shows an abundance of *Densipollenites* and *Striatopodocarpites*, is akin to Assemblage-RI-A (ref. 11), and the youngest assemblage in Patrapara, Assemblage-IV, is comparable to the Assemblage-RI-B (ref. 11), which represents *Striatopodocarpites* and *Crescentipollenites* prominence.

Besides the above-described quantitative structure, some forms which are qualitatively good age indicators are also present in these assemblages (Figure 3,*b–o*), viz. *Microfoveolatispora*, *Didecitriletes*, *Gondisporites*, *Densipollenites* spp., *Guttulapollenites*, *Mamealetus*, cf. *Playfordiaspora*, *Chordasporites* Klaus 1960 cf. *Lundbladispora*, cf. *Lunatisporites* and *Klausipollenites* Jansonius 1962. Cumulatively they confirm a late Late Permian age for these beds having equatability with Raniganj Formation.

Blanford *et al.*[2] recognized Talchir, Damudas and Mahadevas in the Talcher coal field. Their Damuda series included Barakar coal-measures which were supposed to be underlain by the strata referred to as Mahadevas, having a large stratigraphic break between the two[3]. Recently, Raja Rao[1] classified the lithostratigraphic sequence in Talcher coal field into Talchir, Karharbari and Barakar formations as Lower Permian and Kamthi Formation as Upper Permian–Triassic. The presence of Upper Permian Raniganj sequence in the area was also suggested by the megafossil findings of Subramanian (in Raja Rao[1]). The sediments of Kamthi Formation include fine- to medium-grained sandstone, carbonaceous shale, coal bands, greenish sandstone, pink clays and pebbly sandstone at the top (total thickness 250 m). The section exposed at Patrapara fits in the circumscription of the coal–shale–clay package of Kamthi Formation given by Raja Rao[1], although in the map he included this part of the area in the Barakar Formation.

In addition to the Patrapara section, a preliminary palynological study of the uppermost coal–shale sequence in bore hole TCW-6 drilled in the central part of the field between Kosala and Kukurpeta reveals a correlation between the Patrapara section and the depth levels 290.92 m and 303.72 m. The palynozone recognized at the latter depths contains, besides striate pollen, *Klausipollenites*, *Crescentipollenites* and *Densipollenites* in frequency comparable with that in the Patrapara assemblages. Additionally, the most revealing support for a Late Permian age of the TCW-6 palynozone under consideration is the presence of the taxa *Guttulapollenites*, *Satsangisaccites*, *Chordasporites*, *Alisporites* and *Osmundacidites*. In view of this the presence of latest Permian sediments can be envisaged in a wider extent of the western part of the Talcher coal field.

In the Patrapara section the coal–shale–clay beds—having a latest Permian age affinity—and the gritty coarse-grained sandstone resting on its highly denuded surface suggest a considerable gap between the coal-bearing strata and the Mahadevas. The presence of Lower Triassic Panchet Formation is indicated in bore hole TCW-6 where a thick profile of green and chocolate facies overlies the coal–shale facies; the latter contains Upper Raniganj palynoflora. Thus the presence of Raniganj, Panchet and Mahadeva formations *sensu* Subramanian and Chakraborty and Das and Banerjee (in Raja Rao[1])—combinedly designated as Kamthi Formation by Raja Rao[1]—is corroborated by identifying the uppermost Permian sequence on the basis of palynology.

The western part of the Talcher coal field is thus a highly promising area for exploring the subsurface Upper Permian coals.


1. Raja Rao, C. S., *Bull. Geol. Surv. India Ser.* A, 1982, **45**, 41.
2. Blanford, W. T., Blanford, H. T. and Theobald, W., *Mem. Geol. Surv. India*, 1856, **1**, 33.
3. Fox, C. S., *Mem. Geol. Surv. India*, 1934, **58**, 162.
4. Venkatachala, B. S. and Tiwari, R. S., *Palaeobotanist*, 1988, **36**, 24.
5. Tiwari, R. S., *Geophytology*, 1974, **4**, 111.
6. Rana, V. and Tiwari, R. S., *Geophytology*, 1980, **10**, 108.
7. Tiwari, R. S. and Rana, V., in *Proc. Symp. Evolution. Biostratigr* (eds. Sharma, A. K. *et al.*), A. K. Ghosh Commemoration Volume, Today and Tomorrow's Printers and Publishers, New Delhi, 1984, p. 425.
8. Tiwari, R. S., Srivastava, S. C., Tripathi, A. and Singh, V., *Geophytology*, 1981, **11**, 220.
9. Tiwari, R. S. and Ram-Awatar, *Palaeobotanist*, 1989, **37**, 94.
10. Srivastava, S. C. and Jha, N., *Palaeobotanist*, 1989, **37**, 199.
11. Tiwari, R. S. and Singh, V., *Bull. Geol. Min. Metall. Soc. India*, 1986, **54**, 256.
12. Tiwari, R. S. and Tripathi, A., *Palaeobotanist*, 1988, **36**, 87.


ACKNOWLEDGEMENTS. We are grateful to the Director, Coal Division, Geological Survey of India, Calcutta, for providing support in various ways to our efforts for palynodating of Gondwana coals. Thanks are also due to the Director, GSI, Coal-Division-II, Sri S. K. Sahay, and the Senior Geologist of the Talcher Coalfield, Sri P. K. Mohanty, for their kind help and keen interest in the collection of samples.

15 October 1990; revised accepted 18 February 1991

# The crystal and molecular structure of putrescine–DL-glutamic acid complex

**S. Ramaswamy and M. R. N. Murthy**
Molecular Biophysics Unit, Indian Institute of Science, Bangalore 560 012

**The polyamines spermine, spermidine, putrescine, cadaverine, etc. have been implicated in a variety of cellular functions. However, details of their mode of interaction with other ubiquitous biomolecules is not known. We have solved a few structures of polyamine–amino acid complexes to understand the nature and mode of their interactions. Here we report the structure of a complex**