Palynology of Permian-Triassic sequence in Iria Nala, Tatapani-Ramkola Coalfield, India

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Srivastava Suresh C, Anand-Prakash & Kar Ratan 1997. Palynology of Permian-Triassic sequence in Iria Nala, Tatapani-Ramkola Coalfield. *Palaeobotanist* **46** (1,2): 75-80.

The Permian-Triassic sediments exposed along Iria Nala in the northern part of Tatapani-Ramkola Coalfield have been palynologically analysed. The palynological assemblage includes 42 genera and on the basis of quantitative dominance three assemblage zones have been distinguished in ascending order : (i) *Densipollenites magnicorpus* zone, (ii) *Crescentipollenites fuscus* zone and (iii) *Falcisporites stabilis* zone. The first two palynoassemblage zones are restricted to the coal, carbonaceous shale, sandstone sequence (= Raniganj Formation) which is overlain by a khaki shale bed rich in *Schizoneura gondwanensis*. The lithological succession above this bed contains greyish/khaki green splintery shale and sandstone (=Panchet Formation). These shales have yielded the third palynoassemblage zone marked by *Falcisporites stabilis, Playfordiaspora cancellosa* and *Klausipollenites schaubergeri*. The Permian - Triassic boundary lies above the *Schizoneura gondwanensis* bed between the second and third palynozones. The transition is marked by the decline in the frequency of *Crescentipollenites* followed with the increase of non-striate group represented by *Falcisporites*. The onset of Triassic sedimentation is also marked by the presence of khaki shales which closely compares with the Panchet (Lower Triassic) sediments of the type area. Thus, the transition of palynoflora from Late Permian to Early Triassic is gradual and broadly conforms with the lithological changes. There appears to be a continuous sedimentation between the Permian and Triassic periods in this part of Tatapani-Ramkola Basin.

Key-words—Palynology, Tatapani-Ramkola Coalfield, Gondwana, Permian, Triassic, India.

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सारांश

भारत में तटापानी-रामकोला कोयला-क्षेत्र में इरिया नाला में परमियन-ट्रायॅसिक अनुक्रम का परागाणविक अध्ययन

सुरेश चन्द्र श्रीवास्तव, आनन्द प्रकाश एवं रतन कर

तटापानी-रामकोला कोयला-क्षेत्र के उत्तरी भाग में स्थित इरिया नाला के संग-संग अनावरित परमियन-ट्रायॅसिक अवसादों का परागाणविक अध्ययन किया गया। उपलब्ध परागाणविक समुच्चय में 42 प्रजातियाँ हैं तथा परिमाणात्मक विश्लेषण के आधार पर (i) *डेन्सीपोलिनाइटिस मैग्नीकॉर्पस* मंडल (ii) *क्रीसेन्टीपोलिनाइटिस फस्कस* मंडल एवं (iii) *फाल्सीस्पोराइटिस स्टेबिलिस* मंडल आरोही क्रम में बनाये गये हैं। पहले दो मंडल कोयला, कार्बनी शैल, बालुपत्थर अनुक्रम (रानीगंज शैल-समूह), जो कि खाकी शैलों के नीचे हैं, से सम्बद्ध हैं। इस संस्तर के ऊपर स्थित अनुक्रम से तृतीय परागाणविक मंडल उपलब्ध हुआ है। यह मंडल *फ़ाल्सीस्पोराइटिस स्टेबिलिस, प्लेफ़ोर्डियास्पोरा कैन्सेलोसा* एवं *क्लॉसीपोलिनाइटिस शॉबर्जेराई* से लक्षणित है। परमियन-ट्रायॅसिक सीमा *शाइज़ोन्यूरा गोंडवानेन्सिस* संस्तर के ऊपर दूसरे और तीसरे परागाणविक मंडलों के मध्य स्थित है। वनस्पतिक परिवर्तन *क्रीसेन्टीपोलिनाइटिस* की संख्या में कमी तथा धारीदार विहीन समूह में वृद्धि प्रदर्शित करता है। ट्रायॅसिक अवसादन का प्रारम्भ खाकी रंग की शैलों से जाना जा सकता है जो कि इसी क्षेत्र के पंचेत अवसादों से तुलनीय है। इस प्रकार ऐसा पाया गया है कि अनंतिम परमियन से प्रारम्भिक ट्रायॅसिक तक परागाणुवनस्पतिजात में परिवर्तन शनैः शनैः हुआ है। तटापानी-रामकोला द्रोणी में इस क्षेत्र में परमियन और ट्रायॅसिक कल्पों के बीच निरन्तर क्रमबद्ध अवसादन हुआ है।

THE Permian-Triassic boundary in the Indian continental deposits has been traced *vis-à-vis* the transition between Raniganj and Panchet Formations of the Gondwana Sequence. The contact between the Raniganj and Panchet sediments is not well defined. At most of the places, the boundary between these two formations is difficult to mark as the succession is mostly gradational and devoid of diagnostic fossil

content. This problem has drawn the attention of many workers in the past and also forms the main theme of the present communication.

Palynology is best suited for biostratigraphic studies of the Gondwana sediments because of the predominantly continental nature of deposits. On the basis of palynological studies, delineation of Permian-Triassic boundary from different Indian Gondwana basins have been attempted by several workers (Bharadwaj, 1970; Tiwari, 1979; Tiwari & Singh, 1982, 1983, 1986; Tiwari & Tripathi, 1992; Srivastava & Jha, 1990, 1995; Jha & Srivastava, 1996; Ram-Awatar, 1996; Srivastava & Bhattacharyya, 1996). However, most of the above studies are based on bore-core samples and only a few attempts have been made to demarcate the actual boundary in outcrop sections (Banerji & Maheshwari, 1974; Bharadwaj *et al.*, 1979; Kumar, 1996; Pal *et al.*, 1996). A continuous sequence of Raniganj-Panchet sediments is exposed in the Iria Nala and it is thus possible to observe the changing palynofloral pattern across Raniganj-Panchet transition and thereby demarcate the Permian-Triassic boundary in this section.

Tatapani-Ramkola Coalfield—The Tatapani-Ramkola Coalfield is considered to be the western extension of the Damodar-Koel Valley Basin. It is a composite basin, comprising a northern strip of coal-bearing rocks referred to as Tatapani Coalfield and a southern one called the Ramkola Coalfield. The basin is situated between latitudes 23°30'-23°55'N and longitudes 83°00'-83°40'E (Raja Rao, 1983). Not much is known about the stratigraphy, structure, tectonic framework and subsurface succession of rocks as detailed mapping is still under progress. Palaeobotanical knowledge is limited only to a few megafossils described from the Raniganj and Panchet Formations (Bose *et al.*, 1977).

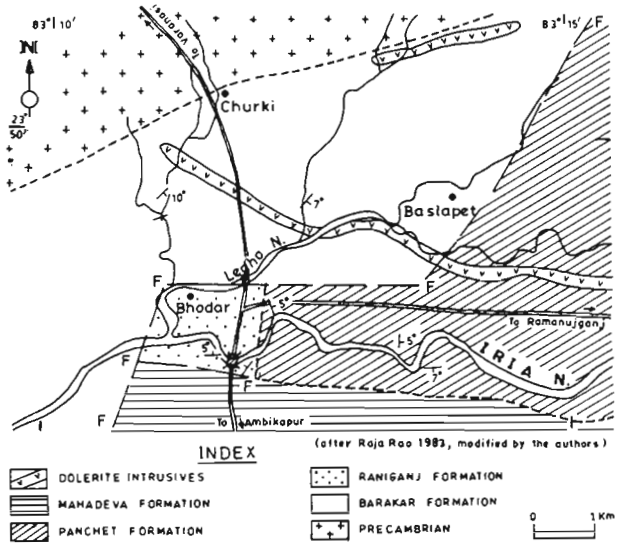
The coalfield is characterised mostly by a plain area with some undulations at places. The central part is occupied by a wide expanse of Supra Panchet sediments, which shows uneven topography and forms ridges and low hills. The Gondwana sediments are preserved in the form of an inlier flanked on either sides by hillocks of Precambrian rocks. The Gondwana sequence is represented by the sediments of Talchir, Barakar, Barren Measures, Raniganj, Panchet and Mahadeva Formations (Table 1).

Table 1—Generalised stratigraphic sequence in Tatapani-Ramkola Coalfield (modified after Raja Rao, 1993)

AGE	FORMATION	LITHOLOGY
Recent	Alluvium	
Cretaceous?	Basic Intrusives	Dolerite dykes
Upper Triassic ?	Mahadeva	Thick, cross-bedded coarse-grained ferruginous sandstones
Lower	Panchet	Yellowish, fine-grained sand stone with alternating red and Triassic green silt-stones, shales and clays
Upper Permian	Raniganj	Micaceous fine-grained ripple laminated sandstones, grey and carbonaceous shales and shaly coal bands
Middle Permian	Barren Measures	Ironstone shales showing box structure, fine-grained sandstone, shales and argillaceous sandstones
Lower Permian	Barakar	Medium to coarse-grained pebbly arkosic sandstone, grey and carbonaceous shales and coal seams
Lower Permian	Talchir	Diamictite, khaki-green needle shales, siltstone, fine-grained sandstone and varves
	----------Unconformity----------	
Archean		Granites, gneisses, mica and talc schists, phyllites and quartz veins

Iria Nala section—An excellent outcrop of Raniganj - Panchet sediments can be observed on the right bank of Iria Nala, 5 km before Wadrafnagar, below the road bridge on Varanasi-Ambikapur road (Text-figure 1). The area east of Bhodar Village, between Ledho and Iria nalas, was earlier shown to have sediments belonging to the Barakar Formation (see the geological map of Tatapani-Ramkola Coalfield in Raja Rao, 1983). However, during field investigations we observed that no Barakar sediments exist in this section. In fact, these sediments rather have closer affinity with the Panchet sediments. Therefore, these sediments are placed in the Panchet Formation instead of the Barakar Formation (Text-figure 1). Palynological results bear testimony to the above observations.

The basal portion of the section consists of Raniganj sediments and begins with a dark grey clayey shale, followed by interbedded sandstone and shale units. The sandstone is characterised by a pale white colour, micaceous content, fine-grain size and well-marked ripple laminations with thin intercalations of grey shales. One such shale bed contains abundant *Schizoneura gondwanensis* im-



Text-figure 1—Geological map of a part of Tatapani-Ramkola Coalfield, Madhya Pradesh, India (modified after Raja Rao, 1983).

pressions. Above the *Schizoneura* bed a sandstone-shale sequence is again exposed. This sandstone is dirty white in colour and slightly coarser in nature than the underlying sandstone. It also has comparatively less mica content. The overlying shale beds are khaki-green in colour and compare closely with the Panchet shales exposed in the type area. Further upstream coarse-grained ferruginous sandstones are exposed and thereafter the outcrops are covered with alluvium. The details of the samples investigated are given in Table 2.

Table 2—List of samples investigated from Iria Nala section in Tatapani- Ramkola Coalfield

Sample No.	Lithology	Palynomorphs
INP-1	Limonitic micaceous shale	-
INP-2	Khaki micaceous shale	-
INP-3	Khaki-grey shale	+
INP-4	Grey clayey shale	-
INP-5	Khaki shale	-
INP-6	Khaki-grey shale	+
INP-7	Grey shale	+
INP-8	Grey clayey shale	+

Present (+); Absent (-)

PALYNOZONES

The palynoflora comprising 42 genera, in general, shows the dominance of striate disaccate pollen amongst which *Faunipollenites* and *Striatopodocarpites* form the dominant association. However, the quantitative association of other taxa differentiates three palynozones. Along with these, the first appearance of some important pollen and spores also characterise the assemblages (Text-figure 2).

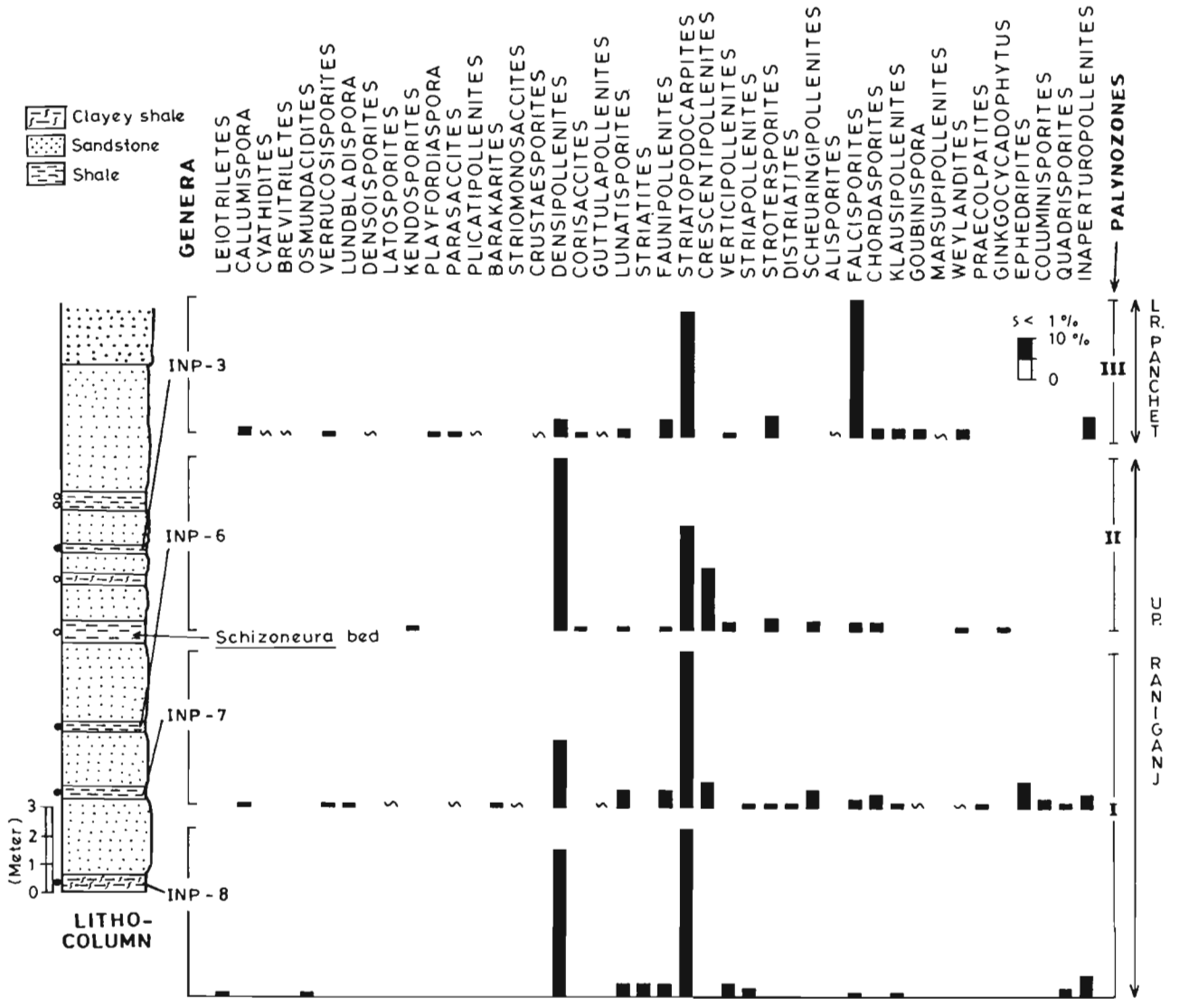
Palynozone I—The grey clayey-shales present at the basal part of the sequence contain 16 - 35 per cent *Densipollenites* in addition to equally significant numbers of striate disaccate pollen. *Densipollenites magnicorpus* is characteristic of this assemblage. *Praecolpatites sinuosus* and *Columinisporites* are restricted to this palynozone, whereas, *Lundbladispora, Falcisporites, Chordasporites, Klausipollenites* and *Goubinispora* make their first appearance in the sequence.

Palynozone II—This palynozone is marked by the subdominance of *Crescentipollenites* (15%), mainly represented by *Crescentipollenites fuscus. Densipollenites* attains maximum percentage (41%), while striate pollen are mainly represented by *Striatopodocarpites* (25%). *Kendosporites, Corisaccites, Lunatisporites, Falcisporites, Chordasporites* and *Weylandites* are present in rare amount.

Palynozone III—The total percentage of striate disaccate pollen remains similar to Palynozone II, but the percentage of non-striate disaccate pollen rises almost equal to that of striate disaccates. *Falcisporites* alone rises to 33 per cent. This palynozone is further characterised by the presence of *Playfordiaspora, Densoisporites, Alisporites, Chordasporites, Klausipollenites, Goubinispora, Callumispora, Cyathidites* and *Verrucosisporites,* though they occur in rare amount.

DISCUSSION

Palynozone I (*Densipollenites magnicorpus* Zone) of the Iria Nala section compares well with Assemblage III (Tiwari & Singh, 1982) and Assemblage R-1A (Tiwari & Singh, 1986) of Raniganj Coalfield. Similar palynoassemblage has been described from the Talcher Coalfield (Tiwari *et al.*, 1991). In Son Valley, similar palynoassemblages have been recorded from the Gopat River section (Maheshwari, 1967) and Nidpur beds (Tiwari & Ram-Awatar, 1990). Palynozone I also compares with the



Text-figure 2—Showing quantitative distribution of various taxa in Iria Nala, Tatapani-Ramkola Coalfield, Madhya Pradesh, India.

palynoflora described from the Bijori Formation of Satpura Basin (Bharadwaj *et al.*,1978), Wardha Valley (Palynozone 1, Srivastava & Bhattacharyya, 1996) and Mailaram and Budharam areas of Godavari Graben (Assemblage III, Srivastava & Jha, 1990 and Palynozone 8, Srivastava & Jha, 1995).

Palynozone II (*Crescentipollenites fuscus* Zone) of the present investigation is comparable to similar assemblages reported from the Raniganj Coalfield (Assemblage III, Bharadwaj & Tiwari, 1977; Assemblage IV, Tiwari & Singh, 1982; Assemblage R-1A, Tiwari & Singh, 1986), Talcher Coalfield (Tiwari *et al.*, 1991), Nidpur beds of Son Valley (Tiwari & Ram-Awatar, 1990), Bijori sediments of Satpura Basin (Sarate & Patil, 1994), Wardha Valley (Palynozone 2, Srivastava & Bhattacharyya, 1996) and from Godavari Graben (Assemblage III, Srivastava & Jha, 1990; Palynozone 9, Srivastava & Jha, 1995). Palynozones I and II represent the younger assemblages of the Raniganj palynozones (Late Permian).

Palynozone III (*Falcisporites stabilis* Zone) is representative of the oldest assemblage of Panchet Formation in Tatapani-Ramkola Coalfield. Similar palynoassemblages have been reported from Bazargaon area of Wardha Valley (Palynozone 3, Srivastava & Bhattacharyya, 1996) and Tamia Ghat section in Satpura Basin (Palynoassemblage B, Kumar, 1996). The present palynozone differs from the *Striatopodocarpites-Klausipollenites* assemblage (P-1A Assemblage, Tiwari & Singh, 1986) from Raniganj Coalfield, and the assemblage described from the Sukri River, Auranga Coalfield (Banerji & Maheshwari, 1975) in having a dominance of *Falcisporites* and relatively lesser amounts of zonate triletes. Palynozone III of the Iria Nala also differs from the *Lunatisporites -Verrucosisporites* assemblage of Mailaram area (Srivastava & Jha, 1990) and *Densoisporites-Lundbladispora* assemblage of Budharam area (Srivastava & Jha, 1995), Godavari Graben, in having dominance of *Falcisporites* and rare percentage of trilete spores.

The Permian-Triassic boundary is located somewhere above the *Schizoneura gondwanensis* bed between palynozones II and III. The transition is marked by the decline in the frequency of *Crescentipollenites* followed with the increase in frequency of non-striate pollen represented by *Falcisporites*. The beds below the boundary are marked by the presence of carbonaceous matter indicative of upper part of Raniganj Formation (Late Permian), while a marked change in lithology to khaki-green shales points to the beginning of Panchet sedimentation (Early Triassic). Similar lithological changes have also been reported from other Indian Gondwana basins (Gee, 1932; Fox, 1934; Bharadwaj *et al.*, 1978, 1979). Striate disaccate pollen with typical Raniganj forms transgress the lithological boundary. Although, striate disaccates retain their dominance, it is the other constituents of the mioflora, as well as the rare forms signifying the younger aspect which reflect the basic change between Permian and Triassic miofloras. The continuously changing pattern of the mioflora without a sudden break, the conformable sequence of Raniganj and Panchet sediments with gradual change in lithology and the incoming of characteristic Triassic miospores, suggest that the Permian-Triassic transition is represented by a 'zone' rather than a 'sharp-line' in the Iria Nala section in Tatapani-Ramkola Coalfield.

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