

POLYCOLPATE GRAINS IN PRE-MIOCENE HORIZONS OF INDIA*

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Palynological examination of different samples of various horizons from Eastern and South-Western India has revealed that round grains ranging from 24–56 μ in size bearing 4–11 colpi, with scabrate exine having reticulate ornamentation, are restricted in pre-Miocene horizons. These grains have got similarity with the earlier recorded Polycolpate grains from the Eocene horizons of Rajasthan (India) and West Punjab (Pakistan). These could be compared with the grain described by Potonié as *Nothofagidites* from the Eocene of Burma. Though the exinous structure is very similar, specific differentiation is possible on the basis of the variation of size, number and size of colpi and thickness of the exine. Significant phenomenon has been observed, that the frequency of grains with more colpi increases with the older horizons of the pre-Miocene formations.

INTRODUCTION

In connection with the 'Oil Quest' an extensive search for microfossils has been made in various samples from different horizons of Eastern (Assam) and South-Western India (Gujerat). Palynological investigations have revealed a rich polospore assemblage from these areas—as an aid for stratigraphical correlation and palaeo-ecological interpretation. The study has shown that a few Polycolpate types of grain are restricted to the pre-Miocene horizons. These pollen grains differ mainly among themselves with the variation in number and size of colpi, thickness of the exine and size, etc., but at the same time they seem to be interrelated by the considerable similarity in their general shape and ornamentation pattern.

MATERIAL AND METHOD

The slides of clayey and shaly samples received from various horizons of Eastern and South-Western India are prepared by macerating the material in nitric acid after removing the carbonates by dilute hydrochloric acid and

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silica by hydrofluoric acid, if any, followed by washing it several times and then floating the recovered material into the heavy liquid—a mixture of potassium iodide, cadmium iodide and zinc iodide of specific gravity 2.3. The floated crop is taken and diluted considerably, so that all the material settles down and then it is centrifuged. The recovered material is mounted in glycerine jelly for examination under the microscope.

DESCRIPTION

The major types are based on the number of colpi present in the grains. Further types are classified on aggregate character of nature of colpi, its length, exine character, its thickness and ornamentation, margin, breadth of the mesocolpium and size range. It has been noticed that mostly the types are dependent on the length of colpi and thickness of the exine. As considerable size variation has been seen within the morphologically similar grains, much importance has not been laid on this character.

The measurements of the size, length of the colpi, thickness of the exine and breadth of the mesocolpi are taken. Colpi up to one-third of the radius of the polar view are called *brevi*, one-third to half the radius as *medi* and more than half *longi*.

The comparative forms of ornamentation have been observed into three degrees, viz. infra-reticulate, finely reticulate and reticulate, and the degree of wavy nature of the margin is represented —+ (almost smooth), + (slightly wavy) and ++ (wavy) and these signs have been used in the text.

General characters of the grains recovered are rounded (all the grains recovered are in polar view), equatorial diameter 24–56 μ ; colpi equatorial, 4–11 in number, length 8–17 μ ; exine tegillate, 1–4 μ thick, scabrate; ornamentation infra-reticulate to reticulate; margin wavy —+ to ++; mesocolpi 8–12 μ broad.

Broadly the following types have been demarcated:

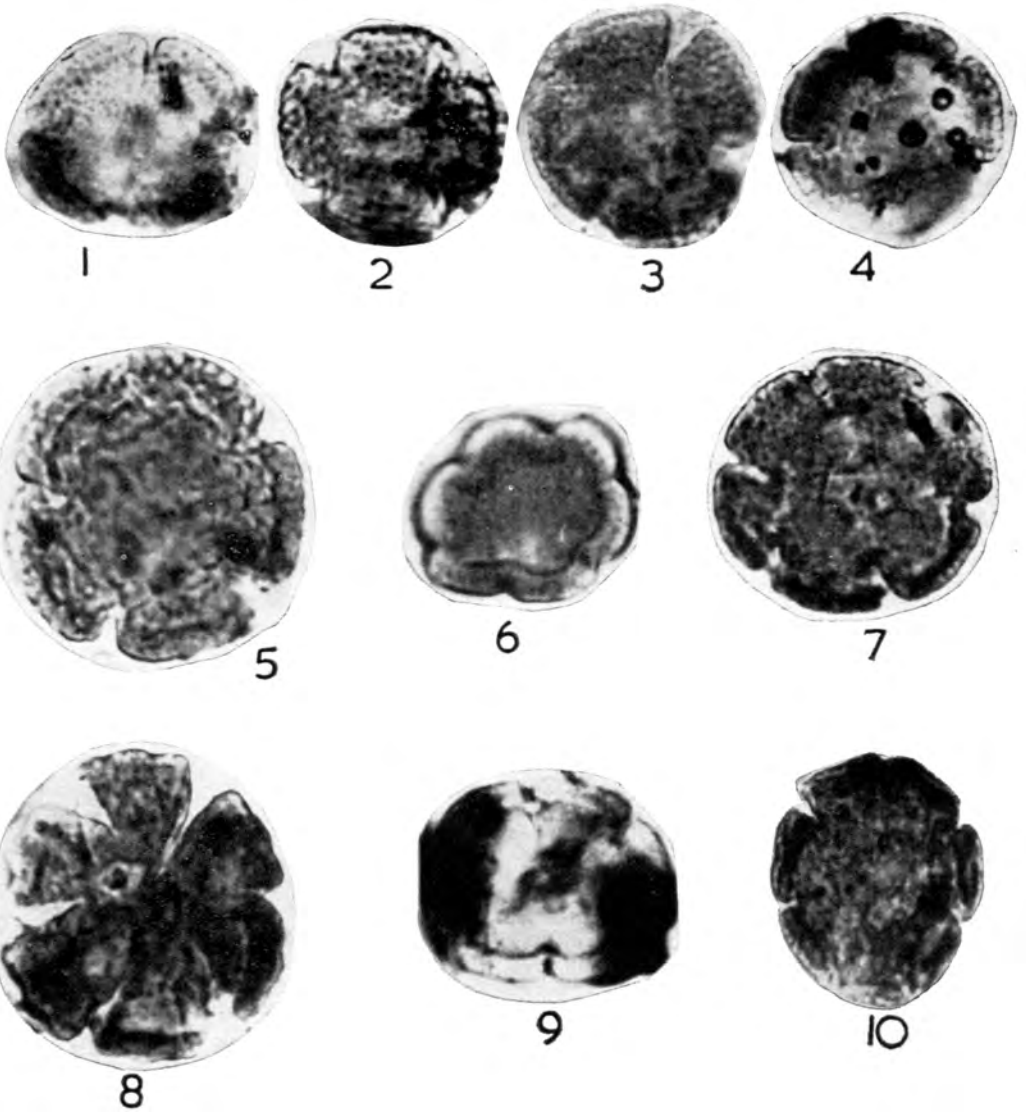
1. *Tetracolpites type*: Equatorial diameter 28–36 μ ; colpi *brevi* to *medi*, 4–6 μ long; exine 1–2 μ thick, scabrate; ornamentation infra-reticulate to reticulate; margin wavy +, ++; mesocolpi 16–20 μ broad (Text-figs. 1–3; Plate XXVII, figs. 1–3).

Horizon:—Oligocene—Lower Eocene.

2. *Pentacolpites type A*: Equatorial diameter 28–42.5 μ ; colpi *brevi* to *medi*, 5–6 μ long; exine 4 μ thick, scabrate; ornamentation reticulate; margin wavy +; mesocolpi 15–20 μ broad (Text-figs. 4, 5; Plate XXVII, figs. 4, 5).

Horizon:—Oligocene—Lower Eocene.

3. *Pentacolpites type B*: Equatorial diameter 28–40 μ ; colpi *brevi* to *medi*, 4–6 μ long; exine 1 μ thick, scabrate; ornamentation finely reticulate to reticulate; margin wavy —+ to ++; mesocolpi 14–20 μ broad (Text-fig. 6).



Description of photomicrographs. $\times 1,000$.

Figs. 1-3. *Tetracolpites*.

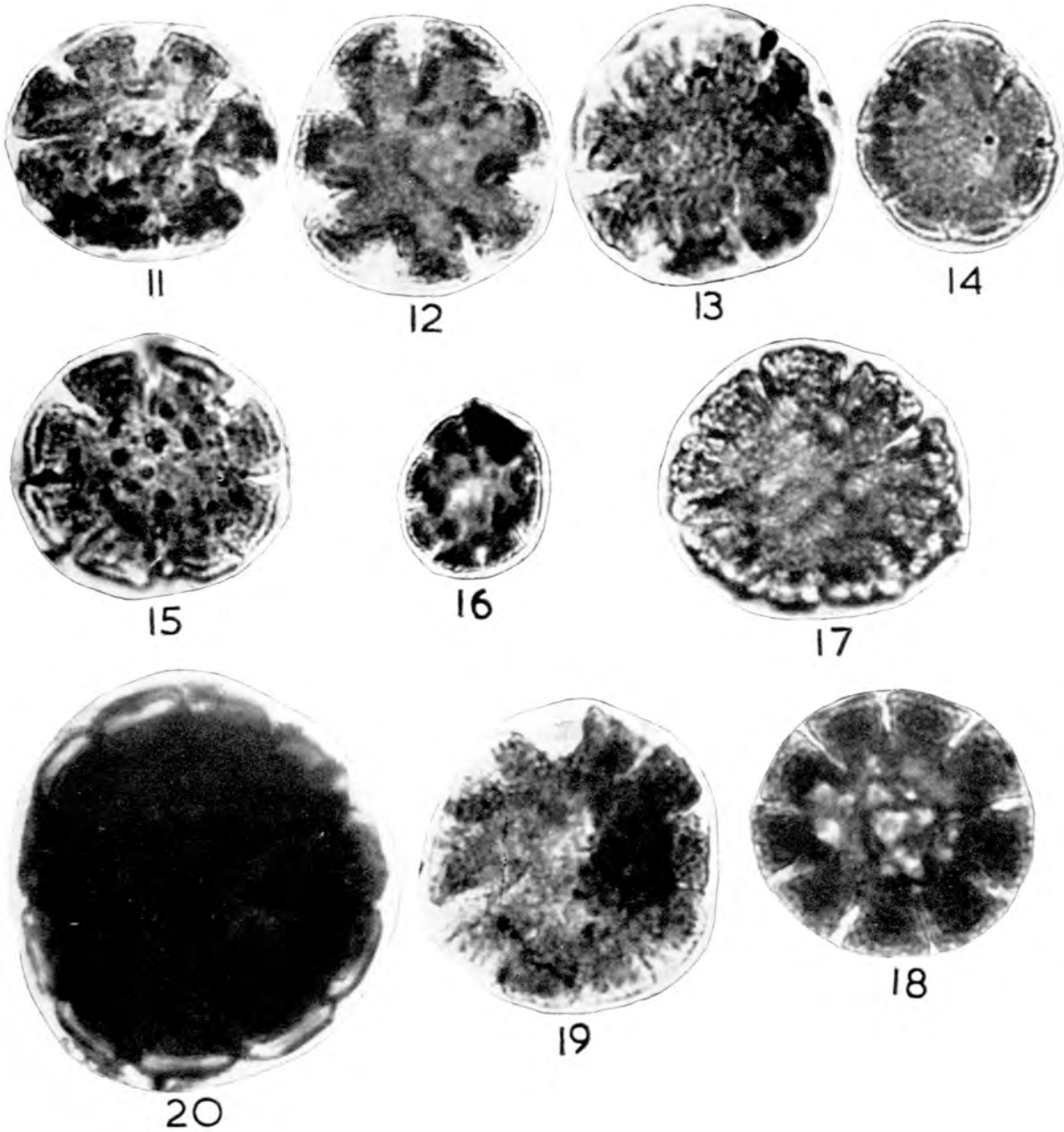
4, 5. *Pentacolpites type A*.

6. *Hexacolpites type A*.

Figs. 7, 8. *Hexacolpites type B*.

9. *Hexacolpites type C*.

10. *Septacolpites type A*.



Description of photomicrographs. $\times 1,000$.

FIGS. 11, 12. *Septacolpites* type B.
 13. *Octacolpites* type A.
 14. *Octacolpites* type B.
 15, 16. *Octacolpites* type C.

FIGS. 17, 18. *Nonacolpites*.
 19. *Decacolpites*.
 20. *11-colpites*.

Horizon :—Oligocene—Lower Eocene.

4. *Hexacolpites type A* : Equatorial diameter 28–40 μ ; colpi medi to longi, 6–11 μ long; exine 3–4 μ thick, scabrate; ornamentation reticulate; margin wavy —+ to +; mesocolpi 12–16 μ broad (Text-fig. 7; Plate XXVII, fig. 6).

Horizon :—Oligocene.

5. *Hexacolpites type B* : Equatorial diameter 32–46 μ ; colpi medi to longi, 5–11 μ long; exine 1 μ thick, scabrate; ornamentation finely reticulate to reticulate; margin wavy —+ to ++; mesocolpi 11–19 μ broad (Text-figs. 8, 9; Plate XXVII, figs. 7, 8).

Horizon :—Upper—Middle Eocene.

6. *Hexacolpites type C* : Equatorial diameter 32–40 μ ; colpi brevi, 2–4 μ long; exine 3–4 μ thick, scabrate; ornamentation reticulate; margin wavy —+ to +; mesocolpi 13–15 μ broad (Text-fig. 10; Plate XXVII, fig. 9).

Horizon :—Middle—Lower Eocene.

7. *Septacolpites type A* : Equatorial diameter 32 μ ; colpi brevi, 5 μ long; exine 3 μ thick, scabrate; ornamentation reticulate; margin wavy +; mesocolpi 13 μ broad (Text-fig. 11; Plate XXVII, fig. 10).

Horizon :—Lower Eocene.

8. *Septacolpites type B* : Equatorial diameter 32–40 μ ; colpi brevi, 5–9 μ long; exine 1–2 μ thick, scabrate; ornamentation finely reticulate to reticulate; margin wavy + to ++; mesocolpi 11–15 μ broad (Text-figs. 12, 13; Plate XXVIII, figs. 11, 12).

Horizon :—Middle—Lower Eocene.

9. *Octacolpites type A* : Equatorial diameter 36–40 μ ; colpi medi, 6–10 μ long; exine 1 μ thick, scabrate; ornamentation finely reticulate to reticulate; margin wavy +; mesocolpi 10–12 μ broad (Text-fig. 14; Plate XXVIII, fig. 13).

Horizon :—Lower Eocene.

10. *Octacolpites type B* : Equatorial diameter 36 μ ; colpi brevi to medi, 5–7 μ long; exine 2–2.5 μ thick, scabrate; ornamentation reticulate; margin wavy +; mesocolpi 12 μ broad (Text-fig. 15; Plate XXVIII, fig. 14).

Horizon :—Lower Eocene.

11. *Octacolpites type C* : Equatorial diameter 24–36 μ ; colpi brevi to medi, 3–6 μ long; exine 1 μ thick, scabrate; ornamentation finely reticulate; margin wavy +; mesocolpi 8–12 μ broad (Text-figs. 16, 17; Plate XXVIII, figs. 15, 16).

Horizon :—Middle—Lower Eocene.

12. *Nonacolpites type* : Equatorial diameter 32–40 μ ; colpi brevi to medi, 3–11 μ long; exine 0.8–1.05 μ thick, scabrate; ornamentation reticulate; margin wavy —+ to ++; mesocolpi 10–12 μ broad (Text-figs. 18, 19; Plate XXVIII, figs. 17, 18).

Horizon :—Upper—Lower Eocene.

13. *Decacolpites type* : Equatorial diameter 36–44 μ ; colpi brevi to medi, 6 μ long; exine 1–1.5 μ thick, scabrate; ornamentation finely reticulate to

reticulate; margin wavy +; mesocolpi 8-11 μ broad (Text-fig. 20; Plate XXVIII, fig. 19).

Horizon :—Lower Eocene.

14. *11-colpites type*: Equatorial diameter 52-56 μ ; colpi longi, 14-17 μ long; exine 3-4 μ thick; ornamentation infra-reticulate; margin wavy - +; mesocolpi 12-17 μ broad (Text-fig. 21; Plate XXVIII, fig. 20).

Horizon :—Upper Eocene.

EARLIER FOSSIL RECORDS OF POLYCOLPATE GRAINS FROM INDIA AND NEIGHBOURING COUNTRIES

Palynologically Tertiary beds of India are not much explored and data on record are meagre. The earliest record is of a Septacolpate grain, made by Sahni, Sitholey and Puri (1947) from the Surmas (Lower Miocene), Assam (Eastern India). All other Polycolpate grains recorded belong to the Eocene horizons. Bose (1952) has recovered *Tetracolpites* and *Heptacolpites* from the carbonaceous clay from Barmer District, Rajasthan (Western India). Rao and Vimal (1952) have described Tetracolpate, Pentacolpate and Hexacolpate grains recovered from the Palana lignites, Rajasthan.

Vimal (1952) has analysed the lignite samples from Dandot, West Punjab (West Pakistan), and recovered grains of *Tetracolpites*, *Hexacolpites*, *Septacolpites* and *Octacolpites* and has tried to compare some with the *Nothofagus* types. These samples also belonged to the Eocene horizons.

Potonié (1960) has described Tetracolpate pollen grain as *Nothofagidites* from the Eocene formations of Kalewa in Burma.

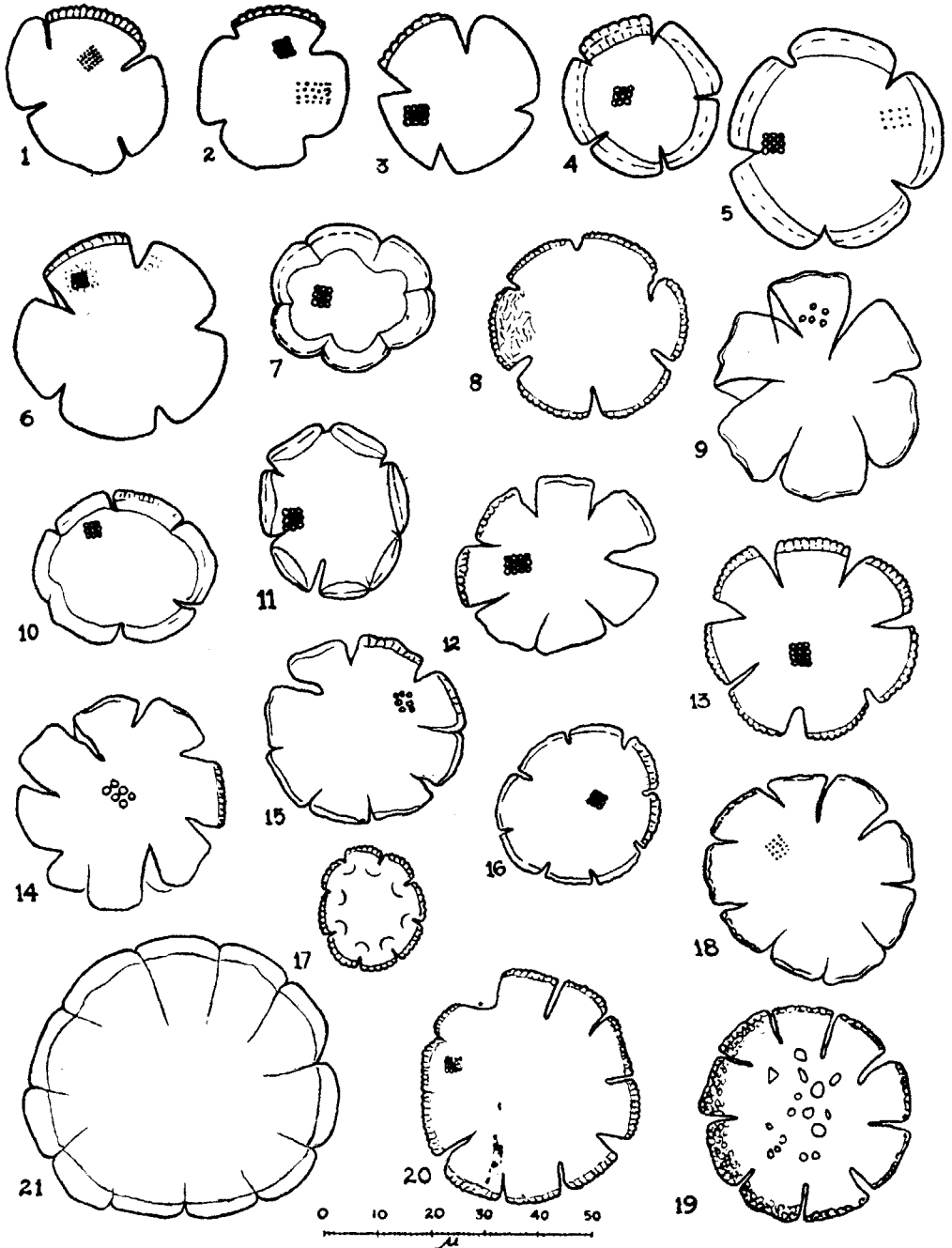
FOSSIL RECORD OF POLYCOLPATE GRAINS FROM OTHER PARTS OF THE WORLD

Similar Polycolpate grains have been recovered from various horizons and localities mostly confined to the Southern Hemisphere, except those recorded by Sein (1961) from the London Clay belonging to the Eocene horizons and compared with *Nothofagus* pollen.

Cookson (1958) has described, from the Tertiary horizons of Australia, about ten species of fossil pollen having four to nine colpi and has identified these as *Nothofagus* spp.

TEXT-FIGS. 1-3. <i>Tetracolpites</i> .	TEXT-FIGS. 12, 13. <i>Septacolpites type B</i> .
4, 5. <i>Pentacolpites type A</i> .	14. <i>Octacolpites type A</i> .
6. <i>Pentacolpites type B</i> .	15. <i>Octacolpites type B</i> .
7. <i>Hexacolpites type A</i> .	16, 17. <i>Octacolpites type C</i> .
8, 9. <i>Hexacolpites type B</i> .	18, 19. <i>Nonacolpites</i> .
10. <i>Hexacolpites type C</i> .	20. <i>Decacolpites</i> .
11. <i>Septacolpites type A</i> .	21. <i>11-colpites</i> .

Cranwell (1959) and Cranwell, Harrington and Spenden (1960) have recorded fossil *Nothofagus* pollen, Polycolpate in nature, from Seymour Island and McMurdo Sound, Antarctica.



Couper (1960) has described *Polycolpites* and *Nothofagus* grains from New Zealand. The oldest horizon from where the *Nothofagus* types are recorded are from the Upper Cretaceous of New Zealand.

DISCUSSION

Comparison

The general outline, nature and number of the colpi and thickness of the exine are the characters which go in favour of their comparison with *Nothofagus*, nearer to *fusca* type, where the exine is firm, scabrate and spinules are not so conspicuous. A few *Pentacolpites*, *Hexacolpites* and *Septacolpites* can be well compared with the figures shown by Sein (1961).

The exine in the pollen grains described here is scabrate but spinules are almost lacking. A few other types with strongly scabrate exine and reticulate ornamentation can be referred to the *Polycolpites* described by Couper (1960).

In *Nothofagus*, the number of colpi within the species vary considerably, sometimes 5-9 colpi are found in one species. This phenomenon is also speculated here as the grains having all other characters almost similar are present in different types. However, with the present state of knowledge it is difficult to establish their affinities with certainty.

Similarity of these grains with those belonging to some eurypalynous families like Euphorbiaceae and Rubiaceae or Pedaliaceae is not as convincing. The distribution of these families in the modern flora where the climate and conditions for their survival remained congenial till recently and the restricted range of these grains in the pre-Miocene horizons in such widely scattered areas are inexplicable.

Distribution

Pollen grains recorded here have been recovered only from the pre-Miocene horizons of Eastern and South-Western India. This observation has been further corroborated by the earlier similar Polycolpate grains recorded by Rao and Vimal (1952), Vimal (1952) and Potonié (1960) from the Eocene horizons of India, Pakistan and Burma. It has been observed that with the older horizons the grains with more number of colpi appear and their frequency increases. This shows that in the Lower Eocene period the flora yielding such pollen was extending all over India and has dwindled slowly and became extinct by the approach of Miocene. Such flora was extending to Pakistan in the West and Burma in the East during the Eocene period.

Sahni, Sitholey and Puri (1947) have recorded a Septacolpate grain somewhat similar in outline from the Surmas of Assam (Eastern India) equivalent to Lower Miocene. No description or microphotograph of this grain is available and the sketch given does not show morphological characters.

Many samples belonging to Surmas and Miocene of Assam have been examined but no such grain has been found in this laboratory.

However, the possible explanation of its presence in Surmas (Lower Miocene) may be that, during the regression of flora, the species might have survived longer in Eastern India than in South-Western.

The similar tendency of the increase in frequency of the grains with more numbers of colpi with the older horizons has been seen in Assam (Eastern India) and South-Western India and they show isoclimatic patches in pre-Miocene times in these regions.

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POSTSCRIPT

Fossil pollens of several types of *Nothofagus*, some resembling the living and the fossil Australian and New Zealand species, have been recently found from the Senonian and the Paleocene of Nigeria. With the available information, it appears, *Nothofagus* was spread widely in India during the Tertiary and probably extended from the centre to the West in Africa, in Rajasthan and Cutch and towards the Far East via Assam and Burma. It follows that, during the past ages, *Nothofagus* was very widely distributed and during the Senonian to Paleocene periods environmental conditions in the now widely separated lands were similar (Puri 1963a, b).

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