or the effect of tetracycline treatment on the establishment of filarial infection in the mammalian hosts[5,6]. The current study was carried out to see whether tetracycline treatment, if carried out in animals harbouring a patent infection, interferes with the subsequent development of mf to L_3 stage in the vector mosquito fed on the blood of these treated animals as well as on the existing microfilaraemia in the peripheral blood of the treated mastomys. Tetracycline, being an antibiotic, was initially tried for five days, but this regimen did not show any effect either on existing microfilaraemia in vertebrate host or on recovery of L_3 from mosquitoes. On the other hand, a longer treatment for six weeks showed miraculous effect on recovery of L_3 from mosquitoes. This treatment also demonstrated lowering of microfilaraemia in vertebrate host. The findings thus reveal that a longer treatment of host with tetracycline is required to obtain antifilarial efficacy. Almost similar findings have been reported by Hoerauf *et al.*[6] who exhibited reduced survival, size and fertility of adult worms of *L. sigmodontis* obtained from jirds treated with tetracycline for 28 days. These worms contained neither bacterium as detected by microscopy nor amplifiable Wolbachia DNA. Their findings thus indicate that the arrested development of filarial parasite after treatment with tetracycline in our study could be due to clearance of Wolbachia. The bacteriostatic activity of tetracycline is known to be related to its accumulation by both active[12,13] and passive[13] transport mechanisms in susceptible species of bacteria and inhibit protein synthesis in prokaryotes by interacting with 16S ribosomal RNA[14]. The present study also revealed that prolonged treatment of filarial host with tetracycline adversely affected the development of ingested microfilariae to infective stage in mosquitoes, without affecting their mf ingestion. Smith and Rajan[7], working with *B. malayi*, *B. pahangi* and *Dirofilaria immitis* in a serum-free *in vitro* system, observed that tetracycline was capable of inhibiting molting of L_3 to L_4 within a dosage range similar to that reported for susceptible rickettsial organisms. Bosshardt *et al.*[5], working with *B. pahangi*, observed low microfilaraemia in jirds treated with tetracycline between 27 and 54 days of infection. It is difficult to explain the exact mechanism for arrested development of mf to L_3 stage in vector mosquitoes. Findings conclude that prolonged treatment with tetracycline provides a good tool to check transmission of filariasis from one host to another, by restricting the larval development in vector mosquitoes as well as by lowering the existing mf in the peripheral blood of the vertebrate host. Nevertheless, reported adverse effects of tetracycline[15,16] associated with possible development of drug resistance limit its frequent use in filaria endemic areas. Therefore, synthesis of a molecule having similar potential with no toxicity would be of use in controlling filarial infection.

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Normapolles group of pollen grains in the Indian Palaeogene palynoassemblage from Ganga Basin, India

Normapolles group of pollen grains with specialized morphocharacteristics of evolutionary significance is a well-recognized group for its restricted stratigraphic occurrence during Upper Cretaceous to Early Tertiary periods[1–3] and also restricted phytogeographical distribution in west Siberia across Europe to eastern North America.

The restricted distribution of the group during late Cretaceous to Early Tertiary was considered to recognize a specific palaeophytoprovince, viz. Euramerian 'Normapolles province' by Zaklinskaya[4]. Three more palaeophytoprovinces have been recognized on the basis of palynological records at this geological period in restricted geographical areas on the globe (Figure 1). The characteristic palynomorphs and the corresponding late Cretaceous–Early Tertiary phytogeographic distribution identified are: Euramerian 'Normapolles' palaeophytoprovince, Beringian '*Aquilapollenites*' palaeophytoprovince, Central Atlantic '*Proxapertites*–Proteaceae' palaeophytoprovince and Antarctic–Australian 'Nothofagidites–Proteaceae' palaeophytoprovince. Srivastava[5,6] however, named the Central Atlantic '*Proxapertites*–Proteaceae' palaeophytoprovince as *Constantinisporis* phytogeoprovince (Figure 1).

Later studies have revealed that the representative palynomorphs of the palaeophytoprovinces I and II occur in palaeophytoprovinces III and IV in the same geological age. From outside the 'Normapolles' province, Normapolles group of pollen grains are recorded in the Upper Cretaceous sediments of China[7–9], Australia[10] and India[11–15]. Nandi[11,12] recorded Normapolles pollen grains in recognizable diversity of more than 20 genera from the Upper Cretaceous sediments of Meghalaya, eastern India. Two Normapolles taxa have been encountered in the lower Senonian strata of Cauvery Basin[13]. Kar and Singh[14] also reported a few species of Normapolles from Late Cretaceous of Meghalaya. Kar[15] described a new genus *Keralaepollis* from the Miocene sediments of Kerala comparable to Normapolles group (Figure 1).

Palaeogene record of Normapolles from outside the 'Normapolles' province comes only from North Western China[9]. There is so far no Palaeogene record of Normapolles from the Indian subcontinent.

A significant number of pollen grains assignable to various taxa of Normapolles group have been encountered in the Early Tertiary palynoassemblage from Ganga Basin, located in the northern part of India within longitude 77°E to 88°E and latitude 24°N to 30°N. This is the first record of Normapolles in the Early Tertiary sediments from the Indian subcontinent (Figure 1). The palynomorphs are recovered from subsurface sediments of one of the boreholes of Ganga Basin, viz. Gandak (Figure 2) drilled by Oil and Natural Gas Commission, Dehradun[16]. The total depth of this borehole is 5314 m, of which 5314–4797 m represents metasediment, 4797–4070 m of Vindhyan age and 4070–3620 m is identified as volcanic and pyroclastics; Tertiary strata extends up to 445 m (ref. 16). Available good samples in the core library of ONGC were collected for palynological study. Out of 62 samples collected between the depths 4007 and 2740 m, the samples from the volcanic and pyroclastic sediments (4007–3634 m) have been found barren of palynomorphs. The samples between 3624–2740 m have yielded a number of important index taxa of Lower Tertiary age[17–19], viz. *Dandotiaspora plicata*, *Proxapertites cursus*, *P. microreticulatus*, *Palmaepollenites eocenicus*, *Matanomadhiasulcites* sp., *Dicolpopollis* sp., *Minutitricolporites minutus*, *Lakiapollis ovatus*, *Striacolporites striatus*, *Psilodiporites hammenii* and *P. erdtmanii*. At least six different taxa

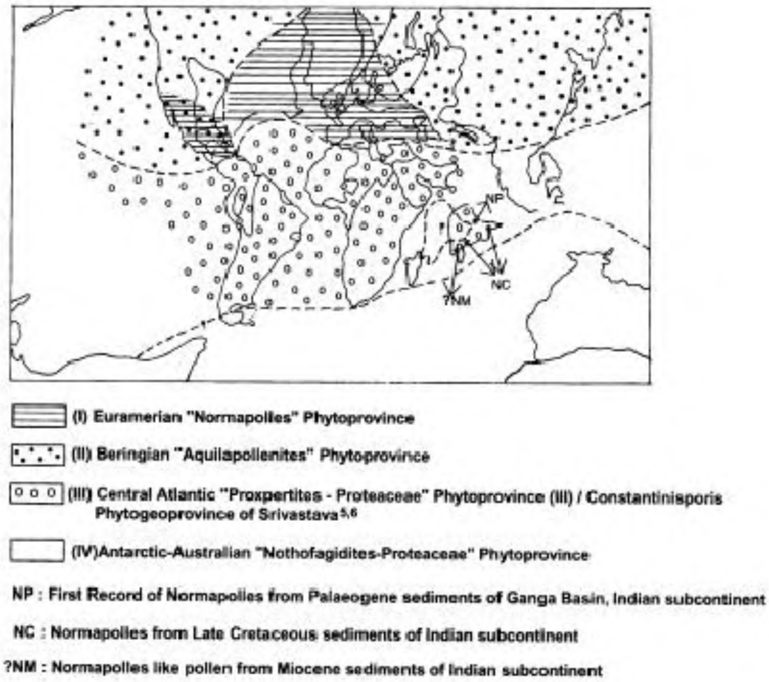

Figure 1. Palaeogeographic map showing distribution of palynomorphs in different phytoprovinces during Late Cretaceous–Early Tertiary periods. (Modified after Zaklinskaya[4]; Srivastava[5,6] and Smith and Briden[25].)

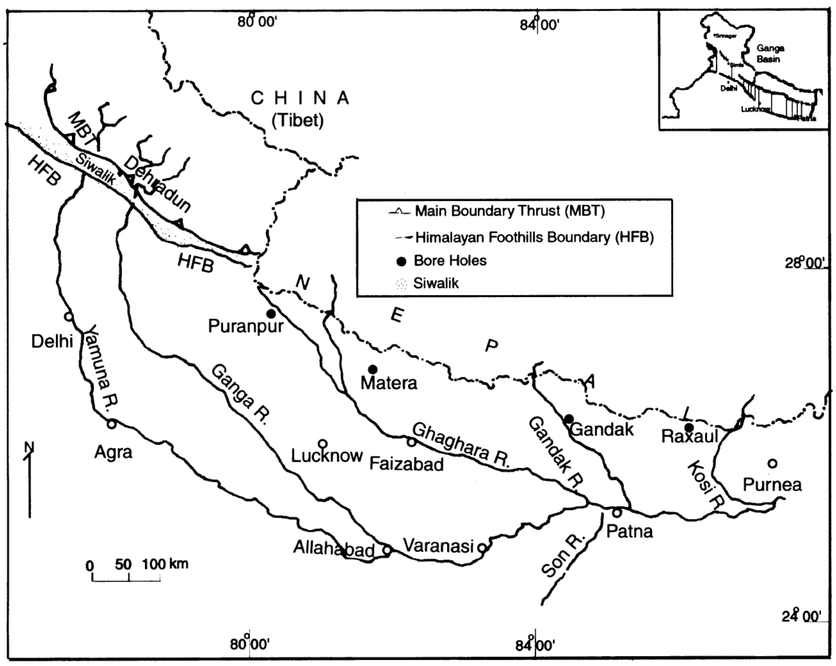

Figure 2. Map of Ganga Basin showing bore hole positions. (Modified after Raiverman[16].)

of Normapolles group of pollen grains have been identified in the samples between depths 3624 and 3001 m. The Normapolles pollen grains identified are *Choanopollenites consanguieus*, *Extremipollis versatalis*, *Interporopollenites* sp., *Oculopollis lapillus*, *Semioculopollis verrucosa* and *Trudopollis pertrudens* (Figure 3 *a–f*). The germinal apertures of the pollen grains have complex morphology. The characteristic features of the taxa are described. In *Choanopollenites*, exogerminals are vertical slit shaped and endogerminals equatorial slit shaped, no praevestibulum present in exogerminal, ektexine significantly thicker than endexine. In *Extremipollis*, endogerminals show a deep v-shaped cuneus, ektexine conspicuously thickened and protruding adjacent to the pore canal, endexine with only one distinct layer or lamellae. In *Interporopollenites*, wall is thick, no equatorial constriction, interloculum present. In *Oculopollis*, pores are present at equator with oculi forming equatorial relief. In *Semioculopollis*, exogerminals are vertical slit shaped, endogerminals somewhat circular to oval, oculi isolated, not connected over one pole. In *Trudopollis*, endogerminal openings are much less than diameter of vestibulum, exogerminals annulate and swollen, interloculum usually present.

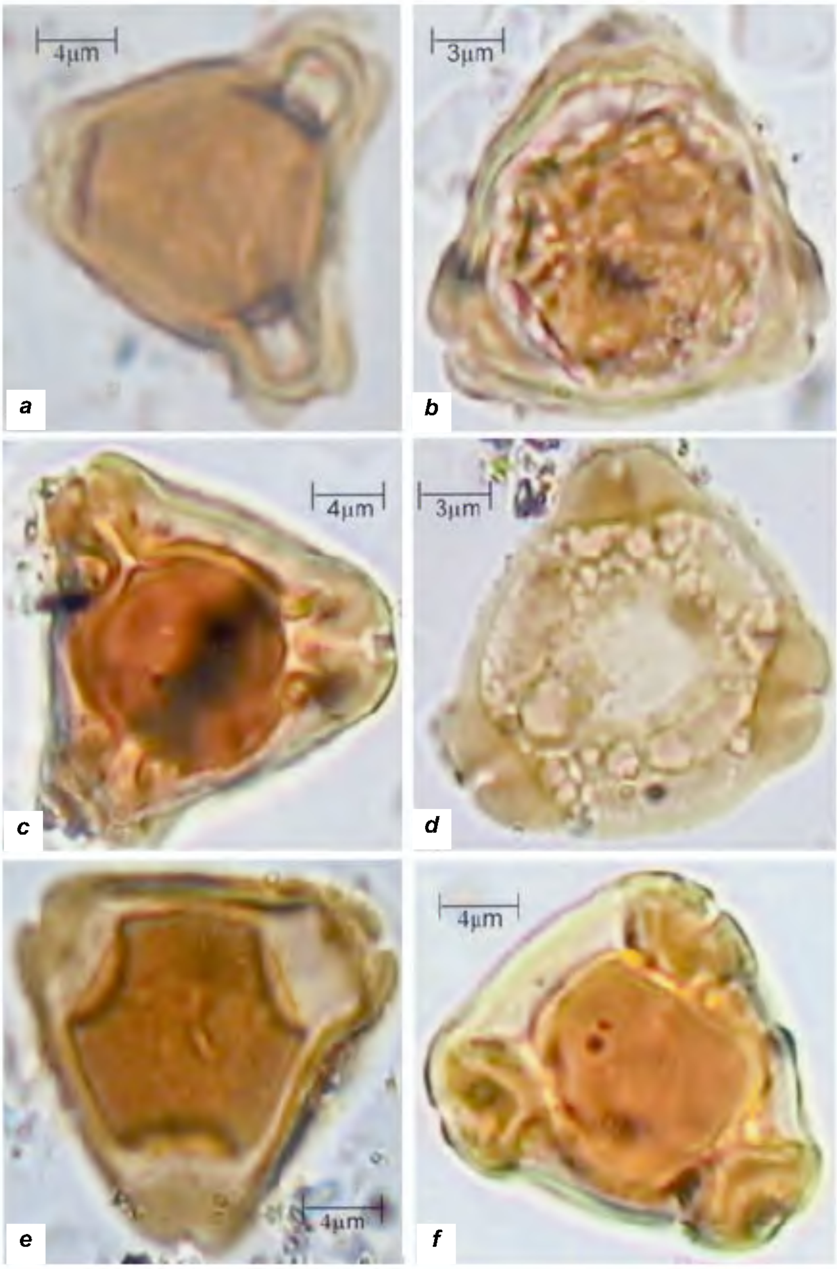

Figure 3. ***a***, *Extremipollis versatalis* Tschudy; ***b***, *Interporopollenites* sp.; ***c***, *Trudopollis pertrudens* Pflug; ***d***, *Semioculopollis verrucosa* Christopher; ***e***, *Choanopollenites consanguieus* Tschudy; ***f***, *Oculopollis lapillus* Pflug.

The Normapolles taxa of the present assemblage compare closely with that of the Late Cretaceous–Palaeogene Normapolles taxa known from the 'Normapolles' palaeophytoprovince[1,2,20–24], Upper Cretaceous of Meghalaya[11,12] and Upper Cretaceous–Palaeogene of NW China[9]. Since the range of occurrence of Normapolles is restricted up to Eocene, the present record of Normapolles pollen grains in the already identified Palaeocene–Eocene palynoassemblage further confirms the Palaeogene age of the Early Tertiary sediments of Ganga Basin, India.

The records of the characteristic palynomorphs of the Late Cretaceous–Early Tertiary periods from outside the respective phytoprovince of contemporary stratigraphic age has long been a subject of discussion. Batten[1], Pacltova[2] and Zaklinskaya[24] consider Normapolles pollen-bearing plant group as both taxonomically and ecologically heterogenous which had grown into different ecological niches. Recent record of *in situ* occurrence of Normapolles type pollen grains in the fossil flower genus *Normanthus miraensis* from Late Cretaceous of Portugal has suggested the affinity of pollens to the members of Fagales[3].

Batten[1] suggested that the occurrence of Normapolles from outside the Euramerian 'Normapolles' province is not unlikely. According to him some taxa, viz. *Trudopollis*, *Nudopollis* and *Plicapollis* might have been produced by more than one plant genus which could grow in the other floral provinces. He opines that the concept of the Late Cretaceous–Early Tertiary phytoprovinces may be considered in view of the records of the Normapolles taxa from phytoprovinces other than Normapolles province. Pacltova[2] suggested that this group might have originated simultaneously in several parts of the globe. Srivastava[5,6] advocated that the integrity of the Late Cretaceous phytogeoprovinces was destroyed by the Late Maastrichtian marine regression which exposed land connections across provinces and allowed interprovincial migration of plants. This observation is well in conformity with the occurrence of Normapolles in different countries outside the Euramerian 'Normapolles' phytoprovince which perhaps flourished under a suitable ecological niche.

The present record of Normapolles pollen grains in the Palaeogene sediments of Ganga Basin, India adds new data for reconsideration of the distribution pattern of the group during Late Cretaceous–Early Tertiary periods.

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