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Modern pollen spectra from Hoshangabad District, south-western Madhya Pradesh, India

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ABSTRACT

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The present communication analyses the pollen deposition pattern in open area at Nitaya and open teak forest at Itarsi-Nagpur Road on the basis of palynological investigation of surface samples. The recovered pollen grains and spores reveal the dominance of non-arboreals and relatively low values of arboreal taxa at both the areas. The arboreals constitute approximately 22% of the total pollen rain in open area at Nitaya whereas their percentage gets higher and reaches up to 32% at Itarsi-Nagpur Road where open teak forest exists. However, non-arboreals are 78% at open area and 68% at open teak forest in Nitaya and Itarsi-Nagpur Road respectively. The constant presence of Cerealia and other culture pollen taxa such as Cheno/Am, *Alternanthera*, Caryophyllaceae, Brassicaceae and *Artemisia* in both the areas points to the agriculture practiced in the area of investigation. The presence of sedges and *Typha* in good frequencies as well as *Polygonum plebeium*, *Hygrophila*, *Polygonum barbatum* and *Eriocaulon*, although meagrely, denotes the marshy condition around the sampling provenance. The recovery of trilete and monolete fern spores demonstrates moist and shady situation around the sampling site. The presence of drifted pollen of *Pinus*, *Cedrus*, *Abies*, *Picea* and *Alnus* shows Himalayan connection of wind circulation pattern as there is no water course leading to central India from the Himalaya.

Key-words: Pollen spectra, pollen rain, surface sediments, Hoshangabad, Madhya Pradesh.

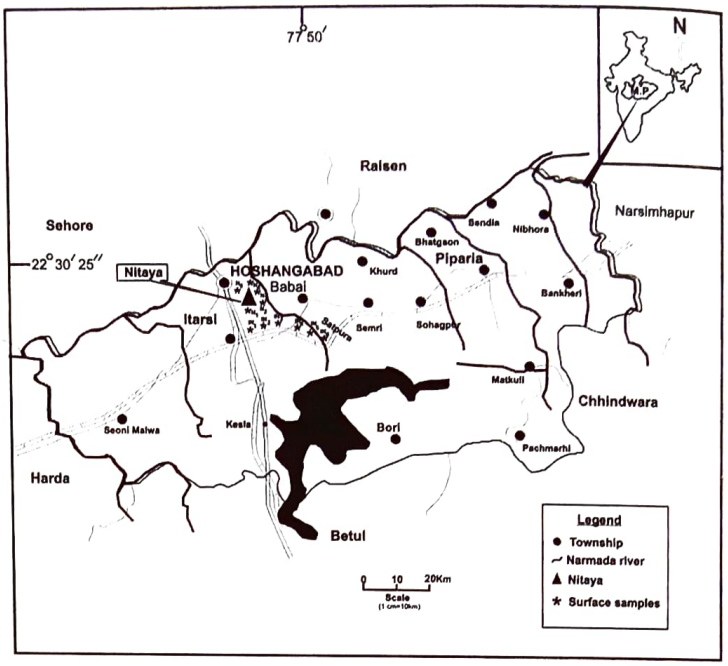
INTRODUCTION

Pollen analysis is the most widely used tool to reconstruct past vegetation and climate and prior to undertake the study it is first and foremost requirement to understand the relationship between vegetation and modern pollen rain. The comparative data-base generated on this interplay serves as modern analogue for the proper delineation of past vegetation and climate because the paucity of data on modern pollen rain may cause significant hindrance not only in producing the data that will be instrumental in pollen analysis but also in resolving controversies concerning the Quaternary vegetation dynamics of the region. In this context, adequate information on pollen deposition has been generated through the palynological studies of surface sediments (surface samples and moss cushions) from South India and Sri Lanka (Bonnefille et al. 1999, Anupama et al. 2000, Barboni & Bonnefille 2001), foothills of Himalaya (Sharma 1985, Gupta & Yadav 1992), northeast India (Basumatary & Bera 2007) and tropical deciduous scrub vegetation in Rajasthan desert (Singh et al. 1973) which have provided valuable comparative data-base on this aspect for the factual delineation of pollen sequences from their respective regions in terms of past vegetation dynamics and coeval climate during the Quaternary Period. However, some sketchy information is available from Madhya Pradesh especially from north-eastern Madhya Pradesh (Chauhan 1994, 2008, Quamar & Chauhan 2007) and south-western Madhya Pradesh (Quamar & Chauhan 2010) that alone constitutes approximately 26% of the total floristics of the country and has great potential for the Quaternary palaeofloristic studies. Hence, in the present paper, an attempt has been made to produce

more data on the relationship between the pollen deposited in the sediments and extant vegetation, their pollen dispersal efficiency and factors affecting the preservation of pollen/spores in the sediments through the pollen analysis of eleven surface samples comprising five from open area at Nitaya and six from the open teak forest at Itarsi-Nagpur Road in Hoshangabad District, south-western Madhya Pradesh.

STUDY AREA

Nitaya lies about 21 km west of Budhani and 17 km southeast of Hoshangabad Township in Itarsi Forest Range (Text-figure 1). This ancient lake basin, subcircular in outline, is quite big in expanse, measuring 300 m in length and 250 m at its widest. Most of the part of the lake basin has got dried and presently it is under intensive paddy cultivation. However, the eastern and southern flanks retain some water and are marked by the perpetually wide swampy margin. Topographically, this entire lake basin and adjoining area is flat and is under agricultural practice by the local inhabitants. The average altitude of the lake and surrounding flat area is about 260 m amsl. However, the hillocks in the southwest are moderate-sized with altitudes varying from 590 to 655 m and support diversified tropical deciduous teak forests.



Text-figure 1. Map showing the sampling sites in Hoshangabad District, Madhya Pradesh.

CLIMATE

The region is characterized by seasonal climatic variability, which is largely influenced by the southwest monsoon. In general, this region enjoys a warm and humid climate. The region experiences four distinct seasonal changes. The winter season commences from December and ends by February. The mean average minimum and maximum temperatures are 7°C and 17°C respectively. However, the temperature comes down to 1°C during the month of January. The summer season from March to middle of June is marked by high temperatures and hot blowing winds with average minimum and maximum temperatures of 27°C and 32°C respectively. The temperature up to 42°C, with the highest of 45°C, is seldom recorded during the hottest month of June. Monsoon season begins in the mid-June and continues till mid-September. However, most of the rain falls during the peak monsoon months of July and August. The average annual rainfall recorded is about 1340 mm and a major fraction of about 92% precipitation occurs during the monsoon period. The relative humidity is generally above 70% during the southwest monsoon, whereas during the rest of the period the air is generally dry. Thus, the climate is generally sultry and seldom becomes salubrious.

VEGETATION

The vegetation around the lake and adjoining area is of open type and comprises a few scattered trees such as *Tectona grandis, Syzygium cumini, Holoptelea integrifolia, Butea monosperma, Aegle marmelos, Mangifera indica, Madhuca indica, Ficus glomerata*, etc. However, *Acacia nilotica* is seen frequently along the roadside and in wasteland together with *Eucalyptus globules, E. lanceolatus, E. paniculata*. On the other hand, *Dendrocalamus strictus* (bamboo clumps) grows gregariously in moist and shady depressions, particularly around villages, whereas thickets of *Phoenix acaulis* can be seen commonly in pockets on the bouldery mounds. Among the shrubby elements, *Ricinus communis, Ziziphus mauritiana, Carissa spinarum, Vitex negundo, Colebrookia oppositifolia,* etc. are common in the heathland around the habitation and cultivated fields. In addition, *Typha latifolia* and *Ipomoea aquatica*

occur abundantly in the waterlogged areas along the stream banks, ponds as well as in the wet land around cultivated fields.

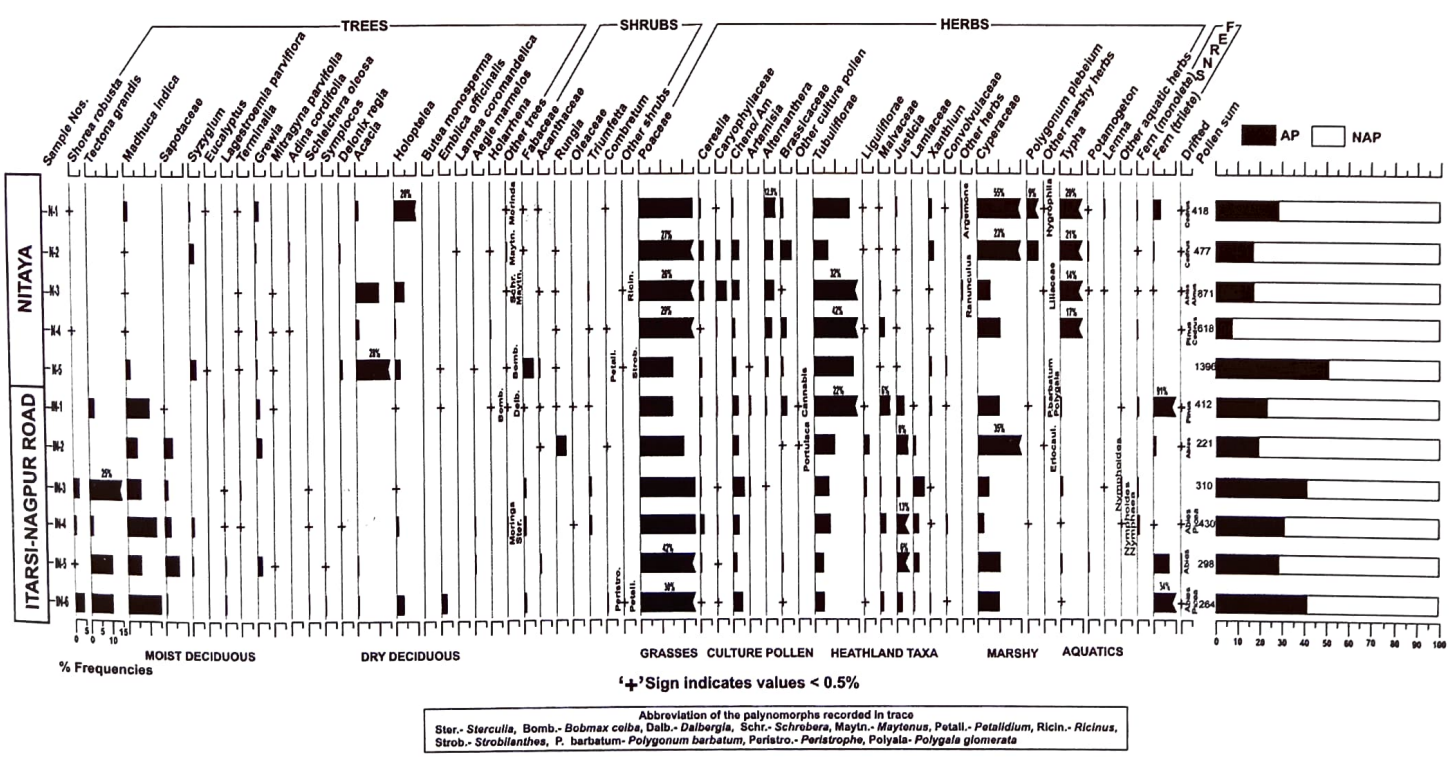
Herbaceous vegetation of terrestrial habitats includes grasses, *Ajuga bracteosa, Mazus japonicus, Ageratum conyzoides, Euphorbia hirta, E. thymifolia, Anagallis arvensis, Sida rhombifolia, Indigofera gerardiana, Leucas aspera, Sonchus oleraceous, Oxalis acetosella, Micromeria biflora,* etc. The marshy habitats along the water course are profusely inhabited by *Polygonum plebeium, P. serrulatum, Polygala chinensis, Hygrophila auriculata, Hydrocotyle sibthorpioides, Eriocaulon quinquangularis, Ammania baccifera, Stellaria media* and tall reed-swamp grass-*Phragmites chinensis, Lemna paucicostata, Typha latifolia, Potamogeton nodosus, Jussieua repens* grow very luxuriantly in ponds, ditches, lakes and waterlogged areas.

MATERIAL AND METHOD

Eleven surface samples, consisting of 5 from open areas at Nitaya and 6 from the forested areas at Itarsi-Nagpur Road, were collected in transect at an interval of 100m each to study the pollen rain/vegetation relationship in the region.

Ten grams of surface samples were boiled in 10% aqueous KOH solution for 5 minutes to deflocculate the pollen from the sediments and to dissolve the humus. This is followed by treatment of the samples with 40% HF solution in order to remove silica. Thereafter, the samples were acetolysed (Erdtman 1943), using acetolysing mixture (9:1 ratio of acetic anhydride and concentrated sulphuric acid). Finally, the sample was prepared in 50% glycerine solution for microscopic examination.

The pollen sums vary from 221 to 1396, depending upon pollen productivity of the samples. The pollen of aquatic plants and fern spores have been excluded from the pollen sums because of their origin from the local sources, however, their frequencies are calculated from the very pollen sums. The recovered pollen taxa, categorized as trees, shrubs, herbs, ferns and drifted, are arranged in the same manner in the pollen spectra (Text-figure 2).



Text-figure 2. Modern pollen spectra from Hoshangabad District, Madhya Pradesh.

POLLEN RAIN COMPOSITION

Pollen spectra (N-1 to N-5) from Nitaya demonstrate the dominance of herbs (non-arboreals) and poor representation of arboreals (trees and shrubs). *Acacia* (1.67-28%) and *Holoptelea* (0.64-19.85) are the major tree taxa and are encountered almost consistently in high frequencies, except in sample N-2. *Madhuca indica* (0.20-2.39%) and *Grewia* (0.22-2.15%) are recorded consistently in good frequencies. *Tectona grandis* is not traceable in the samples, despite its frequent plantation in open area. *Syzygium* (0.95-3.15%) is met with in almost good frequencies in most of the samples. *Adina cordifolia*, *Holarrhena*, *Maytenus* (0.22-0.62% each) and *Delonix regia* (0.62-1.5%) show a bit good number. Other tree taxa such as *Terminalia*, *Combretum*, *Mitragyna parvifolia*, *Butea monosperma*, *Lannea coromandelica*, *Bombax ceiba*, *Emblica officinalis*, *Schrebera*, *Symplocos* and *Morinda* (under 0.5% each) are recovered sporadically in low frequencies.

Shrubby elements, viz. Fabaceae (0.5-5%), Acanthaceae and *Triumfetta* (0.5-1% each) are somewhat better represented in contrast to *Strobilanthes*, *Rungia* and *Ricinus* (under 0.5% each), which are marked by their scanty pollen. Among the non-arboreals, Poaceae (15.4-29.19%) and Tubuliflorae (6.70-42%) are the chief constituents and are recorded in high frequencies. *Alternanthera* (1.43-10.52%), Caryophyllaceae (0.47-5.28%), Brassicaceae (0.32-4.82%) and Cheno/Am (1.19-3.77%) are encountered consistently in good frequencies. However, *Xanthium* (0.45-2.51%), *Justicia* (0.2-1.19) and Malvaceae (0.20-1.45) have low values, but present without fail. Likewise, Cerealia pollen (0.16-2.98%) are recorded in all the samples. *Argemone* (under 1%), Liguliflorae (cf. *Vernonia*), *Solanum*, *Artemisia*, *Evolvulus* and *Cassine* (under 0.5% each) are scarcely present. Marshy herbs, Cyperaceae (5.62-85%) and *Polygonum plebeium* (5.03-8.84%) are met with in high frequencies, whereas *Hygrophila* and Liliaceae (under 0.5% each) are rare. Among the aquatic elements, *Typha* (13.54-21%) has high frequencies, barring the sample N-5. Others, such as *Lemna* (0.1-1.19%) and *Potamogeton* (0.22-0.83%) are sporadic. The pollen of the Himalayan taxa, viz. *Pinus*, *Cedrus*, *Abies* and *Alnus*, are also recorded occasionally. Algal remains (zygospores of *Zygnema* and *Spirogyra*) and fungal spores (*Glomus*, *Diplodia*, *Curvularia*, *Nigrospora*, *Tetraploa*, *Cookeina* and Microthyriaceae) are present in variable numbers.

Pollen spectra (IN-1 to IN-6) from Itarsi-Nagpur Road also demonstrate the dominance of non-arboreals and relatively low frequencies of arboreals. *Madhuca indica* (5.4-15.15%), the main tree constituent of pollen rain, is represented constantly together with Sapotaceae (0.24-7.38%). In addition, *Tectona grandis* (2.09-25.16%) is noticed in most of the samples with fluctuating moderate to high frequencies, except in sample IN-2. *Shorea robusta* (0.33-4.54%), *Holoptelea* (0.32-3.78%), *Grewia* (0.32-2.71%) and *Syzygium* (1-1.86%) are infrequent with low to moderate values. Others, viz. *Mitragyna parvifolia* (0.32-2.65%), *Lagerstroemia parviflora* (0.32-1.13%), *Symplocos* (0.33-1.12%), *Acacia* (0.48-1%), *Terminalia* and *Combretum* (under 1% each), *Adina cordifolia* and *Holarrhena* (0.24-0.64% each), *Butea*, *Moringa*, *Dalbergia* and *Bombax ceiba* (under 0.5% each), *Sterculia*, *Schleichera oleosa* and *Aegle marmelos* are scarcely present. *Emblica officinalis* (0.24-2.65%) is encountered in good frequency in sample IN-6 only.

The shrubby elements, *Rungia* (0.24-4.52%), Fabaceae (1.13-2.25) and *Triumfetta* (0.24-2.09%) are better represented, though sporadically, as compared to Acanthaceae, *Petalidium*, *Peristrophe*, Oleaceae and *Ricinus* (under 0.5% each), which are meagre.

Among the non-arboreals, Poaceae (15.2-42%) is constantly recorded in high values. Others, such as Tubuliflorae (2.34-22.3%), *Justicia* (2.27-5%), Cheno/Am (2.71-5.48%), Lamiaceae (2.32-5.48%) and Malvaceae (0.67-5.82%) are recorded with appreciable frequencies. Cerealia (0.37-2.32%) also has increased values. *Xanthium* (0.23-1.36%) is recorded in good frequencies as compared to *Artemisia* (0.96-1.45%), Liguliflorae (cf. *Vernonia*, 1%), Caryophyllaceae and *Alternanthera* (0.23-0.97% each), which are feebly present. *Portulaca*, *Cannabis*

sativa, Convolvulaceae (*Evolvulus alsinoides*) are rarely encountered in extremely low values. Cyperaceae (2.32-35.2%) has very high values and is recorded consistently, whereas the other marshy taxa, viz. *Eriocaulon*, *Polygonum plebeium*, *P. barbatum* and *Polygala glomerata* (under 0.5% each) are barely found. The aquatic element, *Typha* (0.37-1.29%), is met with regularly, though in low frequencies. *Potamogeton* (1%), *Nymphaea* (under 0.5-1%), *Nymphoides* and *Lemna* (0.5%) are sporadic and low. *Pinus*, *Abies* and *Picea* (under 0.5-1% each) show their stray presence. Algal remains (zygospores of *Zygnema* and *Spirogyra*), fungal remains (e.g. *Glomus*, *Diplodia*, *Curvularia*, *Nigrospora*, *Tetraploa*, *Cookeina*, Microthyriaceae, bi-celled ascospore) and bryophytic spore are seldom recorded in low to high frequencies.

DISCUSSION

The pollen analytical investigation of 5 surface samples (N-1 to N-5) from the vicinity of Nitaya and 6 surface samples from Itarsi-Nagpur Road (IN-1 to IN-6) with teak (*Tectona grandis*) forest has brought out the dominance of non-arboreals and the relatively low frequencies of arboreals at both the areas. The pollen data from the open area at Nitaya depicts that the trees constitute an average 19.72% fraction of the total pollen rain. However, among them *Acacia* (2-28%) and *Holoptelea* (2-20%) are the prominent constituents and the representation of these taxa corresponds more or less with their factual presence in the area since they have recently been planted in most of the open area and wasteland under reclamation programme. The other trees such as *Madhuca indica*, *Syzygium* and *Grewia* are somewhat better represented, probably due to their conservation by the local folk for their multifaceted use. However, a large number of trees comprising *Shorea robusta*, *Terminalia*, *Mitragyna parvifolia*, *Adina cordifolia*, *Lannea coromandelica*, *Holarrhena*, *Emblica officinalis*, *Aegle marmelos*, etc. are extremely sporadic, despite their good occurrence in the nearby open teak forest, merely at a distance of 2 km. The erratic representation of all these taxa in the pollen rain could be attributed to their sparse presence, low pollen productivity owing to entomophilous mode of pollination as well as poor pollen dispersal efficiency (Chauhan 1994, 2008, Vincens et al. 1997, Quamar & Chauhan 2007, 2010). The shrubs are a few and their stray pollen record portrays their meagre presence in the extant vegetation.

Among the non-arboreals, the relatively high frequencies of grasses (Poaceae) and Tubuliflorae correspond with their presence in the herbaceous complex. Likewise, *Alternanthera*, Cheno/Am, Brassicaceae and Caryophyllaceae in moderate frequencies are also truly reflected in accordance to their status in the ground flora. However, steadily high frequencies of sedges (Cyperaceae) and *Typha* imply the prevailing marshy condition around the sampling site, since most of the area here is under intensive paddy cultivation.

On the other hand, the pollen analytical study of 6 surface samples from open teak (*Tectona grandis*) forest in Itarsi-Nagpur Road has also shown the dominance of non-arboreals, however, the arboreals are retrieved in relatively good proportion than those witnessed in Nitaya area. Among the trees, *Madhuca indica*, *Tectona grandis* and Sapotaceae are the major ingredients of the pollen rain as they occur much frequently in the forest floristics. *Shorea robusta* and *Grewia* are also better represented over their stray presence in the adjoining open area. However, a large number of tree taxa, viz. *Lagerstroemia parviflora*, *Mitragyna parvifolia*, *Terminalia*, *Schleichera oleosa*, *Aegle marmelos*, *Bombax ceiba*, *Sterculia*, *Dalbergia*, *Acacia*, *Delonix regia*, *Holoptelea*, etc. are retrieved sporadically, despite their common occurrence in the forest. The irregular representation of all these taxa in the pollen rain could be due to their low pollen production and differential preservation of their pollen in the sediments. The shrubs, as in other areas, are a few and characterised by the occasional pollen of *Triumfetta*, Oleaceae, *Combretum*, Fabaceae etc., except for *Rungia* with the value of 5% in IN-2 only, probably due to its local abundance around the provenance of the sample. The overall representation of these taxa exhibits a true composition of shrubby vegetation in the forest. The main non-arboreal constituents of the pollen rain are Poaceae,

Tubuliflorae, *Justicia* and Lamiaceae in order of their relative dominance and they exhibit a close coherence with their occurrence of the forest floor. However, the consistent presence of Tubuliflorae, in particular, signals the intensive grazing and pastoral activities in the forest (Mazier et al. 2006). The steady record of Cerealia and other culture pollen taxa, viz. Cheno/Am and Caryophyllaceae, in the forest indicates proximity of human habitation and cultivated land.

CONCLUSION

From the ongoing account of the pollen rain vis-à-vis modern vegetation, it is evident that trees constitute only 19.72% pollen, whereas the shrubs contribute barely 1.91% out of the total pollen rain in the open area at Nitaya. On the other hand, the non-arboreals, mainly comprising terrestrial, are marked by the larger proportion (78%) of the total pollen rain in the open area at Nitaya. It could be concluded that the pollen rain composition compares with the actual vegetation of the area under investigation. The pollen rain studies conducted on the surface samples from the open teak forest have revealed that about av. 32% frequency of arboreals comprising 29.05% trees and 2.8% shrubs represent the modern forest in the area, whereas the non-arboreals again constitute the major fraction of about 68% of the pollen rain in the region. This comparative database has been used as modern analogue for the interpretation of the past vegetation and climate change in the region.

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