Permian-Triassic palynofloral transition in Godavari Graben, Andhra Pradesh

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Palynological investigation of bore hole GAM 7 from Mailaram area (Paloncha Neck) in Godavari Graben has revealed five assemblages. Assemblages I to IV represent Late Permian, being dominant in striate disaccate pollen. Assemblage V denotes an Early Triassic age in view of the preponderance of *Lunatisporites pellucidus* and *Verrucosisporites*. The changeover from striate-disaccate to taeniate phase is quick and sharp indicating a palynological break. The transition from Permian to Triassic in this part of Godavari Graben occurs in a paraconformable sequence. The Permian Triassic boundary passes within a gap of 12 m and a definite presence of Panchet palynoflora is established.

Key-words—Palynology, Godavari Graben, Permian-Triassic (India).

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सारॉंश

आंध्र प्रदेश में गोदावरी द्रोणिका में परमी-त्रिसंधी परागाणुवनस्पतिजातीय परिवर्तन

सुरेश चन्द्र श्रीवास्तव एवं नीरजा झा

गोदावरी द्रोणिका में मेलारम क्षेत्र (पलौंचा नेक) से वेध-छिद्र जी-ए-एम०-7 के परागाणविक अन्वेषण से पाँच समुच्चय व्यक्त हुई हैं। रेखीय-द्विकोष्ठीय परागकणों मे भरपूर समुच्चय एक से चार तक अनंतिम परमी आयु इंगित करती हैं। पाँचवीं समुच्चय **ल्यूनाटिस्पोराइटिस पेल्यूसिडस** एवं **वेरुकोसिस्पोराइटिस** की उपस्थिति के कारण प्रारम्भिक त्रिसंधी आयु प्रस्तावित करती है। रेखीय द्विकोष्ठीय से टीनिएट अवस्था में तीव्र परिवर्तन से परागाणविक अनिरंतरता व्यक्त होती है। गोदावरी द्रोणिका के इस भाग में परमी से त्रिसंधी परिवर्तन विशेष क्रम में हुआ है। परमी-त्रिसंधी सीमा 12 मीटर के अन्दर ही प्रेक्षित की गई है तथा इसमें पंचेत परागाणुवनस्पतिजात की स्पष्ट उपस्थिति स्थापित की गई है।

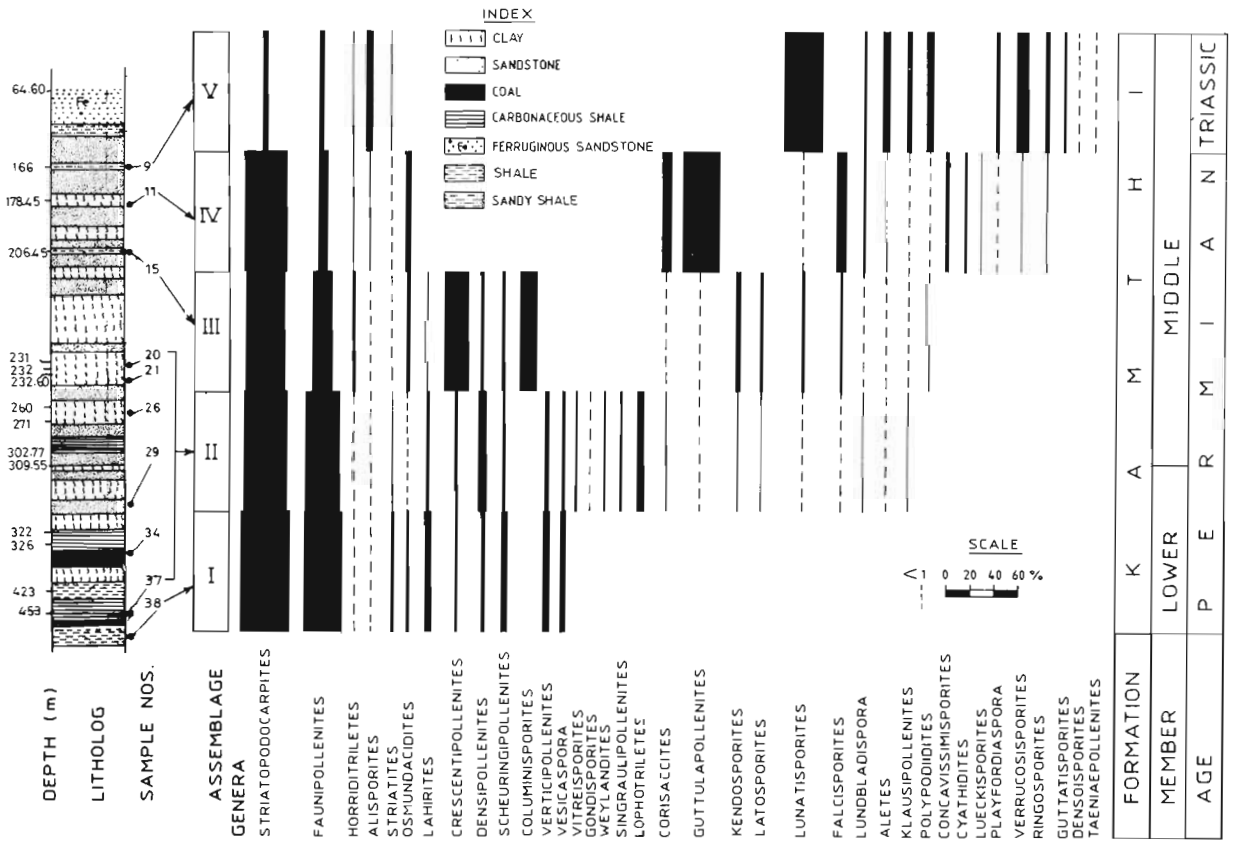
THE Gondwana outcrops in Godavari Graben extend over a length of about 350 km with an average width of 55 km. There is a well-defined constriction in the Paloncha-Kothagudem area where the average width narrows down to about 6 km. The bore-hole GAM7 studied here was drilled in Mailaram area (Paloncha Neck) by the Geological Survey of India.

PALYNOASSEMBLAGES

The vertical distribution of various quantitatively significant palynotaxa in bore-hole GAM7 is shown in Histogram 1. In all, five palyno-assemblages have been demarcated as under:

Assemblage I—This assemblage, recorded at 453 m depth, is dominated by striate-disaccate pollen, chiefly *Striatopodocarpites* (40%) and *Faunipollenites* (32%). Other important genera are *Verticipollenites* (4%) and *Labirites* (5%). *Densipollenites* (2%) and *Crescentipollenites* (2%) appear in low percentage while the trilete spores are very rare.

Assemblage II—Recorded between 423 to 231 m, this assemblage is characterised by the dominance of *Striatopodocarpites* (35%) and *Faunipollenites* (29%). *Densipollenites* increases up to 12 per cent at 423 m but the average value remains around 6 per cent. *Crescentipollenites* (2%) still remains insignificant. *Lunatisporites, Vitreisporites, Kendosporites, Guttulapollenites, Lundbladispora, Falcisporites, Klausipollenites*, etc. appear for the first time. In addition, *Gondisporites, Weylandites*, and



Histogram 1—Distribution of important palynotaxa in bore-hole GAM 7, Mailaram area, Godavari Graben.

Singraulipollenites occur in low percentage only. The percentage of trilete spores also increases as *Lophotriletes* occurs up to 13 per cent between 260-271.75 m depth level.

Assemblage III—At the depth of 206.45 m, striate disaccate pollen are still the dominant elements of the palynoflora (*Striatopodocarpites* 32% + *Faunipollenites* 17%). *Crescentipollenites* rises to 20 per cent. *Columinisporites* (14%) has a restricted distribution. *Kendosporites* (4%) and *Lunatisporites* record a slight increase.

Assemblage IV—This association is recorded at 178.45 m. The striate-disaccate (*Striatopodocarpites* 33%) pollen continue to dominate the palynoflora. Here, the subdominance is formed by *Guttulapollenites* (29%). *Corisaccites* and *Falcisporites* (8% each) also increase in percentage. The genera, like *Phidiaesporites, Triquitrites, Iraquispora, Cyathidites, Concavissimisporites*, are restricted to Assemblage IV. *Osmundacidites* attains its maximum value at 178.45 m.

Assemblage V—It is recorded at 166 m depth level. The striate-disaccate pollen show a sharp decline and are replaced by taeniate pollen genus *Lunatisporites* (32%); *Verrucosisporites* (10%) exhibiting a fair rise in frequency. *Taeniaepollenites* and *Guttatisporites* (3%) are restricted to Assemblage V. *Klausipollenites* (4%), *Playfordiaspora* (3%), *Ringosporites* (4%), *Polypodiidites* (6%) and *Alisporites* (7%) increase in percentage. Aletes (10%) also mark a significant increase.

DISCUSSION

Five palynoassemblages demarcated in bore-hole GAM-7 essentially fall under two groups:

1. Assemblages I to IV are chiefly dominated by striate-disaccate pollen.

2. Assemblage V shows a dominance of taeniate pollen, alongwith cingulate-cavate trilete spores.

The dominance of disaccate pollen in Assemblages I-IV is comparable to the Late Permian palynofloras known from various basins of India. However, the occurrence of the following genera in the present sequence has been observed for the first time in Godavari Graben.

1. *Kendosporites* appears in Assemblage II and becomes significant in Assemblage III in Godavari Graben, whereas in Singrauli (Tiwari & Srivastava, 1984) and Raniganj (Singh & Tiwari, 1982) coalfields this genus occurs sporadically.

2 *Columinisporites* is well-represented in Assemblage III. The only other record in India, though low in percentage, is from Raniganj Coalfield (Singh & Tiwari, 1982) from where similar forms have been described as *Striatosporites*. This genus has been recorded from Baralaba Coal Measures of Australia (Foster, 1979), Late Permian of Africa (Jardine, 1974; Anderson, 1977) and Autunian of France (Alpern & Doubinger, 1973).

3 Presence of *Triquitrites, Iraquispora, Phidiaesporites* in Assemblage IV and *Taeniaepollenites* in Assemblage V forms the first record from the Indian subcontinent. *Ringosporites, Kraeuselisporites, Cyathidites* and *Concavissimi sporites* present in Assemblage IV are also recorded from Panchet Formation of Raniganj Coalfield (Tiwari & Singh, 1983) but the percentage is low as compared to the Godavari Graben. Most of the above genera present in Assemblage IV along with *Guttulapollenites* and *Corisaccites* bear a close comparison with the assemblage recorded from Chhidru Formation in Salt Range (Balme, 1970). The common taxa in Assemblage IV of Godavari Graben and Chhidru Formation of Salt Range (West Pakistan) are: *Leiotriletes* sp., *Lophotriletes* sp., *Cyathidites* sp., *Cyclogranisporites arenosus, Osmundacidites senectus, Triquitrites proratus, Iraquispora labrata, Polypodiidites* sp., *Polypodiisporites* sp., *Playfordiaspora cancellosa* (= *Guthoerlisporites cancellosus*), *Lunatisporites noviaulensis* (= *Taeniaesporites noviaulensis*), *Vitreisporites pallidus, Falcisporites stabilis, Klausipollenites schaubergeri, Striatopodocarpites* (= *Protohaploxypinus*) *microcorpus, Ringosporites* (= *Nevesisporites*) *fossulatus, Verrucosisporites narmianus, Densipollenites indicus, Schizosporis* sp.

Assemblage IV also compares with the *Protohaploxypinus microcorpus* Zone (*Falcisporites* Superzone) of Australia in view of the common occurrence of *Protohaploxypinus* (= *Striatopodocarpites*), *Falcisporites* and *Playfordiaspora* (Rigby *et al.*, 1987). The Late Permian palynoflora of Madagascar (Goubin, 1965) also compares with Assemblage IV in view of the occurrence of *Guttulapollenites hannonicus* and *G. gondwanensis*.

Assemblage V, the youngest palynozone in borehole GAM7, records the conclusive evidence of the presence of Lower Triassic in Godavari Graben. This assemblage compares with *Lunatisporites* and *Verrucosisporites* Assemblage from the Panchet Formation of Raniganj Coalfield (Tiwari & Singh, 1983).

The palyno-assemblage from Budharam Area (Srivastava & Jha, 1988) in Godavari Graben is older than the Assemblage V recorded here in view of higher percentage of *Lundbladispora* and

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PLATE 1

(All co-ordinates refer to Leitz Laborlux D microscope and all photographs are magnified × 500).

1. *Playfordiaspora cancellosa*, Slide no. BSIP 10013; Coordinates 106.4 × 53.2.
2. *Striatopodocarpites microcorpus*, Slide no. BSIP 10003 Coordinates 102.9 × 41.8.
3. *Densoisporites* sp., Slide no. BSIP 10006; Coordinates 98.6 × 61.9.
4. *Cyathidites* sp., Slide no. BSIP 9999, Coordinates 97.5 × 52.8.
5. *Triquitrites* sp., Slide no. BSIP 10004; Coordinates 109 × 40
6,7. *Columinisporites* sp., Slide no. BSIP 10009; Coordinates 113.5 × 44.
8. *Concavissimisporites* sp., Slide no. BSIP 10005; Coordinates 99 × 52.9.
9. *Vitreisporites pallidus*, Slide no. BSIP 10006; Coordinates 108.8 × 65.8.
10. *Ringosporites fossulatus*, Slide no. BSIP 10007; Coordinates 111.4 × 62.3.
11. *Phidiaesporites* sp.
12. *Klausipollenites* sp., Slide no. BSIP 10008; Coordinates 99 × 71.0.
13. *Osmundacidites* sp., Slide no. BSIP 10007; Coordinates 111.4 × 56.
14. *Kendosporites* sp., Slide no. BSIP 10010; Coordinates 99 × 52.9.
15. *Lunatisporites* sp., Slide no. BSIP 10013; Coordinates 103.3 × 68.2.
16. *Polypodiidites* sp., Slide no. BSIP 10015; Coordinates 109 × 62.8.
17. *Taeniaepollenites* sp., Slide no. BSIP 10012; Coordinates 96.5 × 65.6.
18. *Lundbladispora* sp., Slide no. BSIP 10014; Coordinates 104 × 67.9.
19. *Guttulapollenites* sp., Slide no. BSIP 9999; Coordinates 109 × 44.5.
20. *Guttulapollenites* sp., Slide no. BSIP 10002; Coordinates 104.6 × 58.
21. *Guttatisporites* sp., Slide no. BSIP 10003; Coordinates 101 × 45.5.
22. *Lunatisporites* sp., Slide no. BSIP 10011; Coordinates 105 × 56.6.
23. *Verrucosisporites* sp., Slide no. BSIP 10003; Coordinates 101 × 60.
24. *Falcisporites* sp., Slide no. BSIP 10003; Coordinates 108.2 × 60.5.
25. *Lunatisporites* sp., Slide no. BSIP 10011; Coordinates 111 × 58.4.
26. *Iraquispora* sp., Slide no. BSIP 10003; Coordinates 105 × 55.8.
27. *Verrucosisporites trisectus*., Slide no. BSIP 10001; Coordinates 98.7 × 52.

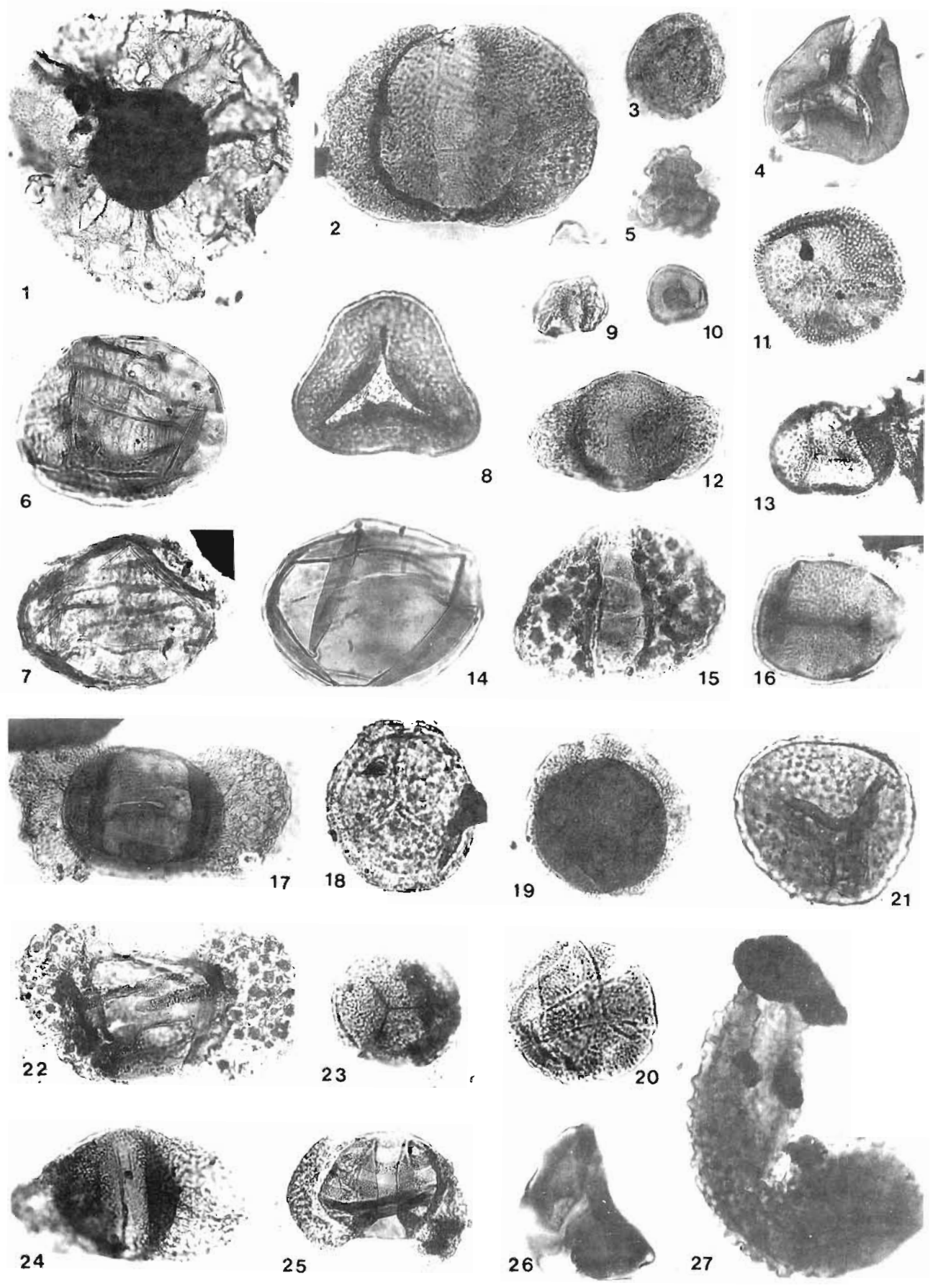

PLATE 1

Densoisporites which precedes the taeniate phase in Damoder Graben. The increase in percentage of *Klausipollenites, Ringosporites, Playfordiaspora, Lundbladispora, Polypodiidites* and *Alisporites* further indicates its affinity with Lower Triassic palynofloras. *Taeniaepollenites*, another rare taeniate genus in the present assemblage, and *Guttatisporites* restricted to Assemblage V only are also known from the Triassic of the Netherlands (Visscher, 1966). *Guttatisporites* has also been observed in low percentages in Panchet Formation of Damoder Valley Coalfield, India (Tiwari & Singh, 1983).

Lunatisporites pellucidus Zone (*Falcisporites* Superzone) of Australia (Rigby *et al.*, 1987) compares with Assemblage V in view of the common occurrence of *Lunatisporites pellucidus*. Similarly, the assemblage of Mianwali Formation, Salt Range (Balme, 1970) is comparable in having *Lunatisporites pellucidus* zone. The species common in the presently identified Assemblage V and Mianwali Formation, Salt Range are *Osmundacidites senectus, Ringosporites* (= *Nevesisporites*) *fossulatus, Ringosporites ringus, Densoisporites playfordii, Kraeuselisporites* sp., *Playfordiaspora cancellosa* (= *Guthoerlisporites cancellosus*), *Lunatisporites* (= *Taeniaesporites*) *pellucidus, L.* (= *Taeniaesporites*) *noviaulensis, Falcisporites stabilis, Klausipollenites schaubergeri, Verrucosisporites narmianus.*

The present palynological evidence indicates that Assemblages I-IV belong to Late Permian while Assemblage V conclusively shows Early Triassic affinity. The change-over from Late Permian to Early Triassic between 178-166 m is sharp and well-defined which is evident from a sudden change of striate-disaccate dominant assemblage to taeniate disaccate dominant assemblage. This conclusion is further substantiated by the study of palynofloral succession from Raniganj Coalfield (Tiwari & Singh, 1986) while a complete succession of Late Permian palynofloras is present in bore hole GAM7 up to 178 m, there is a distinct absence of two palynoassemblages (P-I *Striatopodocarpites* + *Klausipollenites*; P-II *Verrucosisporites* + *Callumispora*) which should precede the present *Lunatisporites* + *Verrucosisporites* Assemblage. This indicates a palynological break, though minor, in the palynological succession of bore core GAM7 between 178 to 166 m. The above palynological assemblage has not been recorded in the present study.The 12 meter strata which consists of greenish grey sandstones, did not yield microfossils.

Lithostratigraphically, the sediments up to 453 m in bore-hole GAM7 represent the Lower and Middle members of the Kamthi Formation (*sensu* Raja Rao, 1982). The Lower Member, between 272.75-453 m, is rich in carbonaceous shale and coal, alternating with white sandstone. The overlying greenish-grey sandstone with greenish-grey shales/clay up to 136 m depth are devoid of coal. The sediments above 136 m are represented by coarse-grained, ferruginous cross-bedded sandstone and alternating sandy shales. The entire sequence above 272.75 m is normally considered to represent the Middle Member of the Kamthi Formation.

Recently, Ramanamurthy and Rao (1987) have reconsidered the lithostratigraphic succession of the Lower Gondwana sediments in Ramagundam area of Godavari Graben and have raised the status of Lower Member and the lower part of the Middle Member to be equivalent to Raniganj Formation while the upper part of the Middle Member (represented by an alternate sequence of red/brown, sandy, calcareous clays and cross bedded sandstones) to be equivalent to the Panchet Formation. However, lithology attributed to Panchet Formation by Ramanamurthy and Rao (1987) in Godavari Graben does not conform to the lithology of Panchet Formation of the Damoder Basin—the type area. The present palynological finding in bore-hole GAM7 also shows that Panchet palynoflora commences much earlier within the green sandstone and clay sequence. Thus the Permian-Triassic boundary transgresses in the upper part of the Middle Member of Kamthi Formation (*sensu* Raja Rao, 1982) and Upper Raniganj (*sensu* Ramanamurthy & Rao, 1987).

Lithozone 3 of the Infra-Kamthi Formation (Kutty *et al.*, 1988), encompasses the Middle Member of the Kamthi Formation of earlier workers. This zone contains the *Endothiodont-Cistecephallus* fauna representing Late Permian-?late Early Permian. The lithological attributes of lithozone 3 may represent a part of the sequence studied in bore-hole GAM7 where the palynological transition has been observed. In view of the above discussion, it now appears certain that the younger part of Middle Member of the Kamthi Formation (*sensu* Raja Rao, 1982), represented by green sandstone and clay, and the overlying coarse-grained ferruginous sandstone with alternating sandy shale should represent the Panchet Formation in Godavari Graben. The first appearance of prevalent red colour of sandstones and clay representing Panchet Formation, as opined by Ramanamurthy and Rao (1987), does not corroborate with the present investigation. However, it appears difficult to demarcate a lithological boundary between the Raniganj and Panchet formations in bore-hole GAM7 as the sandstones and shales with greyish-green tint continue downwards having Late Permian assemblages and, therefore, the

contact between Upper Permian and Lower Triassic sediments is considered to be represented by a paraconformity.

CONCLUSION

Palynological analyses record the presence of definite Lower Triassic sediments in bore-hole GAM7, Mailaram Area (Paloncha Neck), Godavari Graben. The Permian-Triassic boundary is located within Middle Member of the Kamthi Formation. The palynofloral transition from *Protohaploxypinus* (= *Striatopodocarpites*) *microcorpus* to *Lunatisporites pellucidus* Zone indicates a palynological break, though minor in the succession. The palynofloral change-over from Permian to Triassic does not commensurate a lithological change, hence the lithological Permian/Triassic boundary remains to be established. It is further suggested that the Permian-Triassic change-over occurs in a paraconformable sequence.

The sediments containing *Lunatisporites-Verrucosisporites* assemblage may be equivalent to the sediments containing Assemblage PIII A in Damoder Valley. Thus the lithic attributes of the Panchet Formation in Godavari Graben could be represented by greyish-green sandstone and clays overlain by predominantly coarse to medium-grained, cross-bedded sandstone and sandy, calcareous shale which are present in bore-hole GAM7 from the surface up to 166 m depth. Assemblage IV and V, which have a close comparison with a similar succession in Salt Range, impart a palaeogeographic provincialism during the period.

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