIAGNOSIS

The genera *Gnetaceaepollenites* Thiergart (1938, p. 307), *Ephedripites* Bolchowitina (1953, p. 60), *Welwitschiapites* Bolchowitina (1953, p. 61) and *Vittatina* Luber (1940) never show between the ribs the plain grana of our genus.

Lirasporis intergranifer nov. sp.

Holotype — Pl. 4, Fig. 4; diameter 82×109 μ.

Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

SPECIFIC DIAGNOSIS

We add to the generic diagnosis: Ribs much more narrow than the canals between them; in the canals sparse grana ± regularly distributed in distances, perhaps a little greater than the breadth of the canals and always only a single granum between the two adjoining ribs; about 10-20 grana in each canal along the longer axis.

ANALYSES

Preparation 1/10—Diameter 90×112 μ; *extrema lineamenta* broadly oval; outline smooth but notched (gekerbt) at the ends of the longer axis; following the longer axis there is a system of perhaps twenty narrow and parallel ribs; the canals between the ribs are much more broader than the ribs. At the first view we believe to see that these canals are separated by many cross septa in perhaps sixteen rectangular compartments, but these 'septa' consist of little protuberances (grana), which are clear in the higher focus and dark in the deeper.

Preparation 2/5 — Diameter 116×134 μ; grana in the canals very good to be seen with OL phenomenon; grana of adjoining canals sometimes ± in one straight line but in each canal only one granum; more than thirty longitudinal ribs seen on the exposed surface of the grain, the exine appears more dark where the ribs converge at the ends of the longer axis.

Preparation 37/3 (PL. 4, FIG. 3) — Diameter 69×103 μ; the oval outline a little tapering at the longitudinal ends; perhaps twenty ribs are seen; only one granum in between two ribs and about 10-12 in an entire canal.

Preparation 37/4 (PL. 4, FIG. 4) — Diameter 82×109 μ; perhaps twenty ribs seen on the exposed surface; 16-20 grana in an entire canal; chiefly at one of the longitudinal ends of the exine it is jumbled so as to form irregular rounded protuberances similar to that what Samoilowitz (1953, p. 44, PL. 9, FIG. 4a) has shown in *Vittatina subsaccata* and Bolchowitina (1953, p. 61, PL. 9, FIG. 18) in *Welwitschiapites magniolobatus*. Also in *Ephedra* this peculiar character has been observed.

Turma — Monocolpates Iversen & Troels-Smith 1950
Subturma — *Retectines* (Malawkina 1949) R. Pot. 1958

Monosulcites (Erdtman 1947) ex Couper 1953

Lectogenotype — *Monosulcites minimus* Cookson 1947, pp. 34-135, Pl. 15, Fig. 48, *ca*. 30 μ.

Locus typicus — Kerguelen Archipelago; Tertiary.

Monosulcites parvus nov. sp.

Holotype — Pl. 1, Fig. 13; diameter 13×22 μ.

Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

Specific Diagnosis

Size range 10×17 µ to 13×22 µ; shape very irregular but in better cases boat-shaped with ± tapering ends; mostly one small fold ± attaining the *extrema lineamenta*, and it seems opening at first in the middle and not at the ends; besides there are variations of the germinal features which are seen in the analyses; exine finely infragranulose.

Specific Differential Diagnosis

Seems to show more variations than the other species of the genus and has a smaller size.

Analyses

Preparation 48/7 — Diameter 10×17 µ to $13 \times 21{\cdot}5$ µ; *extrema lineamenta* smooth and appearing irregular circular in the equator and irregular oval in the meridian; there are also very irregular forms; a germinal area seems to exist which may be elongated along the longer axis and is accompanied on either side by a longitudinal fold, but the folds surrounding the germinal area may also form a triangle or even a square; between are many irregular forms; exine finely infragranulate. In each perparation there are several grains near one another.

Preparation 49/3 (Pl. 1, Fig. 14) — Diameter $13 \times 21{\cdot}5$ µ; mostly the features approach the monocolpate forms; some of the grains a little tapering to the ends, in some one of the ends more tapering than the other.

Preparation 56/4 (Pl. 1, Fig. 13) — Diameter 13×22 µ; mostly only one fold is seen following the longer axis, not ever completely reaching the outline; meridian sometimes bean-shaped, poles very rounded.

Turma — *Tricolporites*

Cupuliferoipollenites R. Pot.

Genotype — *Cupuliferoipollenites* (al. *Pollenites*) *pusillus* (al. *quisqualis pusillus* R. Pot. 1934, **4**, p. 71, Pl. 3, Fig. 21; 15 µ) R. Pot. 1951, Stuttgart, Pl. 20, Fig. 69; Wien, Pl. 1, Fig. 21.

Locus typicus — Germany, Geiseltal near Merseburg; Lignite; Eocene.

Cupuliferoipollenites sp.

(Pl. 1, Fig. 5)

Analysis

Diameter 13×18 µ; ovate; ends of the longer axis rounded; colpae not reaching equator; pores great; meridian smooth; exine with faint and fine infragranulation.

Turma — *Monoporines*

Genus *Monoporopollenites* Meyer 1956

Genotype — *Monoporopollenites gramineoides* Meyer 1956, p. 111, Pl. 4, Fig. 29, *ca.* 23 µ.

Locus typicus — Germany, Bavaria, Wackersdorf; Lignite; Upper Tertiary.

Monoporopollenites minimus nov. sp.

Holotype — Pl. 4, Figs. 6-8; diameter 8·5 µ.

Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

Specific Diagnosis

Diameter 8·5 to 11 µ; grains only sometimes in massulae; *extrema lineamenta* circular to oval to subtriangular to polygonal; the oval perhaps shows the meridian; one porus is sometimes seen, but in many specimens not at all; exine with very fine infrapunctation; outline smooth occasionally with secondary folds.

Specific Differential Diagnosis

Smallest of the monoporate fossil forms described till now.

Analyses

Preparation 27/3 — Diameter $8{\cdot}5 \times 11$ µ; equator subtriangular; meridian ± circular; faint folds, porus scarcely seen; exine with very fine infragranulation; outline smooth.

Preparation 47/1 (Pl. 1, Figs. 6-8) — Diameter 8·5 µ; grains sometimes in massulae; rounded circular to oval to triangular to polygonal; there is sometimes seen one porus; outline smooth; exine with very fine infrapunctation.

? Turma — *Massuloides* Pflug (in Th. & Pf.) 1953

Polyadopollenites Th. & Pf. 1953

Genotype — *Polyadopollenites multipartitus* Pf. (in Th. & Pf.) 1953, p. 112, Pl. 15, Figs. 65-66.

Locus typicus — Germany, Borken (near Kassel); Lignite; Higher Eocene to Oligocene.

***Polyadopollenites multifidus* nov. sp.**

Holotype — Pl. 4, Fig. 10; diameter of whole massula 70×172 μ; single spore $\pm 21 \cdot 5$ μ.

Locus typicus — India, Malabar Coast, Cannanore Beach; Tertiary.

SPECIFIC DIAGNOSIS

Single grains of massula irregularly rounded to sub-triangular, sometimes with (secondary ?) folds; exine thin, faintly infragranular; outline smooth. The grains are arranged in elongated massula, perhaps also in more rounded ones.

SPECIFIC DIFFERENTIAL DIAGNOSIS

Our species differs from the genotype in having mostly much more than twenty grains in a massula. They may be sometimes more than hundred.

CONCLUSIONS

In the Cannanore lignite the following new genera and species have been described — *Lycopodiumsporites perplexus* nov. sp.; *Cyatheacidites pulcher* nov. sp.; *Polypodiidites impariter* nov. sp.; *Cannanoropollis janakii* nov. gen. et nov. sp.; *Cannanoropollis malabarensis* nov. sp.; *Cannanoropollis medius* nov. sp.; *Inaperturopollenites ruptus* nov. sp.; *Bireticulasporis indicus* nov. gen. et nov. sp.; *Bireticulasporis communis* nov. sp.; *Lirasporis intergranifer* nov. gen. et nov. sp.; *Monosulcites parvus* nov. sp.; *Monoporopollenites minimus* nov. sp.; *Polyadopollenites multifidus* nov. sp. Further we also found *Monolites* sp., *Limitisporites* sp., and *Cupuliferoipollenites* sp.

Most of these forms have not till now been found in the other Tertiary sediments of India. The general habit of the spore content is in spite of this a Tertiary one. Therefore, we conclude from the topographical and geological position that our lignite may belong to the highest Miocene or to the deeper Pliocene.

The most interesting of the new genera is *Lirasporis* having some morphographical features of *Ephedra* but showing between the ribs clear lines of grana. We feel certain that this form will have stratigraphical value. Another curious genus is *Cannanoropollis* which, in spite of morphographical relations, can be differentiated from *Nuskoisporites* and differs clearly from *Tsugaepollenites*. We were astonished to find between the Tricolporites only the genus *Cupuliferoipollenites* and not at all forms of the Triporites, both not being rare in the other Tertiary sediments of India. On the whole the number of species is not great. A diminishing of the number of species is also observed from the European Miocene to the Pliocene. This is only mentioned without attaching greater significance.

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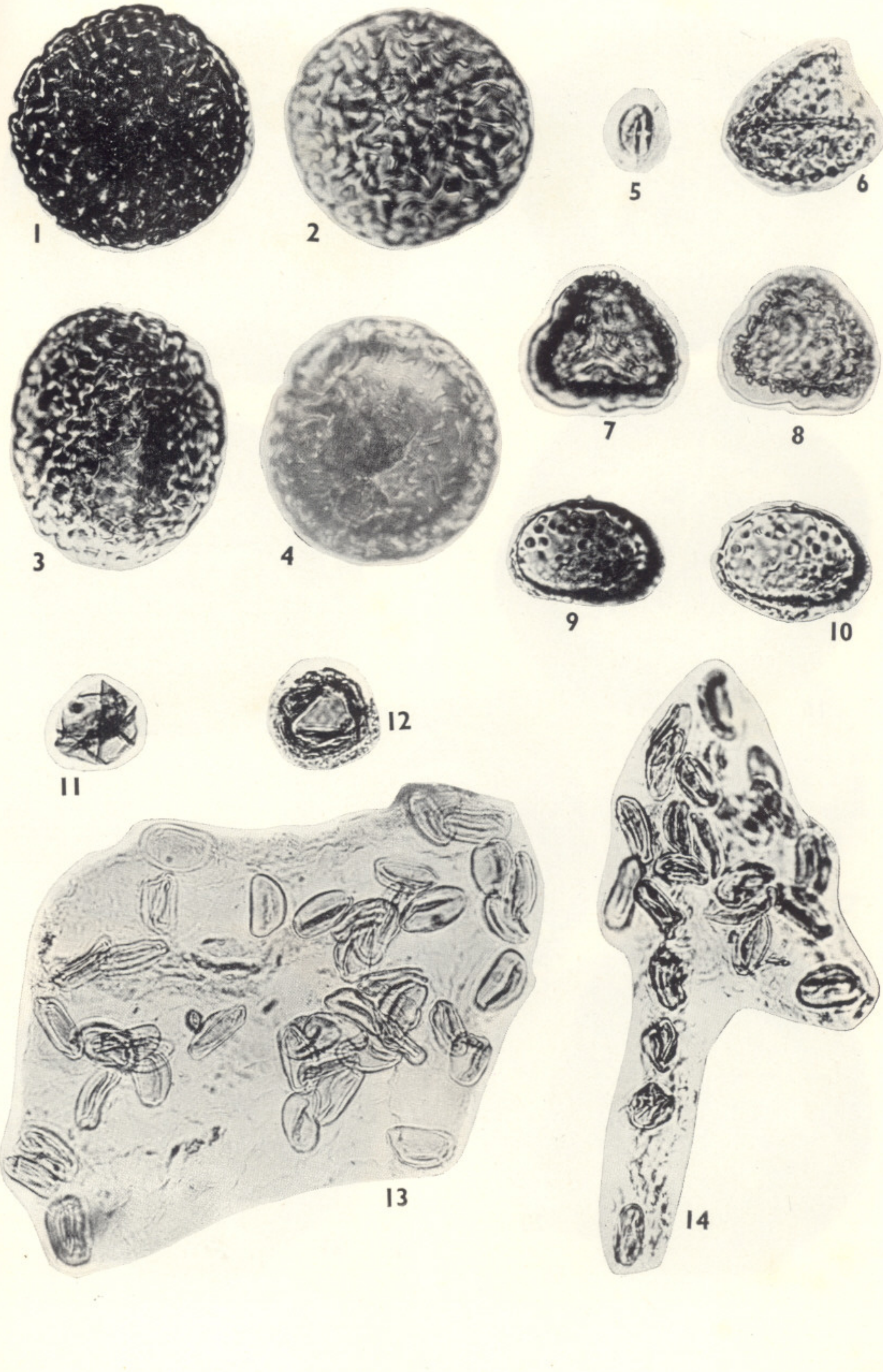
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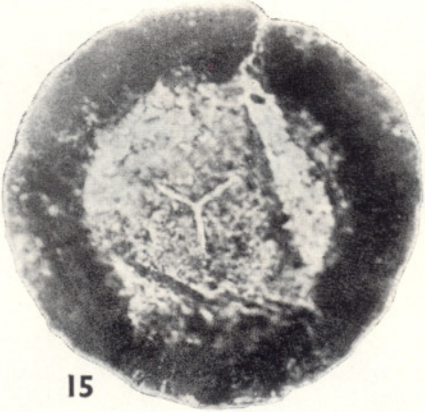

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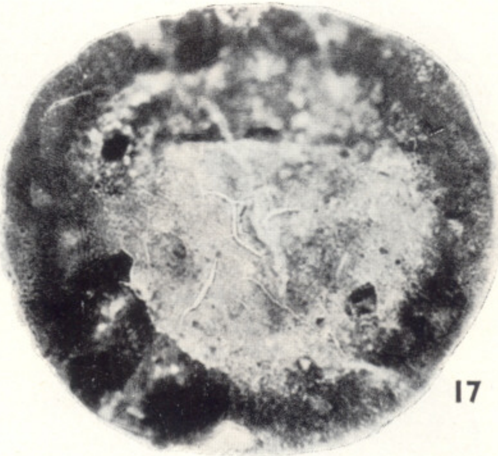

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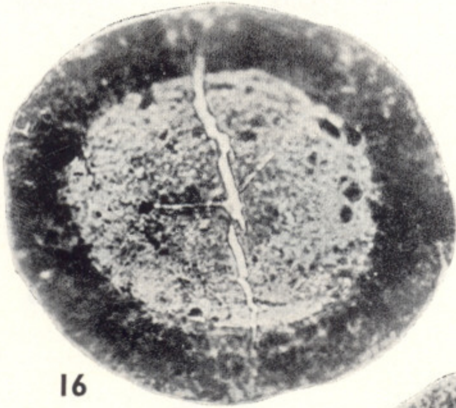

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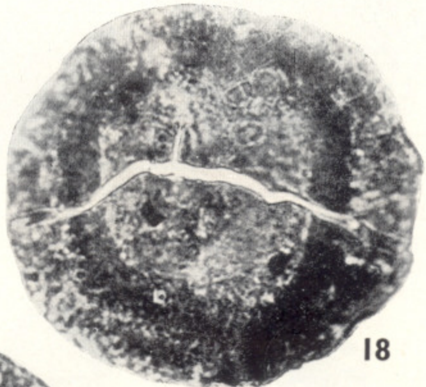

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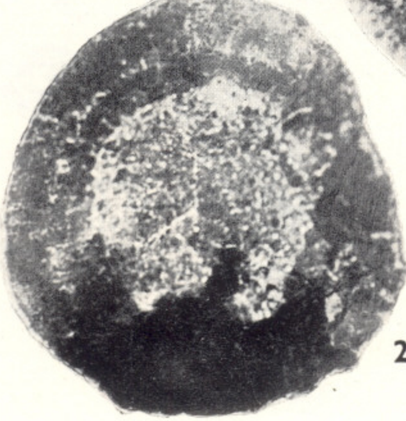

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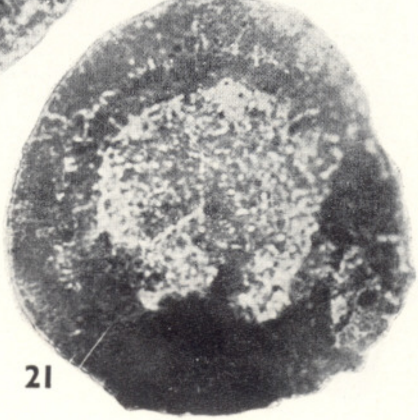

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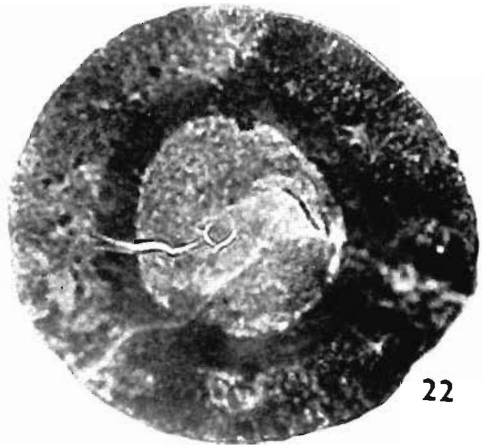
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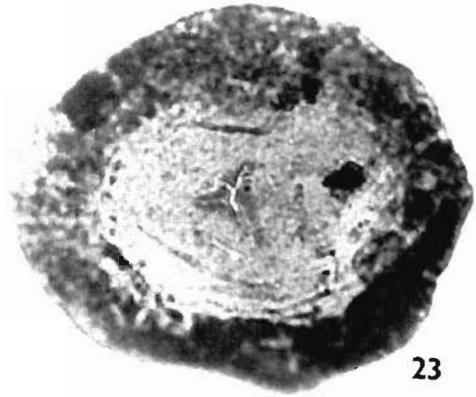
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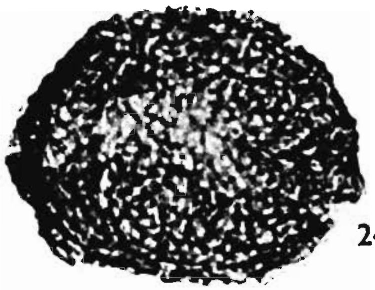
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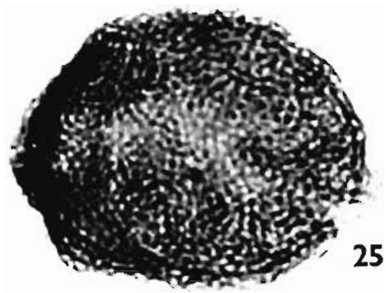
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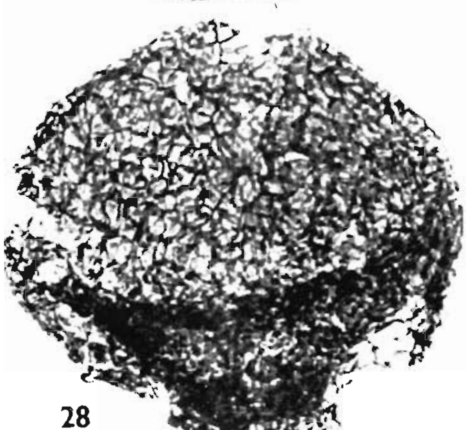
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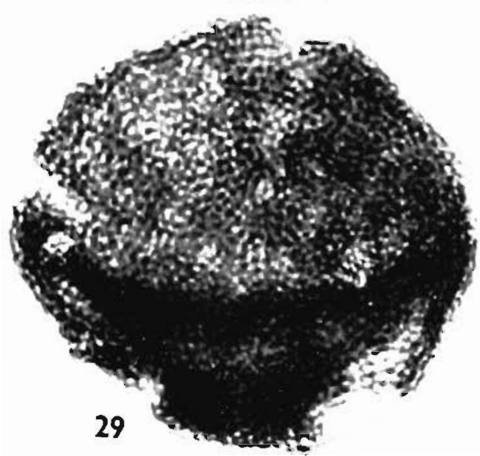
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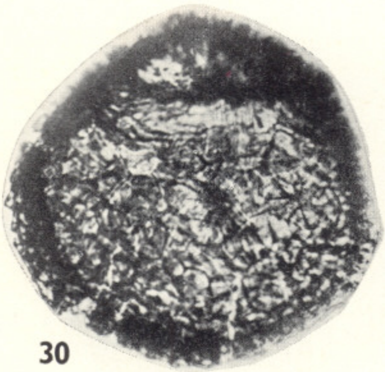

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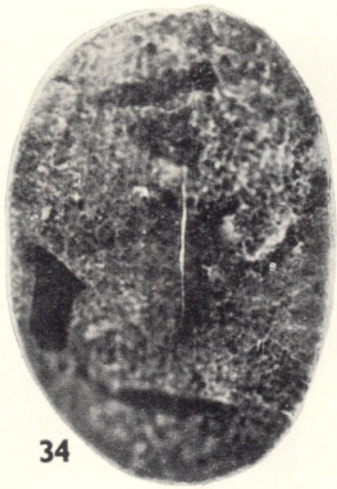

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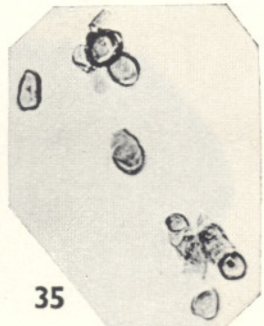

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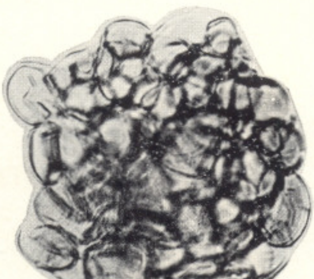

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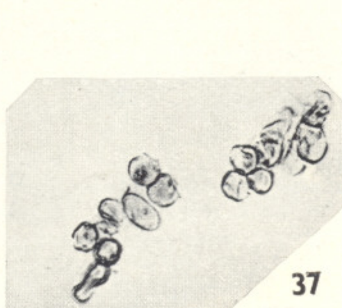

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EXPLANATION OF PLATES

All the figures are from untouched negatives. All × *ca.*500. Specimen No. 29817/396. Slides preserved at the Birbal Sahni Institute of Palaeobotany museum.

PLATE 1

1, 2. *Lycopodiumsporites perplexus* n. sp. Holotype (high and low focus). Slide No. 61/2.

3. *Lycopodiumsporites perplexus* n. sp. Paratype. Slide No. 60/2.

4. *Lycopodiumsporites perplexus* n. sp. Paratype. Slide No. 60/1.

5. *Cupuliferoipollenites* sp. Slide No. 13/2.

6. *Polypodiidites impariter* n. sp. Paratype. Slide No. 53/3.

7, 8. *Cyatheacidites pulcher* n. sp. Holotype (high and low focus). Slide No. 16/1.

9, 10. *Polypodiidites impariter* n. sp. Holotype (high and low focus). Slide No. 49/2.

11. *Inaperturopollenites ruptus* n. sp. Holotype. Slide No. 48/5.

12. *Inaperturopollenites ruptus* n. sp. Paratype. Slide No. 24/2.

13. *Monosulcites parvus* n. sp. Holotype. Slide No. 56/4.

14. *Monosulcites purvus* n. sp. Paratype. Slide No. 49/3.

PLATE 2

15. *Cannanoropolis ja nakii* n. gen.et. n. sp. Genotype and Holotype. Slide No. 1/12.

16. *Cannanoropolis janakii* n. gen. et. n. sp. Paratype. Slide No. 3/12.

17. *Cannanoropolis medius* n. sp. Holotype. Slide No. 1/4.

18. *Cannanoropolis medius* n. sp. Paratype. Slide No. 1/11.

19. *Cannanoropolis malabarensis* n. sp. Holotype. Slide No. 1/16.

20, 21. *Cannanoropolis malabarensis* n. sp. Paratype (high and low focus). Slide No. 1/5.

PLATE 3

22. *Cannanoropolis malabarensis* n. sp. Slide No. 1/9.

23. *Cannanoropolis malabarensis* n. sp. Slide No. 2/10.

24, 25. *Bireticulasporis indicus* n. sp. Paratype (high and low focus). Slide No. 38/2.

26. *Limitisporites* sp. Slide No. 1/3.

27. *Limitisporites* sp. Slide No. 3/13.

28, 29. *Bireticulasporis indicus* n. gen. et. n. sp. Genotype and Holotype (high and low focus). Slide No. 36/5.

PLATE 4

30, 31. *Bireticulasporis communis* n. sp. Holotype (high and low focus). Slide No. 3/9.

32. *Lirasporis intergranifer* n. sp. Paratype. Slide No. 37/3.

33. *Lirasporisintergranifer* n. gen. et n. sp. Genotype and Holotype. Slide No. 37/4.

34. *Monolites* sp. Slide No. 3/8.

35, 36. *Monoporopollenites minimus* n. sp. Holotype. Slide No. 47/1.

37. *Monoporopollenites minimus* n. sp. Paratype. Slide No. 49/4.

38. *Polyadopollenites multifedus* n. sp. Paratype Slide No. 47/2.

39 *Polyadopollenites multifedus* n. sp. Holotype. Slide No. 28/8.