Pollen analysis of spider webs from Khedla village, Betul District, Madhya Pradesh

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Pollen analysis of spider-web samples collected from the open mixed tropical teak (*Tectona grandis*)-dominating deciduous forests and the nearby areas of Khedla village, Betul District, Madhya Pradesh throws light on the interplay between the extant vegetation and pollen rain. The study revealed the dominance of pollen of trees and herbs, whereas shrubs, fern spores and algal remains are meagre. Amongst the trees, *Madhuca indica*, *Holoptelea*, *Lannea coromandelica*, *Emblica officinalis* and *Aegle mermelos* are dominating with fair presence of *Schleichera oleosa*, *Syzygium*, *Grewia*, Sapotaceae, *Flacourtia*, Anacardiaceae and *Acacia*. However, the rest of the forest constituents are not represented in good frequencies despite their frequent presence in the floristics, which could be attributed to their low pollen productivity as well as poor and differential pollen preservation. On the other hand, the ground vegetation is represented by the good number of Tubuliflorae, Poaceae, Cheno/Am, Caryophyllaceae, *Xanthium*, *Capsicum frutescens* and Brassicaceae. However, exceptional high frequencies of Lamiaceae cf. *Pogostemon* and *Hyptis*, and Asteraceae (Tubuliflorae cf. *Blumea* and *Eclipta*) in almost all the samples have been noticed, except SW-4. Ferns which occur abundantly along the adjoining stream banks, are marked by the sporadic retrieval of trilete spores that could be ascribed to the prevailing damp condition around the sampling provenance. The study could also be helpful in evaluating the allergenicity of different pollen grains/spores in the area of investigation, causing asthma, hay fever, dermatitis and other disorders.

Keywords: Allergenicity, pollen analysis, pollen rain, spider webs.

UNDERSTANDING the relationship between the extant vegetation and pollen rain is an indispensable aspect of pollen analysis and the various natural types of pollen traps, viz. surface soils/sediments, moss cushions, leaves and barks have been used conventionally[1–3] in order to study the pollen rain–vegetation relationship. However, recently, spider webs have emerged as a competent natural pollen trap and their study has provided factual data on the modern pollen rain and differential dispersal and deposition of its various entities in a particular geographical area[4,5]. The qualitative and quantitative studies of spider webs have proven to be a strong tool to assess the actual contribution of the local plants in the pollen rain and the overall representation of local and regional vegetation as well. In addition, such study could also aid in understanding the aerospora of the area under study relevant to allergic diseases. Spider webs also provide a useful indicator of environmental pollution and chemistry[6,7]. The present communication deals with the pollen analysis of spider webs from the open mixed tropical teak (*Tectona grandis*)-dominating deciduous forest as well as the nearby areas of Khedla Lake in Khedla village, Betul District, Madhya Pradesh, and is a maiden attempt to unfold the pollen deposition pattern through the record of pollen grains/spores trapped in the spider webs.

Khedla village is situated about 6 km east of Betul township between 77°30′E long. and 21°40′N lat. (Figure 1). Physiographically, most of the area is characterized by undulating surfaces and moderate-sized hillocks. The flat ground is under intensive agricultural practice by the tribals inhabiting therein, whereas the elevated areas support thick, mixed tropical deciduous forests.

The climate of Betul District, in general, is warm and humid, and is characterized by seasonal fluctuations. The average annual temperature is 32.4°C, with annual mean maximum and minimum temperature being 30°C and 3.9°C respectively. The temperature ascends up to a maximum of 48°C during the summer months of May and June, whereas it goes down as low as 1°C during the extreme cold months of December and January. The average annual precipitation is about 900 mm.

Floristically, the study area is characterized by the presence of open mixed dry deciduous forest type[8], of which *T. grandis* is the chief constituent. Others such as *Butea monosperma*, *Bauhinia racemosa*, *B. variegata*, *B. purpurea*, *Syzygium cumini*, *Madhuca indica*, *Lannea coromandelica*, *Aegle marmelos*, *Acacia nilotica*, *Diospyros melanoxylon*, *Ficus infectoria*, *F. benghalensis*, *Schleichera oleosa*, *Mitragyna parvifolia*, *Lagerstroemia parviflora*, *Aegle marmelos*, *Chloroxylon sweitenia*, *Emblica officinalis*, *Terminalia tomentosa*, *Holoptelea integrifolia* and *Flacourtia indica* occur frequently in these forests. The shrubby elements such as *Cassia fistula*, *Indigofera gerardiana*, *Lantana camara*, *Vitex negundo*, *Bougainvillea spectabilis*, *Ziziphus mauritiana*, *Ricinus communis*, *Carissa opaca* and *C. spinarum* can be seen scatteredly distributed in the forests.

The herbaceous vegetation comprises grasses, *Argemone mexicana*, *Ageratum conyzoides*, *Oxalis acetosella*, *Sida rhombifolia*, *Capsicum frutescens*, *Euphorbia hirta*, *Achyranthes aspera*, *Chenopodium album*, *Nepeta indica* and *Pogostemon purpurascens*. The marshy vegetation along the stream banks includes *Polygonum plebeium*, *Hydrocotyle sibthorpioides*, *Hygrophila auriculata*, *Ammania baccifera*, *Rotala rotundifolia*, *Pimpinella tomentosa*, *Scirpus auriculatus*, *Carex oligocarpa*, *Cyperus rotundifolia*, *Ocimum sanctum* and *Mentha arvensis*. *Nymphaea pubescens*, *Nelumbo nucifera*, *Typha latifolia*

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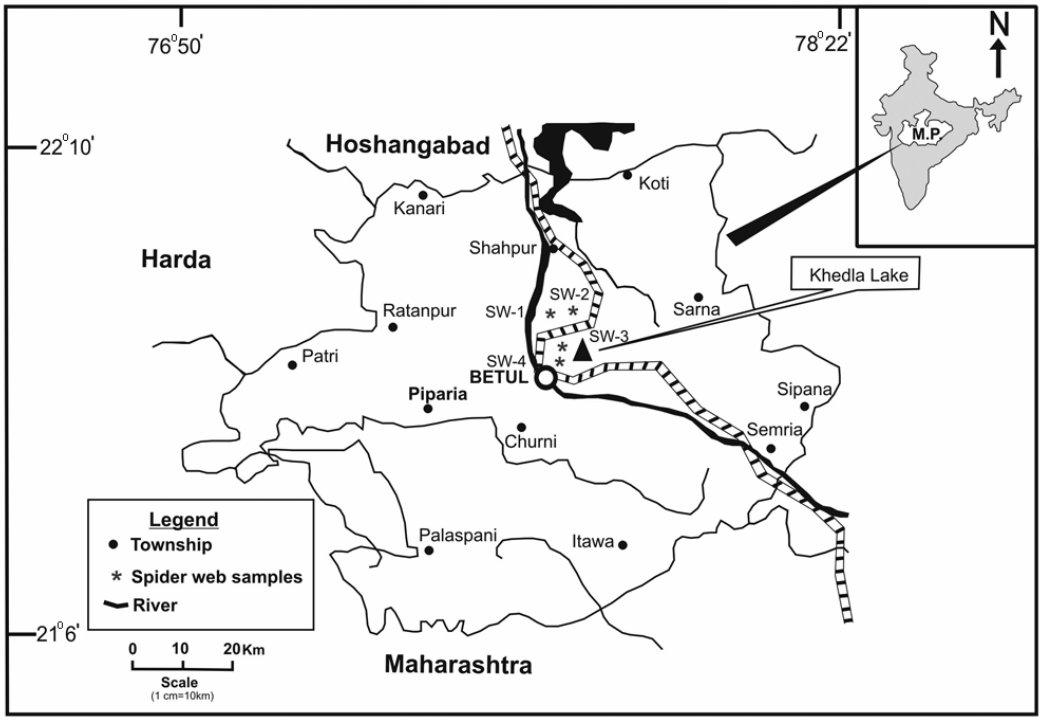

Figure 1. Map showing the collection site of spider-web samples at Khedla village, Betul District, Madhya Pradesh.

and *Eichhornia crassipes* are the common aquatic taxa in the lakes, ponds and swampy areas.

Four spider-web samples (SW-1 to SW-4) were collected from the forest trees occurring on gentle sloped hills in order to understand the pollen deposition pattern. The spider webs were collected from dried twigs of the trees and placed in large-sized polythene bags. The sampling was carried out during the late spring season so as to ensure the maximum representation of plant taxa in the pollen rain of the area under study and to understand the annual pollen influx over a prolonged post-monsoon period.

For the extraction of pollen grains and spores, the spider-web samples were first treated with concentrated hydrochloric acid to dissolve the meshes instantly. Superfluous materials such as small twigs, leaves, fruits and insect parts were removed with a strainer. The samples were washed several times with distilled water to remove acid content by centrifuging and decantation. The filterate was treated with 10 ml concentrated hydrofluoric acid in polythene jars and kept for two days to dissolve silica. The samples were washed with distilled water by centrifuging to remove the silica content. Thereafter, the samples were acetolysed by treating them with acetolysis mixture[9], i.e. acetic anhydride and concentrated sulphuric acid in the ratio of 9 : 1. Finally, the samples were prepared in 50% glycerine solution for microscopic examination.

The precise identification of the pollen grains and spores retrieved (Figures 2 and 3) in the spider-web samples was executed by consulting the reference pollen slides available in the sporothek of the BSIP Herbarium, and also by comparing them with photographs and description given in the literature[10,11].

The pollen sums range from 666 to 1737, depending upon the pollen potential of the spider-web samples analysed. The percentage frequencies of the recovered pollen taxa have been calculated in terms of total terrestrial plant pollen, excluding the pollen of aquatics and spores of ferns and fungi as well, owing to their local origin. The retrieved plant taxa grouped as trees, shrubs, herbs, ferns (pteridophytes), drifted, algal remains and fungal spores are arranged in the same manner in the pollen spectra (Figure 4). The pollen/spore frequencies < 0.5% are indicated by '+' sign. The representation of major pollen rain components has been shown in the composite pie diagrams prepared separately for the samples, depicting the average contribution of each plant group in the regional pollen rain (Figure 5). The spider webs analysed were prospective in pollen/spore content so far as the quantity and diversity are concerned, though variable numbers of various pollen grains and spores were encountered. The detailed pollen-rain compositions are described separately as below.

Pollen rain composition of SW-1 reveals the dominance of non-arboreals over arboreals. Among the arboreals, *M. indica* (18.57%), *Holoptelea* (6.04%) and *Lannea coromandelica* (5.69%) are the dominating taxa and are encountered in good frequencies, whereas *A. marmelos* (3.62%) and *E. officinalis* (2.46%) are recorded in moderate values. *Grewia* and *Schleichera oleosa* (1.09% each) are present in low values in the pollen

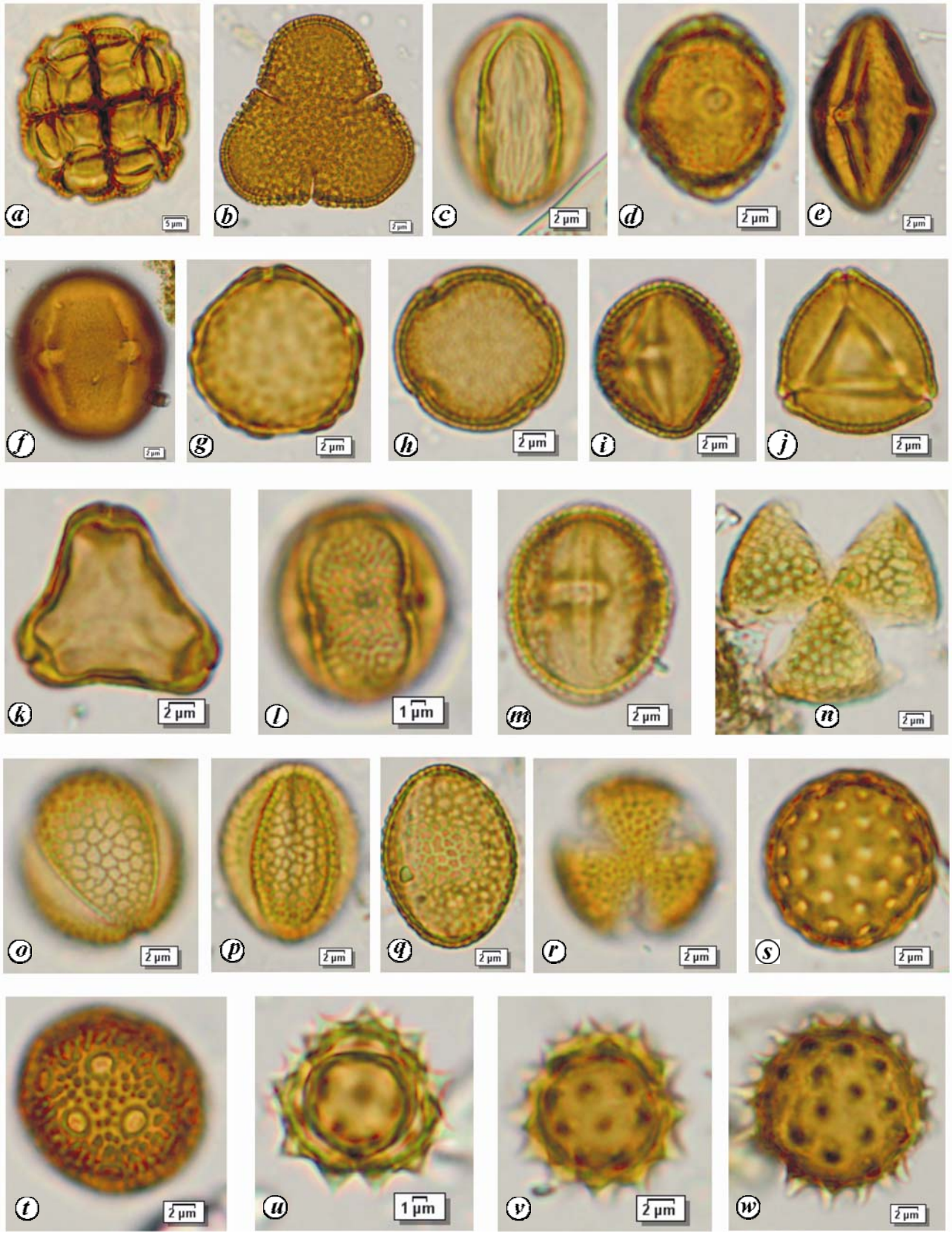

Figure 2. ***a***, *Acacia*; ***b***, *Bombax ceiba*; ***c***, *Lannea coromandelica*; ***d***, *Lagerstroemia*; ***e***, Anacardiaceae; ***f***, *Madhuca indica*; ***g***, Holoptelea; ***h***, *Emblica officinalis*; ***i***, *Aegle marmelos*; ***j***, *Schleichera*; ***k***, *Syzygium*; ***l***, ***m***, *Flacourtia*; ***n–r***, Lamiaceae (*Pogostemon*/*Hyptis*); ***s***, Cheno/Am; ***t***, Caryophyllaceae; ***u–w***, Tubuliflorae.

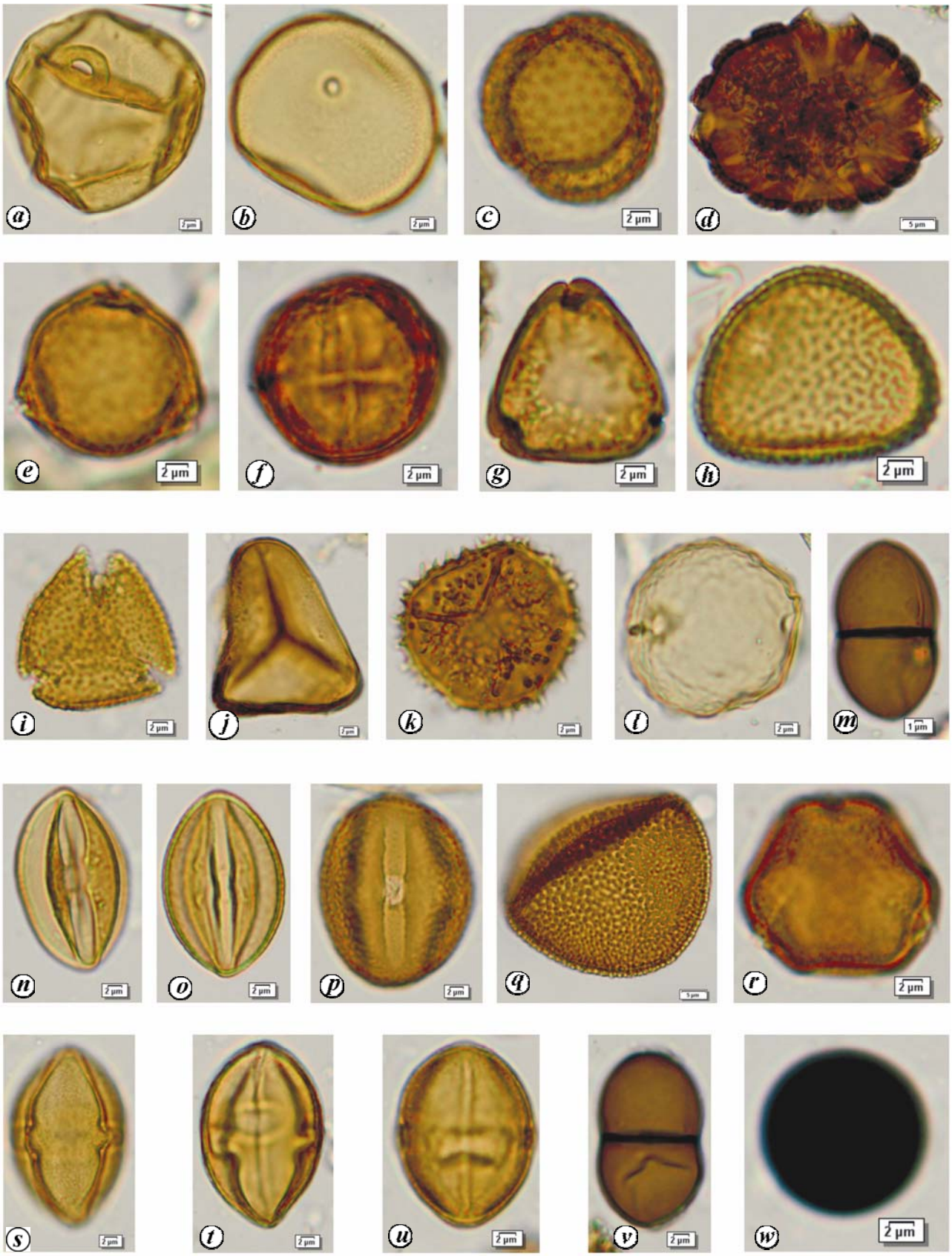

Figure 3. ***a***, Cerealia; ***b***, Poaceae; ***c***, *Xanthium*; ***d***, *Hygrophila*; ***e***, *Capsicum*/Solanaceae; ***f***, *Ricinus communis*; ***g***, *Ziziphus*; ***h***, *Typha*; ***i***, *Nymphoides*; ***j***, Fern trilete; ***k***, Lycopods; ***l***, *Zygnema* zygospore; ***m***, ***v***, *Diplodia*; ***n***, ***o***, Unidentified-I; ***p***, Unidentified-II; ***q***, *Annona* sp.; ***r***, *Ailanthus excelsa*; ***s–u***, Unidentified-III; ***w***, *Nigrospora*.

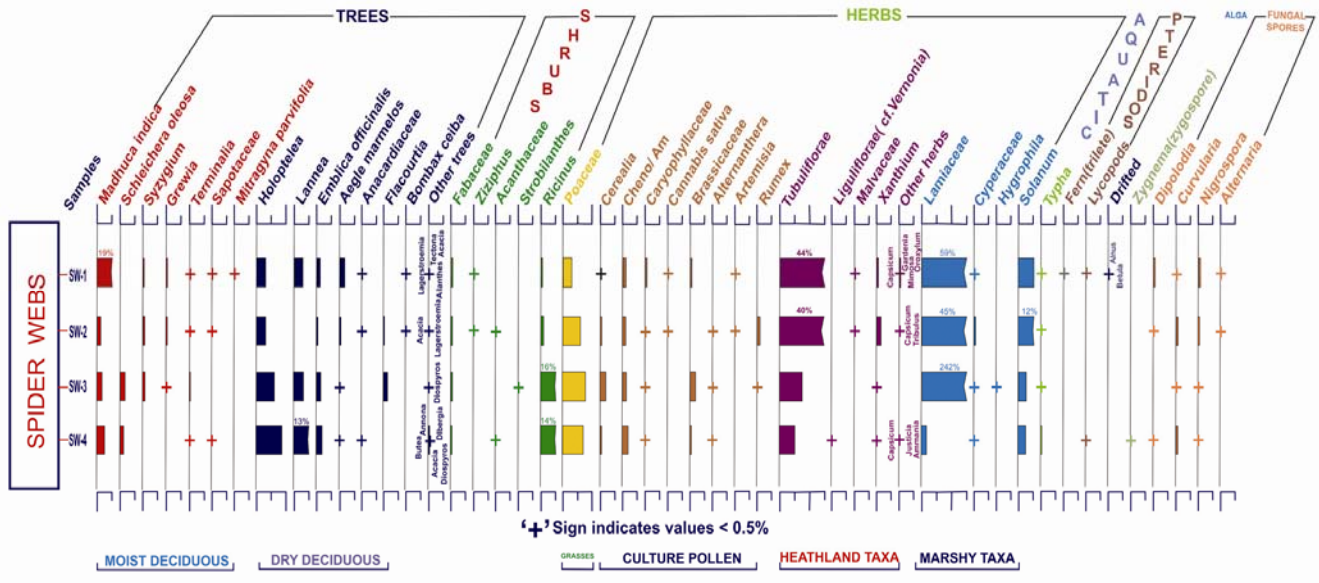

Figure 4. Pollen spectra of the spider-web samples from Khedla village.

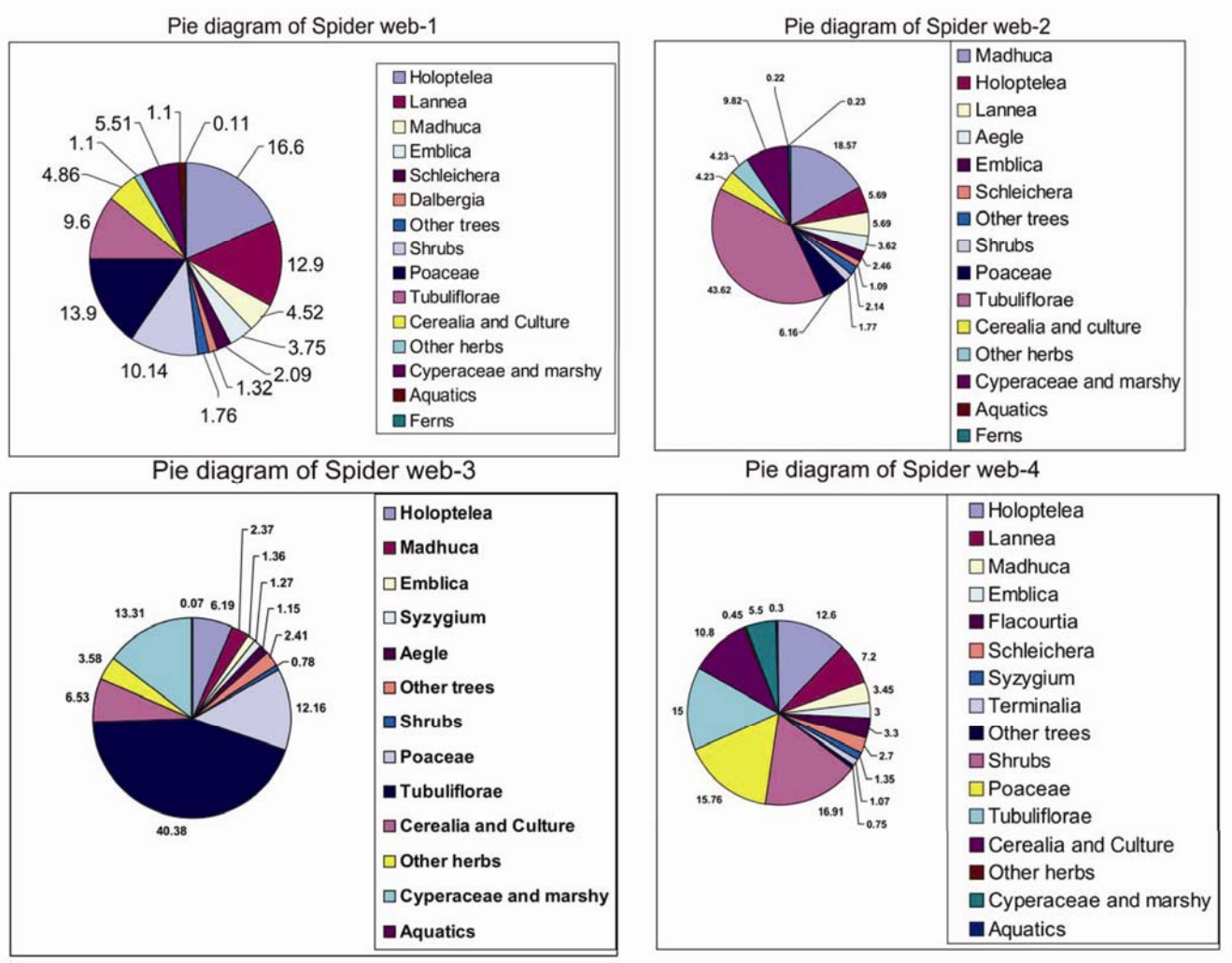

Figure 5. Pie diagram of the spider-web samples showing the major components of the pollen rain in and around Khedla Lake.

spectra. Others, viz. *Syzygium* (0.51%), *Terminalia*, *M. parvifolia*, *L. parviflora*, *Sapotaceae*, *Acacia*, *T. grandis*, Anacardiaceae, *Bombax ceiba* and *Ailanthus excelsa* (< 0.5% each) are met with infrequently. *Ricinus communis* (1.03%) and Fabaceae (0.51%) are the major shrubby components, whereas *Ziziphus mauritiana* (< 0.5%) is scanty. Ground vegetation is predominated by Tubuliflorae (43.62%) followed by Poaceae (6.16%) and Cheno/Am (2.36%). *Capsicum frutescens* (1.66%), *Xanthium* (1.03%), Brassicaceae (0.97%), Caryophyllaceae (0.51%) and Cerealia (< 0.5%) are intermittently represented in the pollen spectra. Other herbaceous elements such as *Cannabis sativa*, *Artemisia*, Malvaceae, *Gardenia*, *Oroxylum* and *Mimosa* sp. (< 0.5% each) are inadequately recorded in very low values. Lamiaceae (59.34%) is present in extremely good values. *Solanum* (9.71%), among the marshy taxa is recorded in high frequencies, whereas Cyperaceae (< 0.5%) is trivial. *Typha* (0.23%) is the sole representative of the aquatic taxa, albiet in low value. Fern spores, viz. trilete and lycopods (< 0.5% each) are meagre. The temperate pollen grains of *Betula* and *Alnus* (< 0.5% each) are also sparsely retrieved. The fungal spores such as *Nigrospora* (1%), *Diplodia*, *Curvularia* and *Alternaria* (< 0.5% each) are recorded lowly.

In SW-2, the recovered palynoassemblage demonstrates the dominance of non-arboreals over low values of arboreals. *Holoptelea* (6.19%), amongst the arboreals, is the chief component of the pollen rain and is recorded in high frequency, whereas *M. indica* (2.37%) is encountered moderately. *E. officinalis* (1.36%), *Syzygium* (1.27%), *A. marmelos* (1.15%), *Flacourtia* (0.86%) and *Grewia* (0.64%) are present sporadically. Other tree taxa, viz. *Terminalia*, Sapotaceae, *Acacia*, Anacardiaceae and *L. parviflora* (< 0.5% each) are poorly represented in the pollen spectra. Among the shrubby elements, *R. communis* (2.15%) is recorded in appreciable value, whereas Fabaceae (0.60%) and *Z. mauritiana* (< 0.5% each) are inadequately represented. Lamiaceae (44.90%) and Tubuliflorae (40.38%) are the dominant herbaceous taxa followed by Poaceae (12.16%), *Xanthium* (2.73%), Cheno/Am (2.30%) and *Rumex* (1.87%). Cerealia (1.09%) is meagrely present. Other herbaceous taxa such as *Alternanthera* (0.50%), Caryophyllaceae, Malvaceae, *Tribulus*, *Artemisia*, *C. sativa* and *C. frutescens* (<0.5% each) are sporadically present. The marshy element, *Solanum* (12.45%) is in good number, whereas Cyperaceae (0.86%) is extremely sporadic. Aquatic element, *Typha* (0.07%) is sporadic. Fungal spores such as *Curvularia*, *Nigrospora* (<1% each), *Diplodia* and *Alternaria* (< 0.5% each) are scarce.

SW-3 also depicts the dominance of non-arboreals over arboreals. *Holoptelea* (12.6%) and *Lannea coromandelica* (7.20%), the dominating taxa are recovered in good frequencies. *Flacourtia* (3.30%), *E. officinalis* (3%) and *S. oleosa* (2.70%) are reported moderately, whereas *Syzygium* (1.35%) and *Terminalia* (1.07%) are recovered in low values. Other tree taxa, viz. *Grewia* and *Diospyros* (< 0.5%) are stray. *R. communis* (16%) is represented in high values in contrast to Fabaceae (0.60%) and *Strobilanthes* (0.15%), which are represented in extremely low value. Poaceae (15.76%) is dominant among the herbs, whereas Tubuliflorae (15%) decreased considerably compared to SW-1 and SW-2. Cerealia, Brassicaceae (3.75% each) and Cheno/Am (2.55%) are encountered moderately. Others such as *Alternanthera*, Caryophyllaceae, *Rumex*, *C. frutescens* and *Xanthium* (< 0.5% each) are recorded scantily. Lamiaceae (242%) is in highest values ever (excluded from the pollen sum in all the samples). The marshy element, *Solanum* (5.10%) has good value, whereas Cyperaceae and *Hygrophila* (<0.5% each) are sparse. *Typha* (0.30%), the aquatic element, is recorded scarcely. The fungal spores, viz. *Curvularia* and *Nigrospora* (< 0.5% each) are poorly encountered.

SW-4 also shows the dominance of non-arboreals over arboreals. *Holoptelea* (16.66%) and *L. coromandelica* (12.90%) are the prominent trees as marked by their high values. *M. indica* (4.52%), *E. officinalis* (3.75%) and *S. oleosa* (2.09%) are encountered moderately, whereas *Terminalia*, *Acacia*, *Annona*, *Butea*, Sapotaceae, *A. marmelos* and Anacardiaceae (< 0.5% each) are trivial. Among the shrubs, *R. communis* (14%) is retrieved in high frequency. Fabaceae (1.32%) is lowly recorded, whereas Acanthaceae (< 0.5%) is rare. Herbaceous flora is represented by Poaceae (13.9%) in high frequency followed by Tubuliflorae (9.60%) Cheno/Am (3.20%) and Lamiaceae (2.98%). Other constituents such as Brassicaceae (0.89%), Cerealia (0.55%), Caryophyllaceae, *Alternanthera*, Liguliflorae, *Justicia*, *C. frutescens*, *Xanthium* and *A. baccifera* (< 0.5% each) are encountered feebly. The marshy element, *Solanum* (4.85%) is recorded in good value, whereas Cyperaceae (< 0.5%) is scantily represented. *Typha* (1.10%), the solitary aquatic element, is recovered in appreciable value. The algal remains, viz. zygospore of *Zygnema* (< 0.5%) and fungal spores, viz. *Curvularia* (0.67%), *Diplodia* and *Nigrospora* (< 0.5% each) are recovered in low values.

Thus, pollen analysis of spider-web samples from Betul District demonstrates the dominance of pollen of trees and herbs, whereas shrubs as well as fern spores and algal remains are poorly represented. Among the arboreal pollen trapped in webs, *M. indica*, *Holoptelea*, *L. coromandelica*, *E. officinalis* and *A. marmelos* are the predominating tree taxa and their representation corresponds largely with their presence in local flora. *S. oleosa*, *Syzygium*, *Grewia*, Sapotaceae, *Flacourtia*, Anacardiaceae and *Acacia* are also reported moderately. *L. parviflora*, *T. grandis*, *M. parvifolia*, *D. melanoxylon*, *Dalbergia*, *B. ceiba* and *A. excelsa* are not represented in good frequencies, despite being the common constituents of the floristics. Their erroneous presence in the pollen rain may be attributed to low pollen productivity and differential pollen preservation as well. Therefore, the palynoassem-

blages recovered from the analysis of spider webs do not reflect the factual composition of local vegetation of the study area, so far as the tree taxa are concerned.

On the other hand, the ground vegetation is honestly portrayed by the encounter of good number of Tubuliflorae, Poaceae, Cheno/Am, Caryophyllaceae, *Xanthium*, *C. frutescens* and Brassicaceae. However, the outstanding high frequencies of Lamiaceae cf. *Pogostemon* and *Hyptis* and Asteraceae (Tubuliflorae) cf. *Blumea* and *Eclipta* in almost all the samples have been noticed, except SW-4. This might have occurred owing to charging of the local environment with the pollen of the tall herbaceous members of these families, which were seen gregariously and in full bloom at the study site while sampling was carried out. Ferns, which occur abundantly along the adjoining stream banks are marked by the sporadic retrieval of trilete spores. Their poor representation could be ascribed to the prevailing damp condition around the sampling provenance, which inhibits their easy dispersal by wind.

In addition to the different types of pollen traps, spider webs have also been proved to be an efficient natural trap of airborne pollen grains and spores, which reflects almost the local vegetation of the study area. The spider-web samples also show variability in terms of the pollen assemblages because of their position, size and age. Wind speed and humidity are other local factors that affect the retention of pollen grains and spores in webs. Further research looking into the causes behind this is required. However, the study could also entail the evaluation of the allergenicity of different pollen grains and spores in the area of investigation, causing asthma, hay fever, dermatitis and other disorders. Allergic diseases can be controlled and symptoms can be minimized if we know what triggers them[12]. Thus, the study may be useful for allergologists too in establishing a right diagnosis[13] and ultimately enable an improved quality of life for the inhabitants of the area of investigation. The results of the study may be used in public awareness programmes about the health hazards caused by pollen grains.

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