

Pollen analysis of spider web samples from Korba District, Chhattisgarh (central India): an aerobiological aspect

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Abstract Pollen analyses of spider web samples, collected from the recently planted *Tectona grandis* (*T. grandis*, teak)-dominated tropical deciduous forest of Bhulsidih Village, Korba District (Chhattisgarh, central India), shed light on the relationship between the extant vegetation and pollen rain. The study revealed the dominance of pollen of herbs and trees, whereas shrubs, fern spores and algal remains are meagre. Among the tree taxa, Sapotaceae, *Syzygium*, *Holoptelea*, *Lannea coromandelica*, *Shorea robusta* and *Grewia* are dominating with moderate to low and intermittent presence of *Madhuca indica*, *Terminalia*, *Mitragyna*, *Schleichera*, Anacardiaceae, *Diospyros*, *Embllica officinalis* and *Flacourtia*. However, the rest of the forest constituents are either not represented at all despite their presence in the floristics, which could be attributed to their low pollen productivity owing to entomophily as well as their poor pollen preservation pattern. On the other hand, the ground vegetation is represented by the very high frequency of grasses (Poaceae) along with Tubuliflorae, Chenopodiaceae/ Amaranthaceae and Cerealia, however, *Artemisia*, *Xanthium*, Malvaceae, Caryophyllaceae and *Justicia* in moderate to lower values. 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, in addition to understanding the pollen–vegetation relationship, could also be helpful in aerobiological study, especially in assessing the allergenicity of various pollen grains/spores in the area of investigation, causing bronchial asthma, hay fever (allergic rhinitis/pollinosis), naso-bronchial allergy and other respiratory disorders along with conjunctivitis, contact dermatitis, eczema, food allergies and other health disorders.

Keywords Pollen analysis · Spider webs · Aerobiology · Allergenicity · Korba · Chhattisgarh (India)

1 Introduction

Establishing the relationship between the extant vegetation and pollen rain with the use of various natural pollen traps/substrates, such as surface soils/sediments, moss cushions/moss polsters, leaves (of *Sarracenia*), spider web samples and modern tree barks, has been accomplished authentically and successfully too (Adam et al. 1967; Faegri et al. 1989; Moore et al. 1991; Groenman-van Waateringe 1998; Bera et al. 2002; Rana 2004; Song et al. 2007, 2013, 2014; Reddy et al. 2009; Quamar and Chauhan 2011; Li et al. 2013; Quamar and Bera 2014, 2016 unpublished data). This aspect is regarded as an indispensable aspect of pollen analysis and one of the prerequisites too behind its

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success. Several mechanical pollen-catching/pollen-trapping devices like Rotorod sampler, Burkard portable air sampler, Burkard personal volumetric air sampler, Tauber trap, Behling trap, modified Oldfield trap and reference trap, however, are also well known to the pollen analysts to study the airborne pollen grains and spores in and around a geographical area (Bera et al. 2002; Jantz et al. 2013). Spider web samples, indicating the environmental pollution and chemistry (Hose et al. 2002), also help in understanding the aerospora of the area under study relevant to allergic diseases. The present communication, however, deals with the pollen analysis of spider web samples collected from the recently planted teak (*T. grandis*)-dominated tropical deciduous forest at Bhulsidih Village of Korba District, Chhattisgarh (central India), to unfold the pollen deposition pattern through the record of pollen grains/spores trapped in the spider webs. The other important objective of the present study is to lay emphasis on the aerobiological aspect, particularly on the evaluation of allergenicity of different pollen grains and spores (regarded as potential cause of allergic disorders) present in the surroundings/atmosphere/environment of the area of investigation, causing bronchial asthma, hay fever (allergic rhinitis/pollinosis), naso-bronchial allergy and other respiratory disorders, as well as conjunctivitis, contact dermatitis, eczema, food allergies and other health disorders.

2 Materials and methods

2.1 Study area

Bhulsidih Village is situated about 10 km east Korba Township (22°21'11"N; 82°47'36"E) (Fig. 1). Physiographically, most of the area is characterized by uneven land surfaces, deep gorges and moderate-sized hillocks. The flat ground is under intensive agricultural practice by the tribals and the other populace inhabiting therein, whereas the elevated areas support thick, tropical deciduous forests.

2.2 Aerobiological survey

2.2.1 Vegetation

The vegetation of the region is characterized by the presence of tropical deciduous forest (Champion and

Seth 1968), of which *T. grandis* is the chief constituent. The common associates of the forest have been shown in a tabular form (Table 1).

2.2.2 Climate

The study area experiences very hot and dry climate. The study area actually enjoys a borderline climate between warm temperate with dry winter (Cwa) and tropical with dry winter (Aw; Köppen 1918), which is hot and humid because of its proximity to the Tropic of Cancer and its dependence on the southwest monsoon for rains. The summer temperature varies between 30 and 47 °C, whereas the temperature ranges between 5 and 25 °C in winter. The temperature may go up to 49 °C during the extreme hot summer month of June and also falls to <0 °C in the cold month of January. However, the average summer temperature is 32 °C, and average winter temperature is 17 °C. The average annual precipitation is about 1506.7 mm.

2.2.3 Methodology

Five spider web samples (SW-1 to SW-5) were collected from the newly planted *Tectona grandis* (teak)-dominated tropical deciduous forest at the Bhulsidih Village of Korba District in order to understand the pollen deposition pattern as well as the aerobiological aspect. The spider webs, having a diameter of ~30–45 cm (mesh size varying) and located at a height of ~1–1.5 m from the ground surface, were collected from dried twigs of the trees and bamboo clumps of the aforesaid *T. grandis*-dominated forest by maintaining a distance of ~100 m each and placed in large-sized polythene bags separately. For the extraction of pollen grains and spores, the spider web samples were first treated with concentrated hydrochloric acid (HCl) 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 filtrate was treated with 10 ml concentrated hydrofluoric acid (HF) in polythene jars and kept for 2 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 (Erdtman 1943), i.e. acetic anhydride and concentrated sulphuric

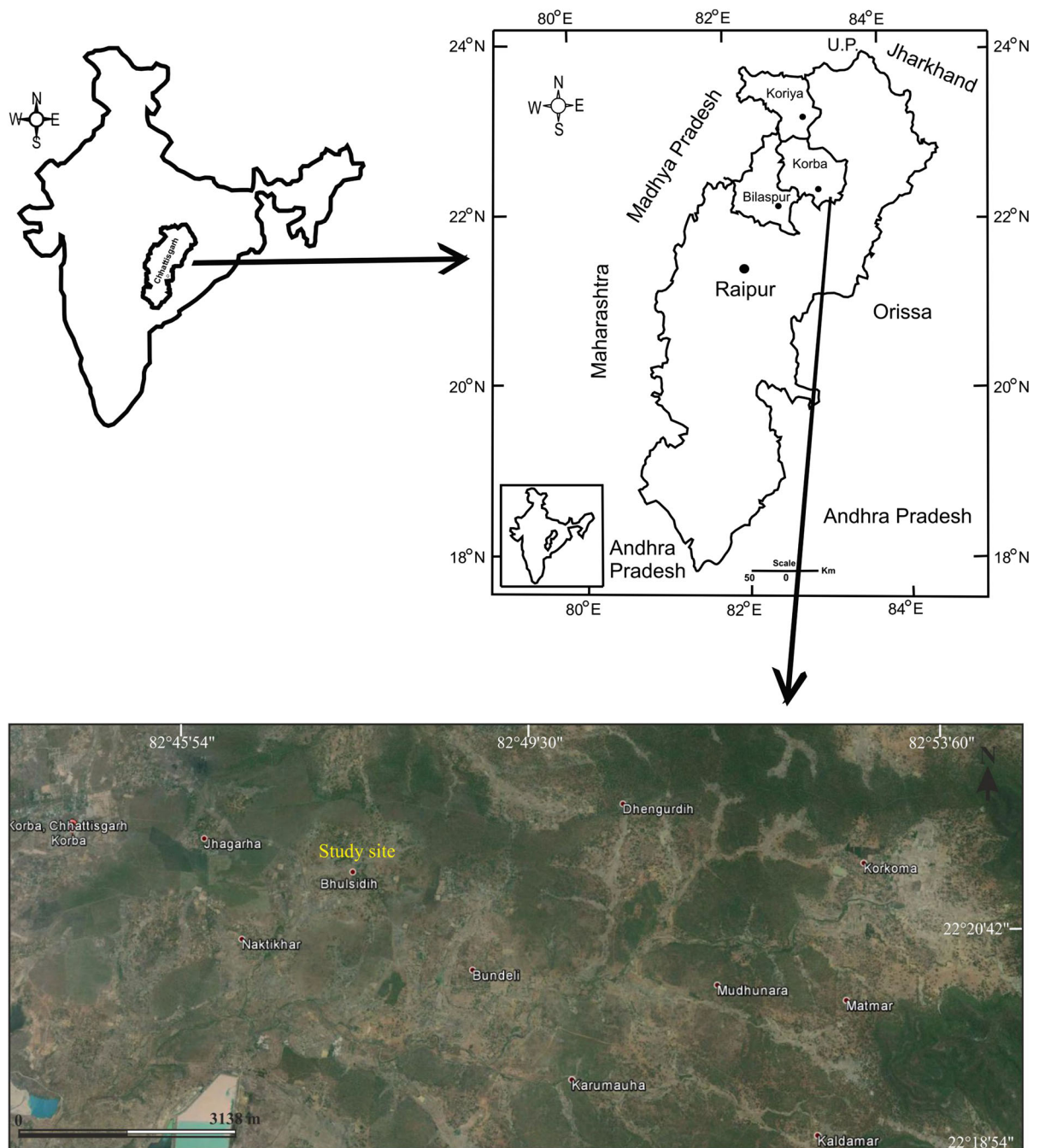


Fig. 1 Map showing the collection site of spider web samples at the newly planted teak (*Tectona grandis*)-dominated tropical deciduous forest at Bhulsidih Village, Korba District (Chhattisgarh)

acid in the ratio of 9:1. Finally, the samples were prepared in 50 % glycerine solution for microscopic examination. A few drops of phenol were also added to avoid any microbial contamination. The precise identification of the pollen grains and spores, retrieved 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 (Chauhan and Bera 1990; Nayar 1990).

Table 1 Vegetation of the study area

Plant/taxa (scientific name)	Family	Habit
<i>Tectona grandis</i>	Verbenaceae	Trees
<i>Shorea robusta</i>	Dipterocarpaceae	
<i>Madhuca indica</i>	Sapotaceae	
<i>Terminalia arjuna</i>	Combretaceae	
<i>T. bellerica</i>	Combretaceae	
<i>Terminalia chebula</i>	Combretaceae	
<i>T. tomentosa</i>	Combretaceae	
<i>Syzygium cumini</i>	Myrtaceae	
<i>Schleichera oleosa</i>	Sapindaceae	
<i>Lannea coromandelica</i>	Anacardiaceae	
<i>Diospyros melanoxylon</i>	Ebenaceae	
<i>Buchanania lanzan</i>	Anacardiaceae	
<i>Aegle marmelos</i>	Rutaceae	
<i>Semecarpus anacardium</i>	Anacardiaceae	
<i>Emblica officinalis</i>	Euphorbiaceae	
<i>Lagerstroemia parviflora</i>	Lythraceae	
<i>Adina cordifolia</i>	Rubiaceae	
<i>Holoptelea integrifolia</i>	Urticaceae	
<i>Mitragyna</i>	Rubiaceae	
<i>Boswellia serrata</i>	Burseraceae	
<i>Ougeinia oojeinensis</i>	Leguminosae	
<i>Miliusa tomentosa</i>	Annonaceae	
<i>Anogeissus latifolia</i>	Combretaceae	
<i>Pterocarpus marsupium</i>	Leguminosae	
<i>Ailanthus excelsa</i>	Simaroubaceae	
<i>Sterculia urens</i>	Sterculiaceae	
<i>Wrightia tinctoria</i>	Apocynaceae	
<i>Kydia calycina</i>	Malvaceae	
<i>Bridelia retusa</i>	Euphorbiaceae	
<i>Bauhinia retusa</i>	Caesalpiniaceae	
<i>B. integrifolia</i>	Caesalpiniaceae	
<i>B. malabarica</i>	Caesalpiniaceae	
<i>B. racemosa</i>	Caesalpiniaceae	
<i>B. Purpurea</i>	Caesalpiniaceae	
<i>Elaeodendron glaucum</i>	Celastraceae	
<i>Ficus infectoria</i>	Moraceae	
<i>Melia azedarach</i>	Meliaceae	
<i>Anogeissus latifolia</i>	Combretaceae	
<i>Bombax ceiba</i>	Bombacaceae	
<i>Ziziphus mauritiana</i>	Rhamnaceae	
<i>Strobilanthes angustifrons</i>	Acanthaceae	
<i>Ricinus communis</i>	Euphorbiaceae	Shrubs
<i>Carissa opaca</i>	Apocynaceae	

Table 1 continued

Plant/taxa (scientific name)	Family	Habit
<i>Rungia repens</i>	Acanthaceae	Herbs/ Terrestrial herbs
<i>R. elegans</i>	Acanthaceae	
<i>Calotropis procera</i>	Asclepiadaceae	
<i>Holarrhena antidysenterica</i>		Herbs/ Terrestrial herbs
Grasses	Poaceae	
Tubuliflorae	Asteraceae	
Liguliflorae	Asteraceae	Herbs/ Terrestrial herbs
<i>Xanthium strumarium</i>	Asteraceae	
<i>Ageratum conyzoides</i>	Asteraceae	
<i>Artemisia</i>	Asteraceae	Herbs/ Terrestrial herbs
<i>Justicia simplex</i>	Acanthaceae	
<i>Chenopodium album</i>	Chenopodiaceae	
<i>Amaranthus viridis</i>	Amaranthaceae	Herbs/ Terrestrial herbs
<i>Alternanthera</i>	Chenopodiaceae	
<i>Sida rhombifolia</i>	Malvaceae	
<i>Portulaca</i>	Portulacaceae	Herbs/ Terrestrial herbs
<i>Euphorbia hirta</i>	Euphorbiaceae	
<i>E. thymifolia</i>	Euphorbiaceae	
<i>Trigonella foenum</i>	Fabaceae	Herbs/ Terrestrial herbs
<i>T. occulata</i>	Fabaceae	
<i>Achyranthes aspera</i>	Amaranthaceae	
<i>Manus japonicas</i>	Scrophulariaceae	Herbs/ Terrestrial herbs
<i>Cynoglossum meeboldii</i>	Boraginaceae	
<i>Viola suffruticosa</i>	Violaceae	
<i>Nepeta indica</i>	Lamiaceae	Herbs/ Terrestrial herbs
<i>Leucas aspera</i>	Lamiaceae	
<i>Colebrookea oppositifolia</i>	Lamiaceae	
<i>Cynodon dactylon</i>	Poaceae	Herbs/ Terrestrial herbs
<i>Polygonum plebeium</i>	Polygonaceae	
<i>Rotala rotundifolia</i>	Lythraceae	
<i>Ammannia baccifera</i>	Lythraceae	Herbs/ Terrestrial herbs
<i>Cyperus rotundus</i>	Cyperaceae	
<i>Schoenoplectiella articulata</i> (L.) Lye	Cyperaceae	
<i>Gnaphalium polycaulon</i>	Asteraceae	Herbs/ Terrestrial herbs
<i>G. luteo-album</i>	Asteraceae	
<i>G. pensylvanicum</i>	Asteraceae	
<i>Hydrilla verticillata</i>	Hydrocharitaceae	Aquatic herbs
<i>Nymphaea stellata</i>	Nymphaeaceae	
<i>Nelumbo nucifera</i>	Nelumbonaceae	
<i>Trapa</i> spp.	Trapaceae	Aquatic herbs
<i>Typha</i> spp.	Typhaceae	

Table 1 continued

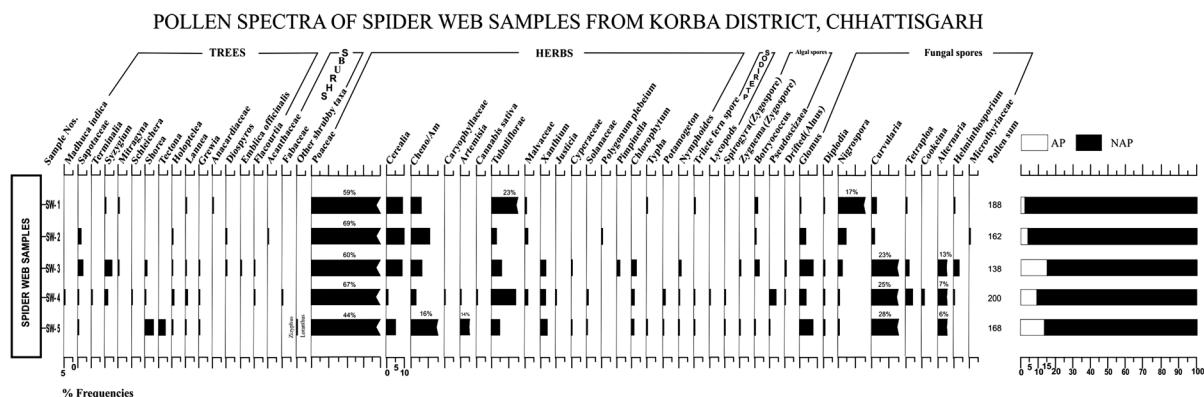
Plant/taxa (scientific name)	Family	Habit
<i>Lemna</i> spp.	Lemnaceae	
<i>Potamogeton</i> spp.	Potamogetonaceae	
<i>Nymphoides</i> spp.	Gentianaceae	
<i>Adiantum philippense</i>	Adiantaceae	
<i>Dryopteris prolifera</i>	Dryopteridaceae	
<i>Ceratopteris thalictroides</i>	Pteridaceae	Pteridophytic taxa
<i>Ophioglossum reticulatum</i>	Ophioglossaceae	
<i>Equisetum debile</i>	Equisetaceae	
<i>Selaginella lepidophylla</i>	Selaginellaceae	
<i>Lycopodium clavatum</i>	Lycopodiaceae	

The pollen sums range from 138 to 200, depending upon the pollen potential of the spider web samples analysed. A few samples were not so productive, so many slides were counted to reach the pollen sum of at least >100. 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), algal remains, drifted and fungal spores are arranged in the same manner in the pollen spectra (Fig. 2). The representation of major pollen rain components has been shown in the composite pie diagrams prepared separately for the samples, depicting the contribution of each plant group in the regional pollen rain (Fig. 3).

3 Results

The pollen rain composition of SW-1 reveals the dominance of non-arboreal taxa (97.88 %) over the arboreal taxa. Among the arboreals, which contribute 2.12 % of the total pollen rain, Anacardiaceae, *Mitragyna*, *Syzygium* and *Lannea* (<1 % each) have sporadic representation. Grasses (Poaceae) (59.04 %) predominate the ground vegetation, which is followed by Tubuliflorae (22.79 %). Cerealia (9.01 %) and Chenopodiaceae/Amaranthaceae (Cheno/Am) (5.83 %) have better representation in comparison with the other herbaceous taxa such as Malvaceae (1.06 %), which is sparsely recorded. *Typha* (1.06 %), the aquatic taxon, and the green alga, *Botryococcus* (1.59 %), is scarcely retrieved in low value. Trilete fern spores (0.53 %) are meagre. The fungal spores such as *Nigrospora* (17.2 %) has high values, whereas *Curvularia* (3.18 %) and *Helminthosporium* (1.06 %) have better representation as compared to *Glomus*, *Tetraploa* and *Diplodia* (0.53 % each), which are recorded low.

In SW-2, the recovered palynoassemblages demonstrate the dominance of non-arboreals (95.73 %) over the low values of arboreal taxa, which have 4.27 % of the total pollen rain. Among the arboreal, Sapotaceae (1.83 %), *Holoptelea* (1.22 %) and *Diospyros* (0.61 %) are the tree taxa, whereas Acanthaceae (0.61 %) is the shrubby element. Poaceae (68.93 %) are the dominant herbaceous taxa, the value of which have comparatively increased and have highest values too, followed by Cheno/Am (10.98 %) and Cerealia (9.78 %). The other herbaceous taxa such as Tubuliflorae (3.05 %) decreased comparatively, whereas Malvaceae (1.83 %) has a bit increased in comparison

**Fig. 2** Pollen spectra of spider web samples from Bhulsidih Village, Korba District

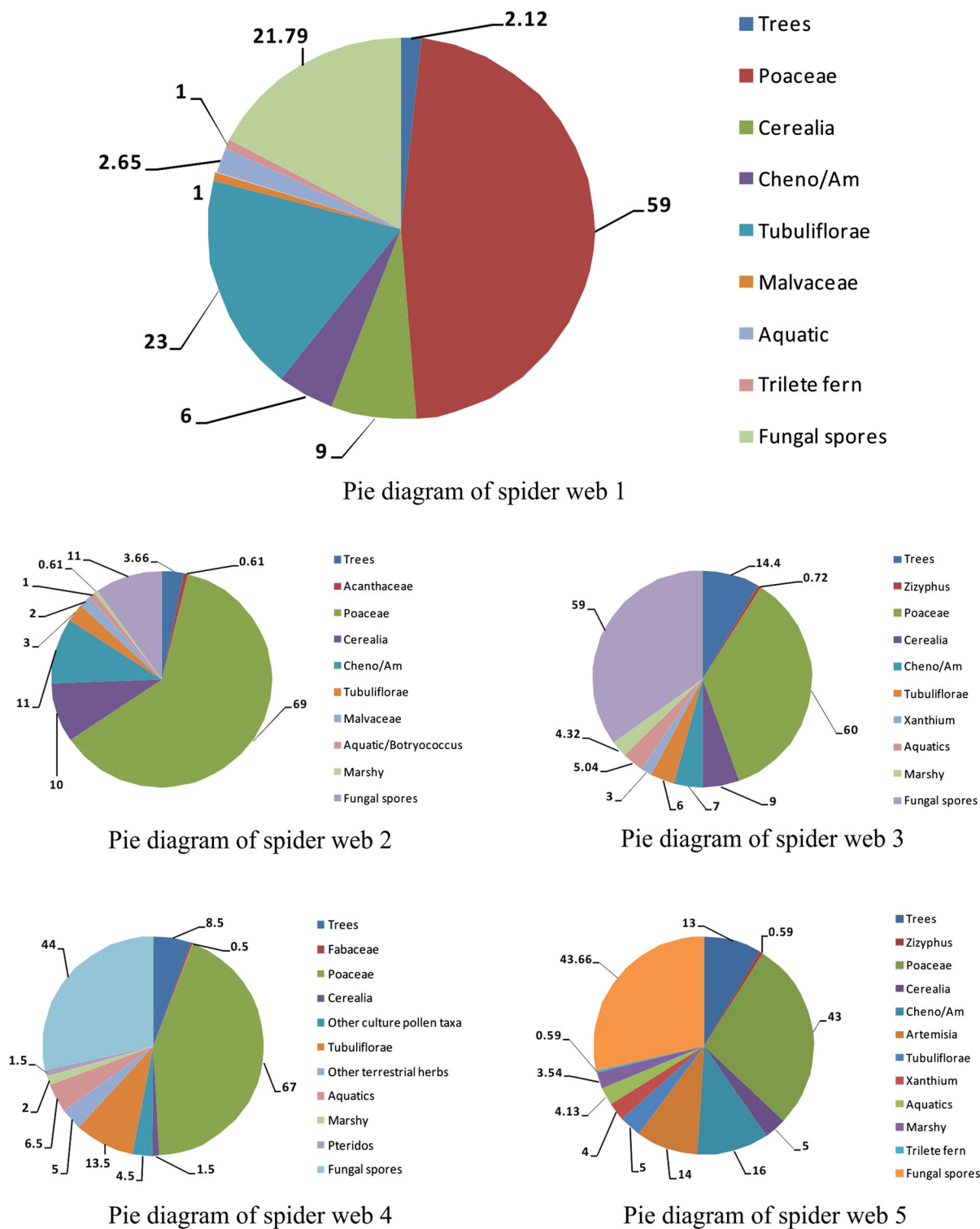


Fig. 3 Pie diagrams of spider web samples showing the major components of the pollen rain in and around the study site

with the previous sample (SW-1). *Polygonum plebeium* (0.61 %), the marshy element, is sporadic. *Botryococcus* (1.22 %) is scantily recorded. *Nigrospora* (4.88 %) and *Glomus* (3.66 %) have high values as compared to *Curvularia* (1.83 %) and Microthyriaceae (0.61 %).

SW-3 also illustrates the dominance of non-arboreals (84.88 %) over the arboreals (15.12 %); however, the values of arboreals have comparatively increased. Among the tree taxa, *Syzygium* (4.32 %) and Sapotaceae (2.88 %) have moderate values. *Shorea robusta* and *Embllica officinalis* (1.44 % each) have low values, whereas *Holoptelea*, *Mitragyna*, *Lannea*, *Diospyros*, *Grewia* and *Flacourtia* (0.72 % each) have meagre representation. *Zizyphus* (0.72 %) is the sole representative of the shrubby taxa. Poaceae (59.76 %), among the herbaceous taxa, show its dominance in the pollen spectra. Cerealia (9.36 %) and Chen/Am (6.48 %) have less representation, whereas Tubuliflorae (5.76 %) a bit increased in the pollen rain as compared to the SW-2. *Xanthium* (1.44 %) is meagre. The marshy taxa such as *Chlorophytum* (2.16 %), *Pimpinella* (1.44 %) and Cyperaceae (0.72 %) have low to stray presence in the pollen rain. *Botryococcus* (2.88 %), *Nymphoides* (1.44 %) and zygospores of *Zygnema* (0.72 %) have moderately and scantily recorded. *Alnus* (<1 %) is the only element of the Himalayan taxa. *Curvularia* (23.04 %), *Alternaria* (12.96 %) and *Glomus* (7.92 %) are recorded in high values, whereas *Nigrospora* (3.6 %), *Helminthosporium* (2.88 %) and *Tetraploa* (2.16 %) have moderate representation in comparison with *Diplodia* (0.72 %), which is sparse.

SW-4 also shows the dominance of non-arboreals (91 %) over the arboreals (9 %). Among the tree taxa, *Syzygium* (2 %), *Holoptelea* (1.5 %), and *Terminalia*, *Shorea robusta* and *Grewia* (1 % each), Sapotaceae, *Madhuca indica*, *Schleichera* and *Flacourtia* (0.5 % each) have moderate to scanty representation along with the shrubby taxa Fabaceae (0.5 %). Herbaceous flora is represented by Poaceae (67 %) in very high frequencies followed by Tubuliflorae (13.5 %), Chen/Am (3 %) and Cerealia (1.5 %). Other constituents such as Caryophyllaceae, *Cannabis sativa*, *Justicia* and *Artemisia* (<0.5 % each) are encountered feebly. The marshy elements such as *Chlorophytum* (1.5 %) and *Solanum* (0.5 %) are recorded in low values. *Nymphoides* and zygospores of *Spirogyra* (0.5 % each), *Potamogeton* (1.5 %) and *Pseudoschizaea* (4 %) are the

aquatic taxa having variable moderate to low frequencies. Fern spores such as trilete fern spores (0.5 %) and *lycopods* (1 %) are meagre. *Alnus* (<5 %) is the only delegate of the Himalayan elements. *Curvularia* (25 %), *Alternaria* (6.5 %), *Glomus* and *Tetraploa* (4 % each) are recorded in high to moderate values, whereas *Nigrospora* and *Cookeina* (1.5 % each), and *Helminthosporium* (0.5 %) are sparse.

SW-5 also portrays the dominance of non-arboreals (86.43 %) over the arboreals (13.57 %). Among the tree taxa, *Shorea robusta* (4.72 %) and *Tectona grandis* (4.13 %), the two dominating taxa of the study area, are recorded in moderate frequencies, whereas their other associates such as *Mitragyna* (1.77 %) and *Grewia*, Sapotaceae and *Holoptelea* (0.59 % each) are scanty along with the shrubby taxa *Zizyphus* and *Loranthus* (0.59 % each). Poaceae (43.07 %), the dominating herb, is recorded in high frequencies followed by Chen/Am (15.93 %), *Artemisia* (13.57 %), Tubuliflorae and Cerealia (4.72 % each) and *Xanthium* (3.54 %). The marshy elements such as *Chlorophytum* (2.36 %), Cyperaceae and *Solanum* (0.59 % each) are low to sporadic. *Nymphoides*, *Typha* and *Potamogeton* (1.18 % each), *Botryococcus*, zygospores of *Zygnema*, *Spirogyra* and *Pseudoschizaea* (0.5 % each) have variable low to sparse values. Trilete fern spores (0.59 %) are scanty. *Curvularia* (27.73 %), *Glomus* (7.67 %) and *Alternaria* (5.9 %) have high frequencies, whereas *Diplodia* and *Nigrospora* (1.18 % each) are recorded in low values.

4 Discussion

The pollen analyses of spider web samples from Korba District, thus, demonstrate the dominance of pollen of herbs (average 59.56 %) and trees, whereas shrubs as well as fern spores and algal remains are poorly represented in the pollen rain. The pollen assemblages in the different spider web samples show variability in terms of the pollen and spore content because of their position, size and age. Among the arboreal pollen (7.62–6.12 % trees and 1.5 % shrubs) trapped in the collected spider webs, Sapotaceae, *Syzygium*, *Holoptelea*, *Lannea coromandelica*, *Shorea robusta* and *Grewia* are the predominating tree taxa and their intermittent representation corresponds largely with their presence in local flora, in addition to, their low

pollen dispersal efficiency (because of entomophilous mode of pollination) as well as poor preservation of their pollen on the substrate. However, *Madhuca indica*, *Terminalia*, *Mitragyna*, *Schleichera*, *Anacardiaceae*, *Diospyros*, *Emblica officinalis* and *Flacourtia* are also reported intermittently and comparatively have moderate values in the pollen rain, although being the common associates of the dominating taxon (*Tectona grandis*) in the floristics, which could be attributed to their low pollen productivity and differential pollen preservation as well. *Tectona grandis*, the dominating taxon of the forest as well as high pollen producer too (Bhattacharya et al. 1999), is encountered in only one sample (SW-5) with moderate value that could be ascribed to its low pollen dispersal efficiency as well as poor pollen preservation. The other forest constituents which grow in the forest have not been encountered at all, which could be inferred to their low pollen productivity owing to the entomogamy. Therefore, the palynoassemblages 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 candidly portrayed by the encounter of very high frequencies of grasses (Poaceae) as well as good number and frequencies of Tubuliflorae, Cheno/Am and Cereal. However, *Artemisia*, *Xanthium*, Malvaceae, Caryophyllaceae and *Justicia* have moderate to very less frequencies and also have intermittent representation in the pollen rain. *Chlorophytum*, *Pimpinella*, *Polygonum plebeium*, *Solanum* and Cyperaceae have intermittent low to sparse representation in the pollen rain, pointing towards the marshy condition around the sampling provenance. *Typha*, *Potamogeton*, *Nymphoides*, *Botryococcus*, zygospores of *Zygnema* and *Spirogyra* indicate the water condition in and around the study area. Ferns, which occur abundantly along the adjoining stream banks, are marked by the sporadic retrieval of trilete spores. The pteridophytic spore *lycopods* too is sparse. Their poor representation could be ascribed to the prevailing damp condition around the sampling provenance, which inhibits their easy dispersal by wind. Drifted pollen of *Alnus* (in a few samples only) shows the Himalayan connection of wind circulation pattern. The retrieval of different fungal spores such as *Glomus*, *Diplodia*, *Nigrospora*, *Curvularia*, *Tetraploa*, *Cookeina*, *Alternaria*, *Helminthosporium* and Microthyriaceae in variable

frequencies signifies the warm and humid climatic condition in the area of investigation.

The study could be significant aerobiologically too, as it could not only throw some light on the airborne pollen grains and spores but also provide the clue to find the remedial measures. These aeroallergens are regarded as a prospective cause of certain allergic disorders such as bronchial asthma, hay fever (allergic rhinitis/pollinosis), naso-bronchial allergy and other respiratory disorders, as well as conjunctivitis, contact dermatitis, eczema, food allergies and other health disorders. The symptoms of allergy caused by pollen grains are breathlessness, running and itching of nose and eyes and are termed as “pollinosis” (Mishra et al. 2002). The pollen content of the atmosphere varies according to local flora, climate (temperature, relative humidity, wind velocity and rainfall), meteorological factors and the season (Bush 1989; Jato et al. 2002; Gioulekas et al. 2004). The pollen grains and spores of various plants have been identified as potential allergens such as *Holoptelea integrifolia*, Poaceae (Grasses), *Anthocephalus* sp., *Butea monosperma*, *Cassia* spp., *Delonix regia*, *Dillenia indica*, *Kleinhovia hospita*, *Moringa oleifera*, *Tectona grandis*, Chenopodiaceae/Amaranthaceae, Asteraceae, ***Ailanthus excelsa***, *Morus alba*, *Ricinus communis*, *Eucalyptus* sp., ***Putranjiva roxburghii*** and ***Casuarina equisetifolia***, *Pinus roxburghii*, *Cannabis sativa*, Myrtaceae, *Terminalia arjuna*, *Melia azedarach* and *Parthenium hysterophorus*, *Dendrophthoe falcata* (Loranthus), *Mimosa pudica*, *Tinospora cordifolia*, *Aegle marmelos*, *Azadirachta indica*, *Polyalthia longifolia*, *Emblica officinalis*, *Prosopis juliflora*, *Salmalia malabarica/Bombax ceiba*, *Terminalia arjuna*, *Pinus roxburghii*, *Alnus* sp., *Betula*, *Quercus*, *Juglans*, *Fraxinus*, *Ilex*, *Fagus*, *Cupressus*, *Taxus*, *Alstonia scholaris*, *Argemone mexicana*, *Cannabis sativa*, *Artemisia*, *Xanthium strumarium*, *Cynodon dactylon*, *Cyperus rotundus*, *Ricinus communis*, *Alternaria alternata*, *Aspergillus flavus*, *A.fumigatus*, *A.nidulans*, *A. niger*, *A.terreus*, *Cladosporium cladosporioides*, *Curvularia lunata*, *Fusarium oxysporum*, *Alternaria*, *Nigrospora*, *Chaetomium*, *Cladosporium*, *Helminthosporium*, *Torula*, *Epicoccum*, *Curvularia*, *Fusarium*, *Monilia* sp. and *Penicillium citrinum*. (Ghosh 1989; Khandelwal 1992, 2001; Khandelwal et al. 1996; Bhattacharya et al. 1999; Abreu et al. 2003; Hussain et al. 2012; Rangaswamy et al. 2013; Ahlawat et al. 2014). Wind-pollinated

plants have a high potential of causing pollen allergy in susceptible individuals (Hussain et al. 2012) in comparison with the entomophilous plants (Mandal and Chanda 1981; Tilak 1984; Agashe 1989; Ong et al. 1995; Mondal et al. 1992, 1997), which were thought to be non-allergic. Therefore, a constant surveillance of airborne pollen is essential for understanding and treating allergic diseases related to pollen hypersensitivity (Cristofori et al. 2010). It is estimated that over 20 % of the world's population suffer from (IgE mediated) allergic disorders (Johansson and Haahtela 2004). In India also, the magnitude of allergic problem is alarming as more than 25 % of its population is known to suffer from major allergic problems (Sharma et al. 2007), out of which 73.4 % is constituted by respiratory allergy, while allergic rhinitis is about 3–4 % of the allergic problems (Shaikh 1997; Vishwanathan 1964).

So, in general, it can be stated that

1. It is hardly avoidable to get exposed to the natural allergen, and hence, it is quite indispensable to have up-to-date information of airborne pollen concentration which not only enables allergologists to establish right diagnoses and (will) ultimately facilitate an improved quality of life for the inhabitants of the area of investigation. (Altungolu et al. 2010; Ahlawat et al. 2014) but also will aid allergy sufferers to adopt preventive measures such as pharmaceutical therapy integrated with reduced exposure (World Health Organisation, 2003-http://www.worldallergy.org/professional/who_paa_2003.pdf). Allergic diseases can be controlled, and symptoms can be minimized if we know what triggers them (Guvensen et al. 2005).
2. The factors that exert an influence on the pollen production, ultimately affecting the retention of pollen grains and spores in webs, are wind speed and humidity besides CO₂ concentration, temperature, precipitation, etc. Increase in temperature will lead to an increase in the pollen production. The pollen production also relies on the accumulated rainfall in the previous months before the pollination season take place. Thus, airborne pollen can act as a rainfall indicator (Emberlin et al. 2000, 2007).
3. It is required to have “Pollen Calenders” in order to determine the pollen types and their proportions in the atmosphere/surroundings. Thus, it is suggested to prepare a “Pollen Calender” of the study area as has been done in many countries of the world (Giner et al. 2002; Abreu et al. 2003; Guvensen and Ozturk 2002, 2003; Gioulekas et al. 2004; Newnham et al. 1995; Weryszko-Chmielewska and Piotrowska 2004; Peternel et al. 2005; Docampo et al. 2007; Bilisik et al. 2008, etc.).

5 Conclusions

1. Spider web samples, besides various natural pollen traps/substrates, have also been proved to be an efficient natural trap of airborne pollen grains and spores.
2. The palynoassemblages recovered do not reflect the factual composition of the local vegetation of the study area, so far as the tree taxa are concerned (6.12 %). On the other hand, the ground vegetation is candidly portrayed by the encounter of very high frequencies of grasses (Poaceae) (average 59.56 %) and others (dominating terrestrial herbs—average 6.87 % and other terrestrial herbs—average 5.77 %).
3. The spider web samples also show variability in terms of the pollen assemblages because of their position, size and age.
4. Further research is required with large number of spider web samples from the untouched areas of the Chhattisgarh State and also from other areas of the subcontinent to generate good data set for the transfer functions regarding pollen representation on the various environmental parameters, as well as indicator taxa for particular ecosystems. This exercise will not only refine our understanding on the pollen deposition pattern of the area in question, which has a significant proposition for the reconstruction of past vegetation and climate i.e. pollen analysis, in the real sense of the term, but also, aerobiologically, will help evaluate allergenicity of the various aerospora around the area of investigation and also evaluate the risk of pollen allergy in similar other regions (Hamid et al. 2015).
5. Government organisations, non-government organisations (NGOs) as well as other national and international bodies may utilize the outcome of the present study in the public awareness

programmes regarding the aforementioned allergic disorders and other health hazards caused by pollen. Various media (print, electronic, etc.) can be used in disseminating the knowledge among the public regarding the allergic pollen and their forecasts (Hamid et al. 2015) so that they may become vigilant and simultaneously adopt preventive measures.

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