

Early Cretaceous angiospermous pollen from the intertrappean beds of Rajmahal Basin, Bihar

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Palynological succession representing Permian to Early Cretaceous sequence through bore-hole no. RJNE-32 drilled (near Mirzachowki) in Rajmahal Basin revealed that the angiospermous pollen make their first appearance in the first intertrappean bed. These forms are assigned to *Retimonocolpites peroreticulatus*, Aff. *Clavatipollenites* sp. 1, cf. *Stephanocolpites* sp., *Retimonocolpites* sp., *Liliacidites* sp. and cf. *Stellatopollis* sp. They are associated with the typical Early Cretaceous palynoassemblage. This is the first record of Early Cretaceous reticulate monosulcate and colpoidate angiospermous pollen from India.

Key-words—Palynology, Angiosperm, Early Cretaceous, Rajmahal Formation (India).

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सारांश

बिहार में राजमहल बेसिन के अन्तर्द्वीप संस्तरों से प्रारम्भिक क्रीटेशी आवृतबीजी परागकण

अर्चना त्रिपाठी एवं राम शंकर तिवारी

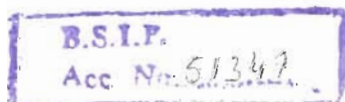
राजमहल बेसिन में किये गये वेध-छिद्र आर-जे-एन-ई०-३२ (मिर्जा चौकी के पास) से परमी से प्रारम्भिक क्रीटेशी अनुक्रम के परागाणविक अध्ययन से व्यक्त हुआ है कि आवृतबीजी परागकण प्रथम अन्तर्द्वीप संस्तर से मिलने प्रारम्भ हो जाते हैं। इन उपलब्ध परागकणों को *रेटिमोकोल्पाइडिस पीरोरेटिकुलेटस*, सजातीय *क्लेवाटिपोलिनाइडिस* जाति 1, सजातीय *स्टीफेनोकोल्पाइडिस* जाति, *रेटिमोकोल्पाइडिस* जाति, *सिक्वीएसिडाइडिस* जाति एवं सजातीय *स्टीलाटोपोलिनाइडिस* जाति से नामांकित किया गया है। ये सभी परागकण सामान्य प्रारम्भिक क्रीटेशी परागाणविक समुच्चय से सहयुक्त हैं। प्रारम्भिक क्रीटेशी कालीन *रेटिकुलेट मोनोसल्केटी* एवं *कोल्पाइडेट* आवृतबीजी परागकणों का भारत से यह पहला अभिलेख है।

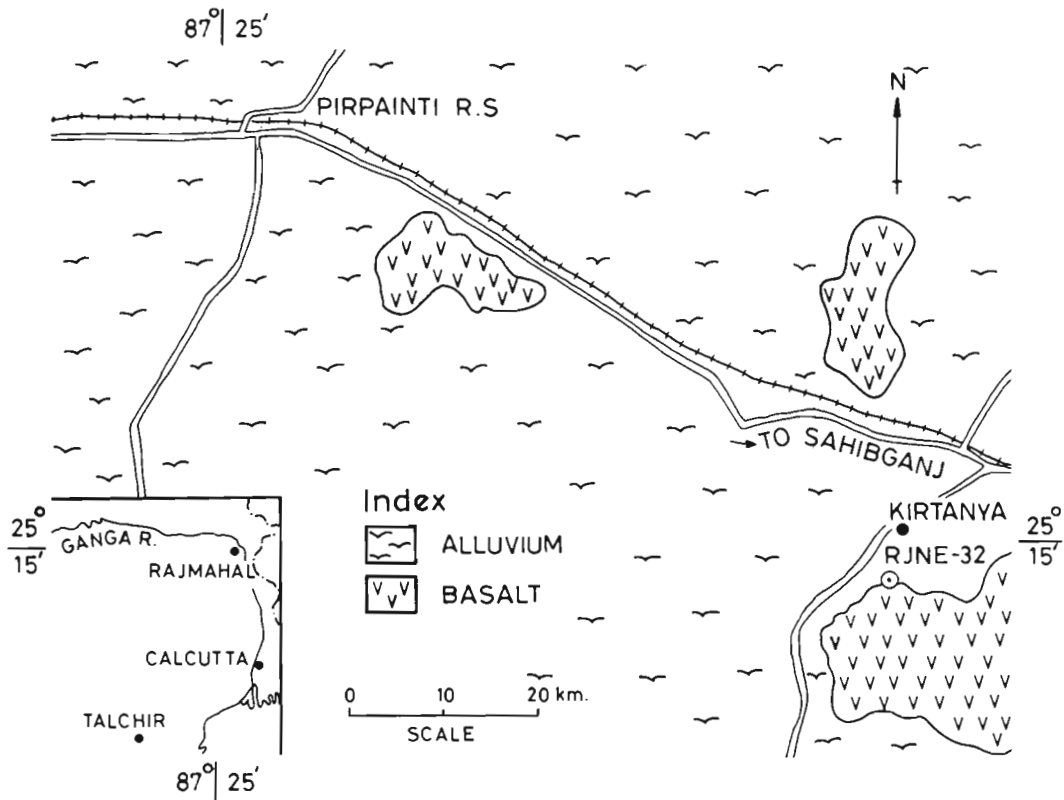
THE palynological sequence through Mesozoic strata (Dubrajpur & Rajmahal formations) from Rajmahal Basin, Bihar has been effectively developed during the last few years (Tiwari *et al.*, 1984; Tripathi, 1989; Tripathi *et al.*, 1990). However, the precise dating and correlation of various intertrappean beds still remain a challenge because the synchronicity of flows in different areas of this basin could not be established. Therefore, the palynostratigraphic events in the Upper Mesozoic strata have significant role in solving this tangle.

The palynological assemblages recovered so far from the intertrappean beds are well diversified; they include coniferous and cycadophytic pollen and pteridophytic spores, but the occurrence of angiospermous pollen is not on record except from Nipania chert (Vishnu-Mittre, 1954). In the present

study of core samples in bore-hole RJNE-32 from the intertrappean beds a fair number of specimens have been observed, some of which positively answer the circumscription of angiospermous pollen having characteristic columellate-tectate exine. However, a few forms are marginal cases for their assignment to this group. In this paper the angiospermic group of pollen are recorded along with the typical Lower Cretaceous palynofossils.

Bore-hole RJNE-32 is located at Kirtanya Village near Mirzachowki (87°30' : 25°15') in the north-west region of Rajmahal Basin (Map 1); it cuts across basaltic flows entombing five intertrappean beds and passes through the underlying Dubrajpur sediments, reaching up to the depth level of 840.00 m entering the Permian sediments (Text-fig. 1). In all, 141 samples were analysed from 31.50 to 471.00 m





Map 1—Location of Bore-hole RJNE-32 in Rajmahal Basin, Bihar, India.

depth. In general, the infratrappean sequence representing Dubrajpur Formation includes kaolinic sandstone, coarse-grained ferruginous sandstone, greenish sandstone and grey and chocolate shale. The intertrappean beds contain buff, chocolate and green-coloured shales, clays and sandstones.

OBSERVATIONS

Following taxa, assigned to angiospermous pollen, have been identified.

Retimonocolpites peroreticulatus (Brenner)
Doyle 1975 in: Doyle *et al.*, 1975
Pl. 1, figs 1, 2; Text-fig. 2.1

Oval, $39 \times 29 \mu\text{m}$, monosulcate; coarsely reticulate ornamentation loosely connected with nexine at places tending to detach from nexine; lumina $5-7 \mu\text{m}$ wide, muri appearing to be smooth.

Retimonocolpites sp.
Pl. 1, fig. 3; Text-fig. 2.6

Oval, $38 \times 25 \mu\text{m}$, monosulcate; exine ca $1 \mu\text{m}$ thick, reticulation irregular, lumen size $1-2.5 \mu\text{m}$, muri less than $1 \mu\text{m}$; in optical view columellae not observed.

Aff. *Clavatipollenites* sp. 1 in: Walker & Walker 1984
Pl. 1, figs 6-9; Text-fig. 2.2

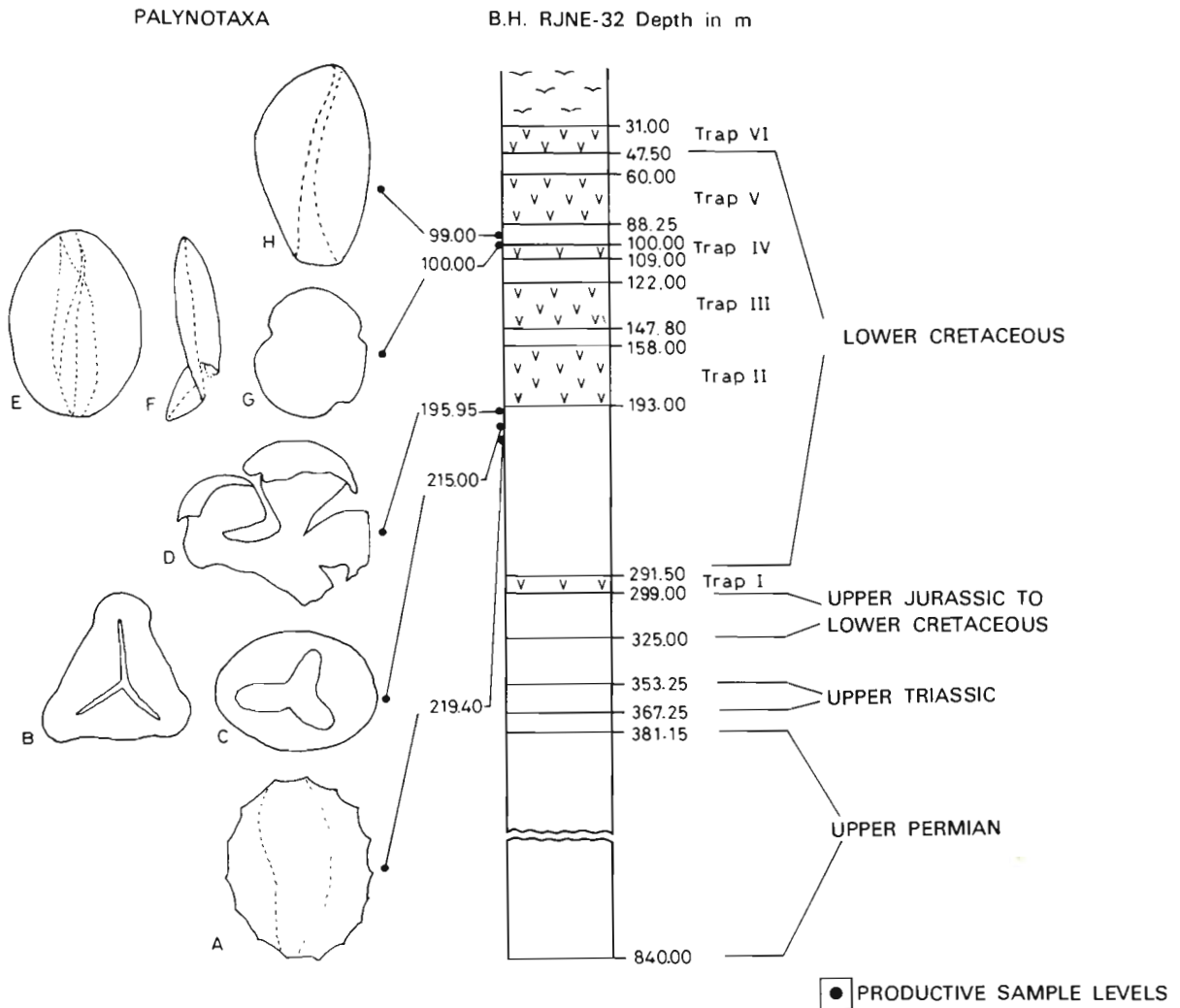
Subcircular, $61 \times 81 \mu\text{m}$, trichomosulcate, sexine $1 \mu\text{m}$ thick, nexine less than $0.5 \mu\text{m}$, semitectate, on surface punctate, at places simulating fusion of puncta, in optical view well-developed columellae seen; tectum smooth, discontinuous at places.

Cf. *Stephanocolpites* sp.
Pl. 1, figs 10-12; Text-fig. 2.3

Subtriangular, $20 \mu\text{m}$, tricolpoidate (?), inter-apical region slightly indented without any defined structure, exine tectate-reticulate on both the surfaces, reticulum irregular, lumina $1-3 \mu\text{m}$ wide, muri scabrate, in optical view columellae $0.5 \mu\text{m}$ high.

Liliacidites sp.
Pl. 1, figs 4, 5; Text-fig. 2.5

Monosulcate, $70 \mu\text{m}$, boat-shaped, sulcus full-length, exine reticulate, lumina up to $2.5 \mu\text{m}$ wide, reticulation existing all over the surface except on bordering region of the sulcus and the terminal areas.



Text-figure 1—Lithology of Bore-hole RJNE 32 showing the depth levels of various traps and productive samples containing angiospermous pollen. **A**, *Retimonocolpites peroreticulatus*; **B**, Type A; **C**, Aff. *Clavatipollenites* sp. 1; **D**, Type B; **E**, *Retimonocolpites* sp.; **F**, *Liliacidites* sp.; **G**, Cf. *Stephanocolpites* sp.; **H**, Cf. *Stellatopollis* sp.

PLATE 1

(All photomicrographs are $\times 1500$ unless otherwise stated). Stage coordinates are given on England Finder (EF).

- 1, 2. *Retimonocolpites peroreticulatus* Dolby 1975; 1 Showing very coarse and loose reticulum; 2. Same specimen in different foci showing nature of reticulum at the colpi margin and portion of detached muri (arrow); Slide no. BSIP 10369; EF : G25/4.
3. *Retimonocolpites* sp. showing nature of (mixed small and big) meshes; Slide no. BSIP 10372; EF : H36.
- 4, 5. *Liliacidites* sp.: 4. $\times 750$; 5. A portion magnified showing bigger meshes in the centre becoming smaller and finally absent towards the terminal ends; Slide no. BSIP 10373; EF : T 33/2.
- 6-9. Aff. *Clavatipollenites* sp. 1, in Walker & Walker, 1984; 6. Showing trichotomosulcate nature $\times 500$; 7. Same specimen's part magnified showing columellate semitectate exine in optical view; 8-9. Same specimen's part magnified

- showing punctate nature, puncta coalesce at places in surface view; Slide no. BSIP 10370; EF : G35/3.
- 10, 12. Cf. *Stephanocolpites* sp., 10. Showing reticulate pattern on one surface, tectate columellate nature at the margin in optical view and indentation at three interapical sides (? colpoidate nature); 11. Same specimen showing reticulation on the other surface; 12. Portion of specimen in fig. 10 focussed to show columellate tectate exine; Slide no. BSIP 10373; EF : N10/3.
13. Cf. *Stellatopollis* sp. showing nature of exine; Slide no. BSIP 10374; EF : Q13/12.
- 14, 15. Type A—in two foci levels showing trichotomosulcate nature and exine pattern; Slide no. BSIP 10370; EF : N18/2.
16. Type B—a piece of broken specimen showing reticulate pattern on surface and columellate tectate nature in optical view; Slide no. BSIP 10371; EF : P35/4.

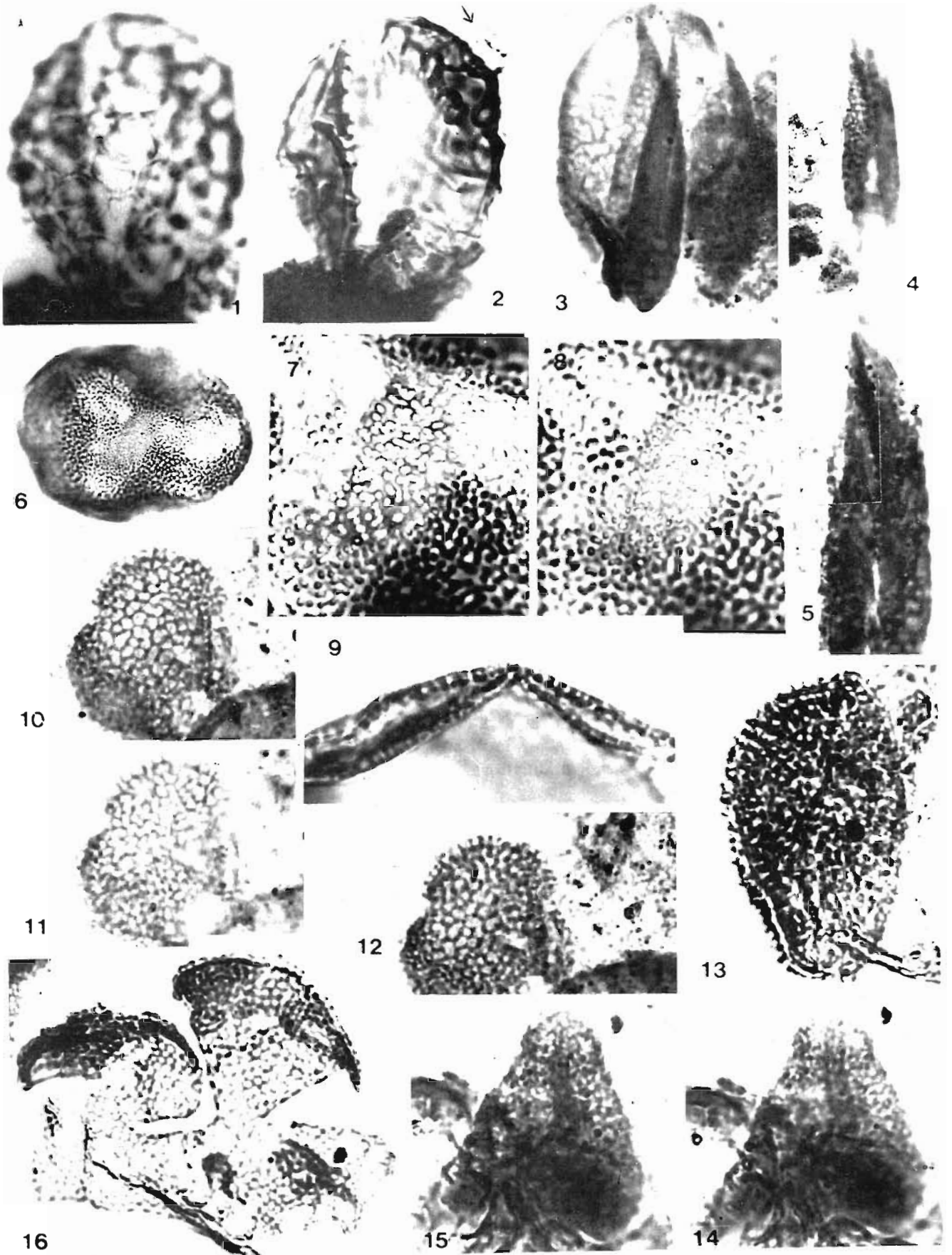
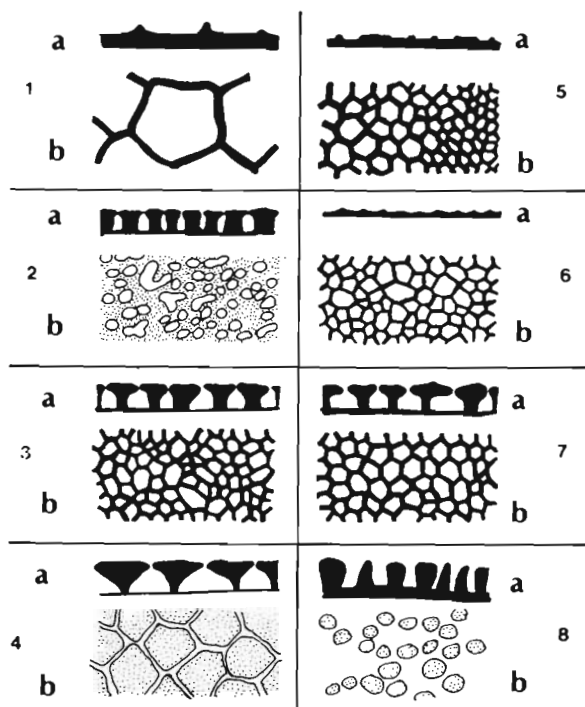


PLATE 1



Text-figure 2—Schematic and semidiagrammatic sketch of exine (not to the scale); **1**, *Retimonocolpites peroreticulatus*; **2**, Aff. *Clavatipollenites* sp. 1; **3**, Cf. *Stephanocolpites* sp.; **4**, Type A; **5**, *Liliacidites* sp.; **6**, *Retimonocolpites* sp.; **7**, Type B; **8**, Cf. *Stellatopollis* sp.—**a**, optical view, and **b**, surface view.

Cf. *Stellatopollis* sp.

Pl. 1, fig. 13; Text-fig. 2.8

Oval, $38 \times 23 \mu\text{m}$, monosulcate, exine ca $1 \mu\text{m}$ thick bearing bacula, coni and clavae, sculptural elements $1 \mu\text{m}$ high and $5.1 \mu\text{m}$ wide, reticulation not visible.

Type A

Pl. 1, figs 14, 15; Text-fig. 2.4

Triangular with slightly swollen apical regions $26 \mu\text{m}$, with triradiate ridge-trichotomosulcate; exine semi-tectate, on surface polygonal pattern formed by interbaculate canal-like spaces; in optical view exine less than $1 \mu\text{m}$ thick consisting of small bacula with fan-shaped triangular heads at the free ends.

Type B

Pl. 1, fig. 16; Text-fig. 2.7

Broken part of pollen, measuring $75 \times 57 \mu\text{m}$, exine $1 \mu\text{m}$ thick, tectate-reticulate, muri $1 \mu\text{m}$ thick, lumina $1.3 \mu\text{m}$ in size, in optical view columellae $0.5 \mu\text{m}$ high.

A total number of 8 specimens of angiospermous affinity have been recovered in a

thorough scanning of four slides ($22 \times 40 \text{ mm}$ cover glass) each of 5 samples. Obviously, the occurrence is very rare. These forms start appearing from upper part of the first intertrappean bed from below, at the depth of 219.40 m. Other samples having angiospermous pollen represent 215.00, 195.95 (first intertrappean), 100.00 and 99.00 meter (4th intertrappean) depths (Text-fig. 1).

In addition, the following genera showing gymnospermous and pteridophytic affinities have also been encountered in the intertrappean beds. They are: *Araucariacites*, *Callialasporites*, *Podocarpidites*, *Vitreisporites*, *Podosporites*, *Classopollis*, *Aequitriradites*, *Coptospora*, *Cooksonites*, *Triporoletes*, *Murospora*, *Cicatricosisporites*, *Contignisporites*, *Appendicisporites*, *Densoisporites*, *Klukisporites*, *Ischyosporites*, *Leptolepidites*, *Concavissimisporites*, *Santhalisporites*, *Baculatisporites*, *Gleicheniidites*, *Concavisporites*, *Matonisporites*, *Spheripollis*, *Osmundacidites*, *Cyathidites*, *Monolites*, *Cycadopites* and *Phragmothyrites*.

The palynological sequence of the bore-hole RJNE-32 reveals that the assemblage recovered at a depth of 291.00 to 52.50 m has the dominance of gymnosperm pollen, i.e., *Araucariacites*/*Podocarpidites* along with the characteristic genera listed above. The totality of composition suggests a resemblance with Early Cretaceous palynofloras of the Indian peninsula (Singh & Venkatachala, 1988).

DISCUSSION

The palynoassemblages of Early Cretaceous age from other areas of the Rajmahal Basin (Vishnu-Mittre, 1954; Sah & Jain, 1965; Maheshwari & Jana, 1983; Tiwari *et al.*, 1984) are rich and diversified but there is no record of angiosperm pollen in them except *Sporojuglandoidites jurassicus* Vishnu-Mittre 1954 from Nipania chert. This taxon has not been found in the present material.

From the Indian peninsula rich and diversified palynoassemblages of Early Cretaceous age are known, but the published data reveal that the angiospermous characters are recorded in only three assemblages. The presence of *Clavatipollenites* has been reported (not illustrated) from the Goru Formation (Aptian-Albian) of Jaisalmer, Rajasthan (Lukose, 1974). In Dalmiapuram Formation (Early Albian) near Kallakkudi, Tiruchirapally Jain and Taugourdeau-Lantz (1973, p. 60; pl. 1, figs 31, 32) illustrated a specimen as Spore-type B assigning its similarity with *Clavatipollenites*; however, it is a tricolpate pollen (personal observation, courtesy Dr K. P. Jain). Yet another report is from Cauvery Basin

(Late Albian through Late Cretaceous, Venkatachala & Sharma, 1974). The assemblage of Late Albian age contains *Tricolpites reticulatus*, *T. microreticulatus*, *T. crassimarginatus*, *Liliacidites varigatus*, *L. dividus*, etc. No comparable form has been recorded in the present material.

The palynofloras from intertrappean beds in Rajmahal Basin have been studied from Nipania Chert (Vishnu-Mittre, 1955), Basko and Sakari gali Ghat (Sah & Jain, 1965), Mandro (Maheshwari & Jana, 1983), Bore-hole RJR-2 between Tinpahar and Rajmahal (Tiwari *et al.*, 1984) and Bore-hole RJNE-32 near Kirtanya (present study). These beds are also rich in plant fossils (Sengupta, 1988). Palynologically these beds are dated as Early Cretaceous. The precise dating is rather difficult because of the absence of marine control, dependable radiometric dating and short ranging plant fossils. The radiometric dating of various traps (115 Ma \pm 10) in this basin could have helped to determine the age of intertrappeans. So far only few dates are available for traps (McDougall & McElhinny, 1970; Agarwal & Rama, 1976; Baksi *et al.*, 1987) but the placement of these traps is difficult when considered in a sequence of several volcanic activities in the basin.

The recent attempts to trace the earliest appearance of angiospermous or angiospermid exine character have resulted in finding an important event that such morphologies have evolved much earlier than Early Cretaceous, i.e., from Late Triassic (Cornet, 1989; Vasanthi *et al.*, 1990) although angiospermous affinity has not been assigned to such forms. However, the earliest pollen having columellate-tectate exine identified as of angiospermous affinity, i.e., *Clavatipollenites*, are on record from Valanginian-Lower Hauterivian (Gubeli *et al.*, 1988) and Barremian (Kemp, 1968; Doyle *et al.*, 1975, 1977; Walker & Walker, 1984, 1986). As we go up in time, the other morphological types having angiospermous affinity appear, i.e., tricolpates in early Middle Albian, tricolporoidates in Middle to Late Albian, tricolporate in Early Cenomanian, and triporates in Middle Cenomanian.

In the present material, the angiospermous pollen are simple and the array of quality is less diversified. No form comparable to the type species *Clavatipollenites hugesii* Couper 1958 has been recorded in the present material. But the unquestionable angiospermous pollen are represented by the semitectate and tectate reticulate forms with distinct columellae, as seen in light microscope, viz., Aff. *Clavatipollenites* sp. 1 in Walker & Walker, 1984; Cf. *Stephanocolpites* sp. and the specimen designated as Type A. Beside these, the

reticulate monosulcate taxa *Retimonocolpites peroreticulatus* Dolby 1975 in: Dolby *et al.*, 1975, *Retimonocolpites* sp., *Liliacidites* sp. and Cf. *Stellatopollis* sp. have also been recorded but the columellate nature of exine could not be unequivocally confirmed under the light microscope, although Dolby *et al.* (1975) and Walker and Walker (1975) have demonstrated the occurrence of these features in similar forms.

Thus the totality of characters and composition of angiospermous pollen in Rajmahal Basin qualify for an Early Cretaceous aspect apparently older than the Albian.

CONCLUSIONS

1. The angiospermous pollen recovered from Bore-hole RJNE-32 are assigned to *Retimonocolpites peroreticulatus*, *Retimonocolpites* sp., Aff. *Clavatipollenites* sp. 1, Cf. *Stephanocolpites* sp., *Liliacidites* sp., Cf. *Stellatopollis* sp., Type A and Type B. These taxa are recorded for the first time from India.
2. The angiospermous pollen components of the present palynoflora are less diversified in aperture types as well as in the exine pattern. It is concluded that these forms qualify for an Early Cretaceous age, apparently older than Albian.
3. These taxa start appearing from the Upper reaches of first intertrappean bed at the depth-level of 219.40 m in this bore-hole.

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