1. Singh, J. S. and Singh, S. P., *Forests of the Himalaya*, Gyanodaya Prakashan, Nainital, 1992.
2. Rai, S. C., Sharma, E. and Sundriyal, R. C., *Environ. Conserv.*, 1994, **21**, 30–34.
3. Singh, J. S., Pandey, U. and Tiwari, A. K., *Ambio*, 1984, **13**, 80–87.
4. Singh, J. S., Tiwari, A. K. and Saxena, A. K., *Environ. Conserv.*, 1985, **12**, 67–69.
5. Singh, J. S., Singh, L. and Pandey, C. B., *Curr. Sci.*, 1991, **61**, 477–479.
6. Houghton, R. A. and Hackler, J. L., *Global Change Biol.*, 1999, **5**, 481–492.
7. Houghton, R. A., Hobbie, J. E., Melillo, J. M., Moore, B., Peterson, B. J., Shaver, G. R. and Woodwell, G. M., *Ecol. Monogr.*, 1983, **53**, 235–262.
8. Lugo, A. E., Sanchez, M. J. and Brown, S., *Plant Soil*, 1986, **96**, 185–196.
9. Dixon, R. K., Brown, S., Houghton, R. A., Soloman, A. M., Trexler, M. C. and Wisniewski, J., *Science*, 1994, **263**, 185–190.
10. De Jong, B. H. J. *et al.*, *Environ. Manage.*, 1999, **23**, 373–385.
11. Cook, A. G., Janetos, A. C. and Hinds, W. T., *Environ. Conserv.*, 1990, **17**, 201–212.
12. Schimel, D. S., *Global Change Biol.*, 1995, **1**, 77–91.
13. Cairns, M., Barker, J., Shea, R. and Haggerty, P., *Interciencia*, 1996, **21**, 216–223.
14. Sharma, E., Sundriyal, R. C., Rai, S. C., Bhatt, Y. K., Rai, L. K., Sharma, R. and Rai, Y. K., *Integrated Watershed Management*, Gyanodaya Prakashan, Nainital, 1992, p. 120.
15. Sundriyal, R. C., Sharma, E., Rai, L. K. and Rai, S. C., *Vegetatio*, 1994, **113**, 53–63.
16. Sharma, R., PhD thesis, HNB Garhwal University, Srinagar, 1995.
17. Sundrial, R. C. and Sharma, E., *For. Ecol. Manage.*, 1996, **81**, 113–134.
18. SYSTAT, Statistic, SYSTAT 6.0 for Windows, SPSS, Chicago, 1996.
19. Detwiler, R. P. and Hall, C. A. S., *Science*, 1988, **239**, 42–47.
20. Srivastava, S. C. and Singh, J. S., *Biol. Fertil. Soils*, 1989, **8**, 342–348.

ACKNOWLEDGEMENTS. We thank the Director, G.B. Pant Institute of Himalayan Environment and Development for providing necessary facilities and staff of the Sikkim unit for help in the laboratory and field. We acknowledge financial support from Council of Scientific and Industrial Research, New Delhi.

Received 22 September 2003; revised accepted 13 February 2004

S. C. RAI*
PURNIMA SHARMA

G.B. Pant Institute of Himalayan Environment and Development,
North-East Unit,
Vivek Vihar,
Itanagar 791 113, India
**For correspondence.*
e-mail: raisc1958@rediffmail.com

Palynological assemblage from the Anjar intertrappeans, Kutch district, Gujarat: Age implications

In the recent past, the Anjar intertrappean beds have been considered important Deccan-volcano-sedimentaries to document Cretaceous–Tertiary boundary events[1–4]. After the discovery of Ir anomalies in this intertrappean section, a greater thrust was laid on documenting palynological evidences in support of Cretaceous–Tertiary boundary events. In view of this, extensive survey was undertaken to explore palynological data from the Anjar intertrappeans of Kutch district, Gujarat. This is a record of the palynological assemblage from this intertrappean section.

The pollen- and spore-yielding Anjar intertrappean beds are exposed near Viri village about 3.5 km south of Anjar town, Kutch district. These intertrappeans lie between III and IV basalt flows in the study area and are lithologically made up of carbonaceous shales, marl, limestones and a thin bed of gypsum. The limestones are mostly cherty in nature (Figure 1).

The Deccan traps cover substantial areas in Madhya Pradesh, Maharashtra, Karnataka, Gujarat, Andhra Pradesh and parts of Uttar Pradesh and Rajasthan. Palaeobiological investigations of the intertrappeans in the above areas have been extensively carried out by a number of workers[1,3,5,6]. The palynological microbiota has already been recorded from infra- and intertrappean beds of Jabalpur region, Madhya Pradesh[7–10] and Lalitpur, Uttar Pradesh[6]. However, many animal fossils[1,3,11–14], and anomalously high concentration of iridium[2,15] have been documented from the Anjar intertrappeans. The palynological assemblage recovered in the present study, though quantitatively poor, is a detailed documentation of palynoflora from the Anjar intertrappeans. The present miofloral assemblage is made up of *Gabonisporis bacaricumulus*, *G. vigourouxii*, *Gabonisporis* sp., *Proxapertites granulatus*, *Proxapertites* sp., *Palmidites* sp., *Racemonocolpites maximus*, *Triorites* sp., *Proteacidites reticulatus, Proteacidites* sp. cf. *P. miniporatus*, *Aquilapollenites indicus* and some Early Cretaceous reworked palynomorphs, viz. *Crybelosporites striatus*, *Aequitriaradiates ornatus* and fungal spores. Besides the above palynobiota, a rich assemblage of freshwater fauna comprising gastropods and ostracods has also been recovered during the present investigation.

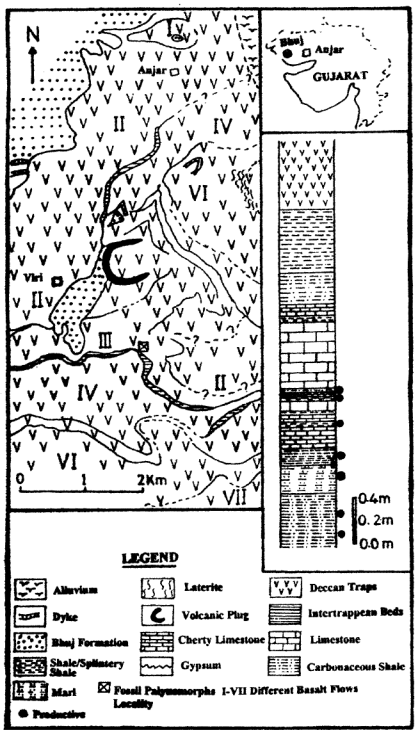

Figure 1. Geological map of Anjar area and lithostratigraphic section at the collecting locality (map after Ghevariya[1]).

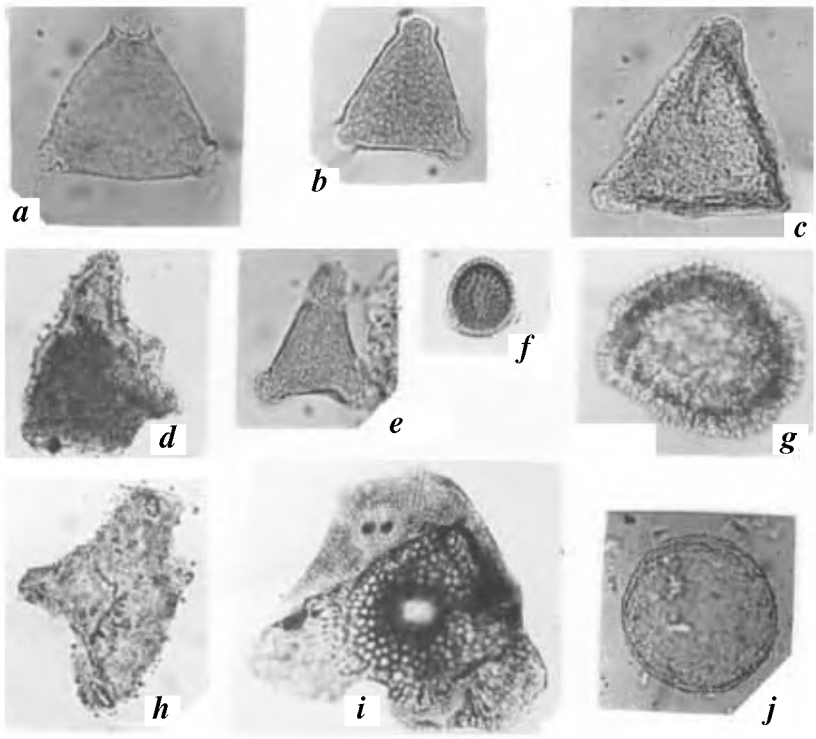

Figure 2. ***a***, ***b***, *Proteacidites reticulatus*; ***c***, *Proteacidites* sp. cf. *miniporatus*; ***d***, ***h***, *Aquilapollenites indicus*; ***e***, *Triorites* sp.; ***f***, *Gabonisporis* sp.; ***g***, *Gabonisporis bacaricumulus*; ***i***, Fungal spore and ***j***, *Proxapertites granulatus* × 500.

The characteristic palynofossils recorded during the present study from the Anjar intertrappeans are shown in Figure 2. The age diagnostic palynotaxa of the present assemblage such as *G. bacaricumulus*, is considered to have disappeared in Maestrichtian time in India. *Proxapertites* and *Racemonocolpites*, on the other hand, though dominant taxa in Palaeocene–Eocene times, do extend to Maestrichtian as well. *Aquilapollenites* also starts appearing from Turonian and extends up to Tertiary. Pollen grains of *Proteacidites* range from Late Cretaceous to Tertiary. Hence there is no index palynotaxon of Palaeocene time interval in the present assemblage, thereby restricting the age of Anjar intertrappean beds to the Maestrichtian time interval.

1. Ghevariya, Z. G., *Curr. Sci.*, 1988, **57**, 248–251.
2. Bhandari, N., Shukla, P. N., Ghevariya, Z. G. and Sundaram, S. M., *Geophys. Res. Lett.*, 1995, **22**, 433–436.
3. Bajpai, S. and Prasad, G. V. R., *J. Geol. Soc. London*, 2000, **157**, 157–260.
4. Tandon, S. K., *Sediment. Geol.*, 2002, **147**, 177–192.
5. Prasad, G. V. R., Khajuria, C. K. and Manhas, B. K., *Hist. Biol.*, 1995, **9**, 319–334.
6. Singh, R. S. and Kar, R., *Gondwana Geol. Mag.*, 2003, **6**, 217–223.
7. Dogra, N. N., Singh, R. Y. and Kulshreshtha, S. K., *Curr. Sci.*, 1988, **57**, 954–956.
8. Dogra, N. N., Singh, R. Y. and Kulshreshtha, S. K., *Cretaceous Res.*, 1994, **15**, 205–215.
9. Dogra, N. N. and Singh, R. Y., Contrib. XV Indian Colloquium on Micropalaeontology and Stratigraphy, Dehradun, 1996, pp. 601–605.
10. Sahni, A., Venkatachal, B. S., Kar, R. K., Rajanikanth, A., Prasad, G. V. R. and Singh, R. Y., *Mem. Geol. Soc. India*, 1996, **37**, 267–283.
11. Bajpai, S., Sahni, A. and Srinivasan, S., *Curr. Sci.*, 1993, **64**, 42–45.
12. Bajpai, S., Sahni, A., Jolly, A. and Srinivasan, S., Seminar Cum Workshop, IGCP 216 and 245, Chandigarh, 1990, pp. 101–105.
13. Ghevariya, Z. G. and Srikarni, C., Seminar Cum Workshop, IGCP 216 and 245, Chandigarh, 1990, pp. 106–109.
14. Bajpai, S. and Srinivasan, S., Contrib. XV Indian Colloquium on Micropalaeontology and Stratigraphy, Dehradun, 1996, pp. 471–473.
15. Bhandari, N., Shukla, P. N., Ghevariya, Z. G. and Sundaram, S. M., *Geol. Soc. Am.*, 1996, **307**, 417–424.

ACKNOWLEDGEMENTS. N.N.D. is grateful to the Department of Science and Technology, New Delhi for financial assistance. We are also thankful to Mr Yogesh Kumar, Department of Earth Sciences, Kurukshetra University, Kurukshetra for help during sample collection.

Received 15 December 2003; revised accepted 15 March 2004

N. N. DOGRA[1,*]
Y. RAGHUMANI SINGH[2]
R. Y. SINGH[3]

[1]*Department of Earth Sciences, Kurukshetra University, Kurukshetra 136 119, India*
[2]*P.G. Department of Geology, University of Jammu, Jammu Tawi 180 006, India*
[3]*Centre of Advanced Study in Geology, Panjab University, Chandigarh 160 014, India*
**For correspondence.*