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Recovery of palynomorphs from the high-altitude cold desert of Ladakh, NW India: An aerobiological perspective

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ABSTRACT

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Palynomorphs from the air catches samples have been recorded for the first time from the arid landscape of Ladakh, Jammu and Kashmir. The study revealed that the pollen of *Pinus* sp. was the solitary tree taxon recorded from the air catches samples. The recovery of grasses, Caryophyllaceae and Asteraceae pollen shows agrarian activities in the region. The presence of fungal spores in the samples indicates warm and humid climatic conditions that prevail along the humid river valleys in the study area. Though the present record of aerobiota/palynomorphs is of fragmentary nature, nevertheless, this maiden attempt could be helpful in building the database on the distributional pattern of aerobiota in the study area with the aerobiological implication.

Key-words: Palynomorphs, air catches, aerobiology, Ladakh.

INTRODUCTION

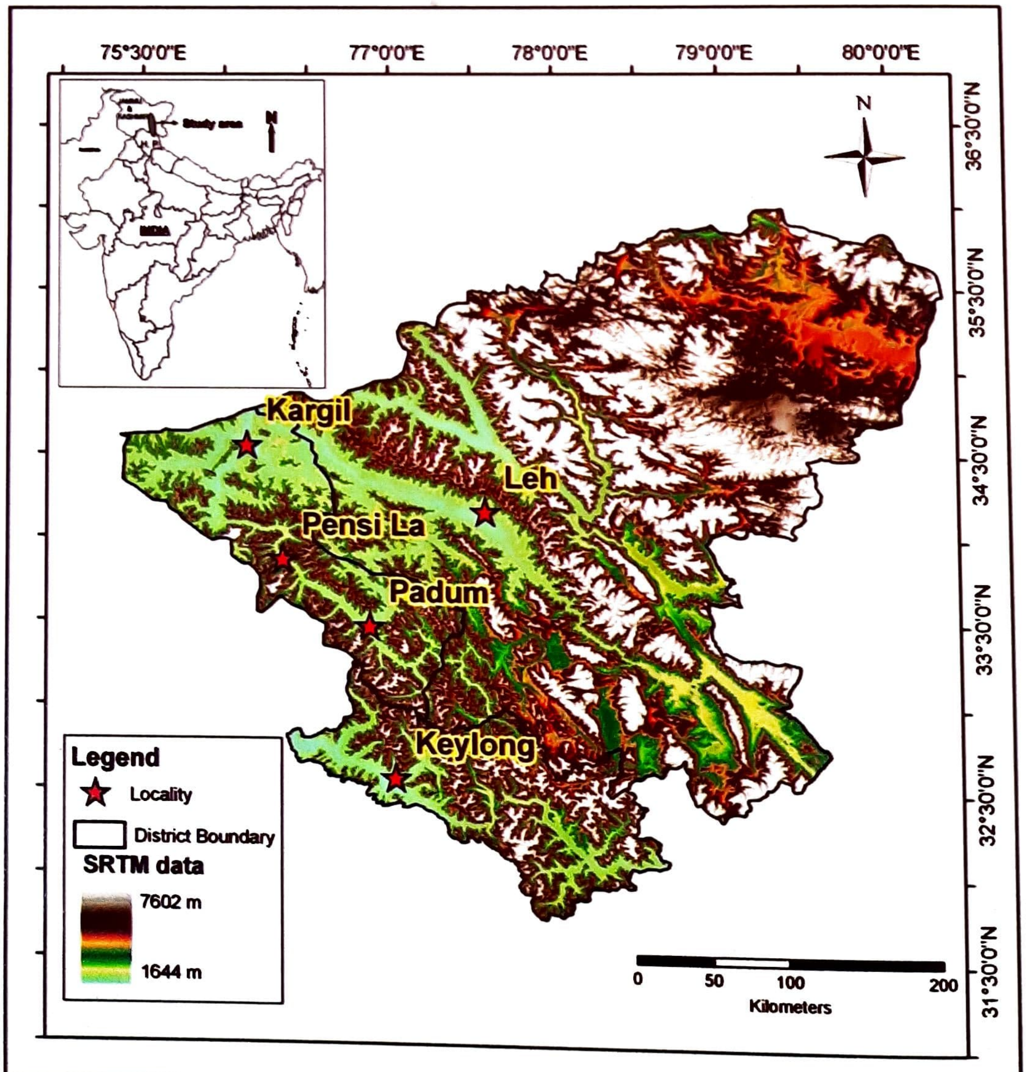
Palynomorphs are the organic-walled microfossils found in palynological preparations. The term "Palynomorphs" encompasses pollen grains, spores, diniflagellate cysts, acritarchs, chitinozoa, and scoleocodonts, however, other microfossils such as diatoms that are dissolved by HF are excluded from it (Tschudy 1961). Surface soil/sediments, mud samples, moss cushions/polsters, spider web samples, leaves (of *Sarracenia*) and tree bark samples are the commonly used substrates/media for the recovery of palynomorphs with the principal aim to understand the pollen deposition pattern of the study area that can be regarded as modern analogue for the reconstruction of past vegetation and climate (Adam 1967, Faegri & Iversen 1989, Moore et al. 1991, Groenman-van Waateringe 1998, Bera et al. 2002, Ranal 2004, Song et al. 2007, Quamar & Chauhan 2011, Song et al. 2013, Li et al. 2013, Song et al. 2014, Quamar & Bera 2015a,b). Aerobiological studies using Burkard sampler and air catches studies have been carried out from southern Ocean, Schismacher oasis and N-NW India (Bera & Khandelwal 2003, Bera 2005). The study on free-fall aerosols to understand the air-borne palynomorphs/aerospora/aerobiota in N-NW India has also been undertaken by Yadav et al. (2007). Several other mechanical pollen catching/trapping devices such as Rotorod sampler, Burkard Portable Air sampler, Burkard Personal Volumetric Air sampler, Tauber trap, Behling trap, modified Oldfield trap, reference trap, etc. are also well known for the study of airborne pollen grains and spores in a wide array of geographical area

(Bera et al. 2002, Jantz et al. 2013). In the present communication, an attempt has been made to extract and recover the palynomorphs from the air catches samples, collected from the altitudes ranging from 2500 to 4300 m asl at Ladakh, India with an aim to record the aerobiota for the first time from this region.

STUDY AREA

Ladakh, delimited by the Eastern Karakoram Range in the north and the Higher Himalaya of the Western Himalaya Range in the south, lies in the bio-geographic zone 1 (Trans Himalaya) amongst the 10 biogeographical zones of India (Raj & Sharma 2013). Mostly rugged mountains and valleys of Ladakh region is occupied by Kargil, Zanskar, Leh and Nubra valleys and cover more than 70% of the geographical area of the state. Kargil is located at a distance of 204 km from Srinagar, almost midway on the Srinagar-leh National Highway and is located at an average height of 10,000 ft. above sea level. Zanskar is a high altitude (11,500–23,000 ft.) semi-desert lying on the Northern flank of the Great Himalayan Range and is occupied by two main branches of the Zanskar River. Leh is the northern as well as the eastern most part of J&K State. It is one of the highest regions of the earth (altitude ~8,800 to 18,000 ft.) with mountains running along parallel ranges. The climate is very cold and in winter, temperatures dip to - 40 °C. Nubra valley known as Ldumra (the valley of flowers) is situated in the north of Leh. The average altitude of the valley is ~10,000 ft. above the sea level and is a high altitude cold desert with rare precipitation and scant vegetation except along river beds.

The arid landscape of Ladakh is a high altitude (> 3000 m asl) cold desert lying in the Eastern part of Jammu and Kashmir state of India (Text figure 1). The Higher Himalayan ranges act as a barrier and prevent



Text Figure 1. Shuttle Radar Topography Mission digital elevation model (SRTM-DEM) showing the study area.

the northward penetration of the Indian Summer Monsoon creating desert like conditions in this region (Raj & Sharma 2013). As the region geomorphologically and geographically falls in the rain shadow zone of the Indian summer monsoon, the main town of Leh in the region is reported to receive only 80–100 mm of rain in a typical year (Juyal 2014). Climatically the region is referred to the cold desert and is characterized by exceptionally low temperatures (25°C below freezing point), insufficient precipitation (rainfall and snowfall), diurnal pattern of temperature fluctuations and shortened growing season with insignificant growing season precipitation (Humbert-Droz & Dawa 2004).

VEGETATION OF THE STUDY AREA

The West Himalayan High-Level Blue Pine (*Pinus wallichiana*) Forest, West Himalayan Dry Juniper Forest or Steppe Forest and Sub-alpine Forest are found around the arid zone of the Ladakh (Champion & Seth 1968). It has been suggested (Champion & Seth 1968) that *Pinus wallichiana* is the characteristic of the West Himalayan High-Level Blue Pine Forest. In addition to this, *Pinus gerardiana*, *Abies spectabilis*, make up the top canopy trees, whereas *Betula utilis*, *Sorbus foliosa*, *Rhododendron campanulatum* form the second storey trees and *Juniperus communis*, *J. wallichiana*, *J. macropoda*, *Rhododendron anthopogon*, *Salix* spp., *Caragana* sp., *Ephedra*, *Lomicera* spp., are the shrubby vegetation of the area. The cold desert region of Ladakh Himalaya (Plate 1, figs. 1 & 6) comes under alpine and high alpine zones and is dominated by annual and perennial herbs, followed by few stunted shrubs and bushes growing in the moist and shady areas along the melt water and perennial streams (Plate 1, figs. 2-4 & 7). The harsh climate and low temperature limit the diversity of plant species in this region. Most of the vegetation can be seen on the river banks and fan deposits where the availability of moister is in plenty (Plate 1, figs. 2-4). Terrace cultivation in the area is a common practice but it is restricted to the summer months only (Plate 1, figs. 5 & 8). The vegetative growth starts at the commencement of summer when the melting snow provides abundant moisture. The flora is in full bloom in the months of mid July to August but starts disappearing by the end of September. The mountain slopes, meadows and alpine pasture lands give a spectacular display of flowers (Chaurasia et al. 2008).

MATERIAL AND METHODS

Microslides (70 mm x 26 mm x 1 mm) were used to trap the airborne palynomorphs in the month of July, 2015. The glass slides were smeared on both the sides with glycerine jelly in the form of a thin film. Subsequently, the slides were exposed in the air/environment for 10-15 minutes, and then put in the zipped polythene bags in order to prevent any contamination. A total number of 42 samples were analysed, however, 14 samples were found productive and used in the present study. The processing of samples in the laboratory was done using special care with each slide washed with ultra-pure water and then centrifuged. The supernatant was decanted and the residue was poured in plastic vials. A few drops of glycerine and phenols were added in the sample to make them homogeneous as well as to prevent any microbial attack/degradation.

RESULTS AND DISCUSSION

All the processed samples were studied under Olympus BH-2 microscope with attached DP 25 Software for photography. Conventionally ~250 pollen/spores are counted from an individual sample, however, in the present case the pollen and spore counts were not sufficient to construct pollen spectra. The study clearly indicated that *Pinus* pollen (Plate 2, figs. 1-4), which is the characteristic of West Himalayan High-Level Blue Pine Forest of the area, was the sole tree taxon recorded; . Also, a few *Pinus* pollen were degraded to an extent that suggest microbial and/or chemical degradation of pollens in the study area. Kelong sample was the solitary site from which the blue pine pollens were recovered indicating the wind transportation pattern in and around the study area. Besides, some other tree taxa such as *Pinus gerardiana*, *Abies spectabilis*, *Betula utilis*, *Sorbus foliosa*, *Rhododendron campanulatum*, etc. and shrubs such as *Juniperus communis*, *J. wallichiana*, *J. macropoda*, *Rhododendron anthopogon*, *Salix*

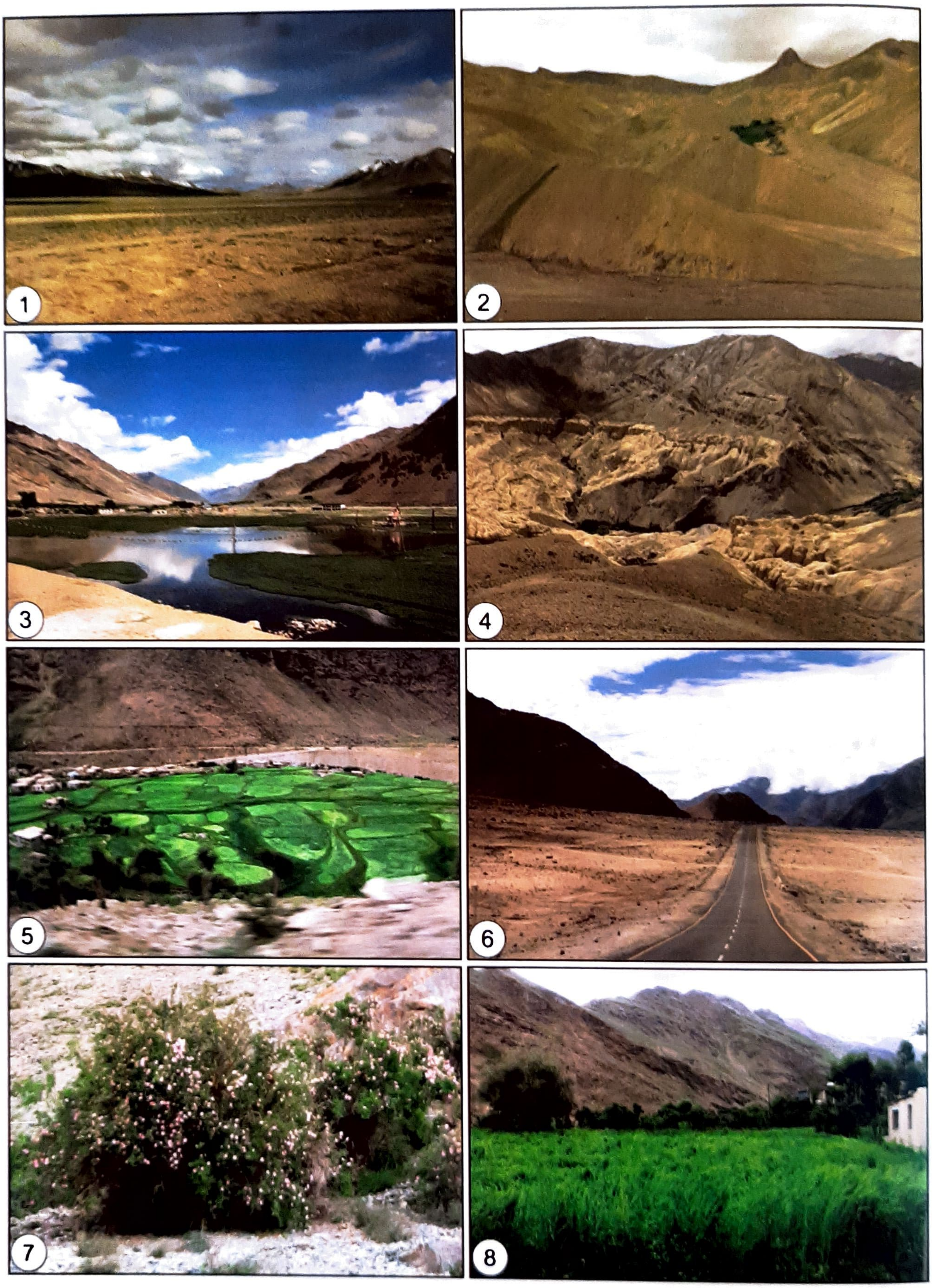


Plate 1

Field photographs showing different localities and patterns of vegetation, **1.** Pasture land of famous Moore plains, **2.** Selective patchy vegetation near moisture sources, **3.** Dispersed trees and grassland near Sani Lake, Padum, Zanskar, **4.** Vegetation cover along streams, **5.** Man-made terrace cultivation along the river banks, **6.** View of deserted valley near Leh, **7.** Wild rose in Zanskar valley, **8.** Wheat cultivation and willow trees near a village in Suru valley.

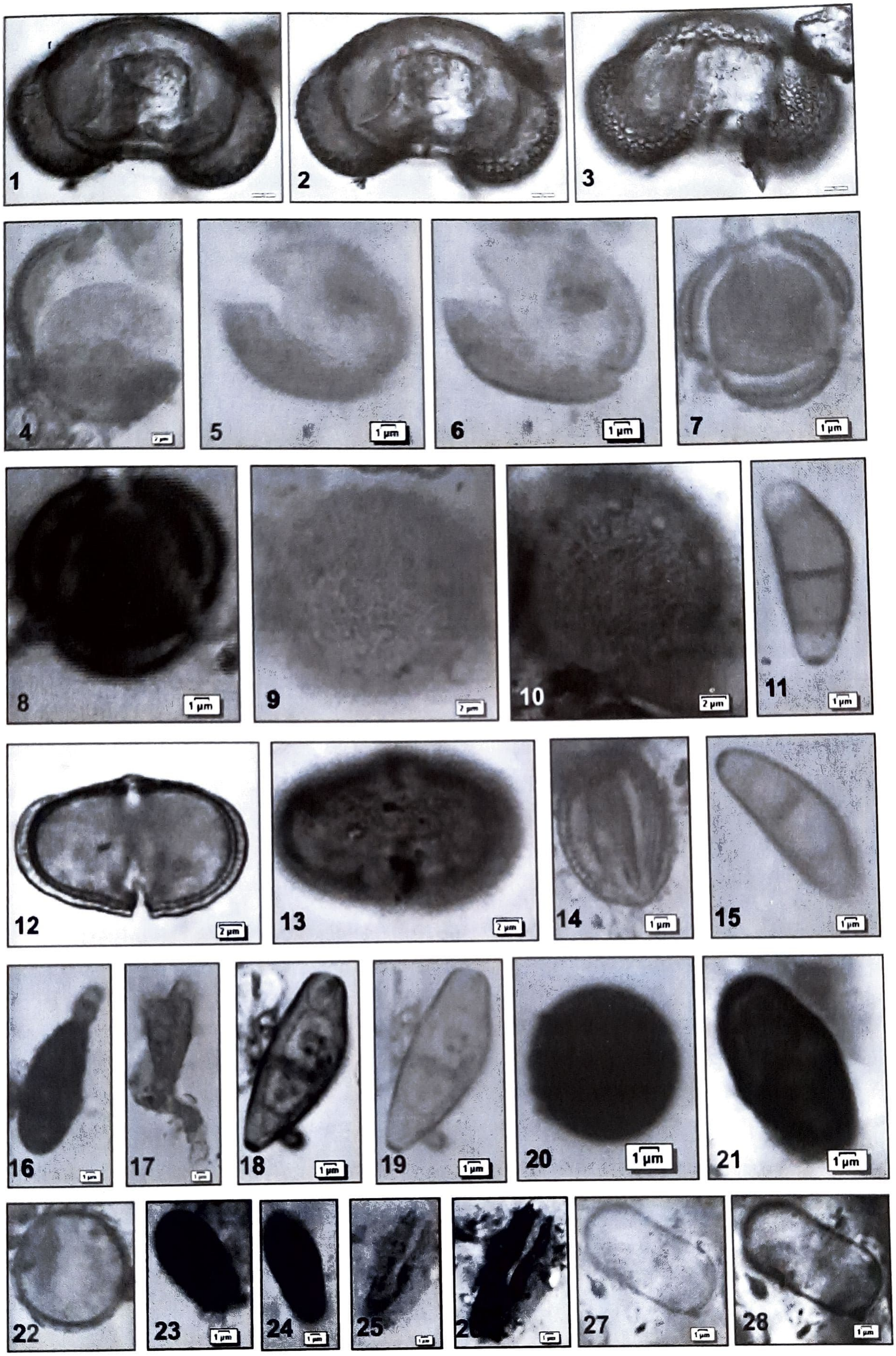


Plate 2

1-4. *Pinus* sp., 5 & 6. *Nelumbium nuciferum* (Nymphaeaceae), 7 & 8. *Artemisia* (Asteraceae) 9 & 10. Caryophyllaceae, 11 & 15. *Curvularia* (Moniliaceae), 12 & 13. *Carum carvi* (Apiaceae), 14. Ranunculaceae, 16 & 17. *Alternaria* (Dematiaceae), 18 & 19. *Helminthosporium* (Moniliaceae), 20. *Nigrospora* (Trichosphaeriaceae), 21. *Diplodia* (Botryosphaeriaceae), 22. Poaceae (Grasses), 23. Fungal spore I, 24. Fungal spore II, 25 & 26. Unidentified I, 27 & 28.Unidentified II.

spp., *Caragana* sp., *Ephedra*, *Lomicera* spp. are also growing in and around the study area but were not recovered at all, the reason assigned could be differences in their flowering periodicity, timing of collection of samples, wind velocity and direction, low (pollen) dispersal efficiency, pollen sinking speed, microbial and chemical degradation, etc. The occurrence of Poaceae (grasses), *Artemisia* (Plate 2, figs.7 & 8) and Caryophyllaceae (Plate 2, figs.9 & 10) pollen in the air catches indicates agrarian activities in the region. In addition, pollen of families Apiaceae (Plate 2, figs.12 & 13), Ranunculiaceae (Plate 2, fig.14) and Nymphaeaceae (cf. *Nelumbium nuciferum*) have also been recorded in the samples (Plate 2, figs. 5 & 6). *Alternaria*, *Helminthosporium*, *Curvularia*, *Diplodia* and *Nigrospora* are the prominent fungal spores recovered from the samples. Amongst the recorded fungal spores, *Alternaria* and *Curvularia* are saprophytic, whilst *Helminthosporium*, *Diplodia* and *Nigrospora* are of parasitic nature (Plate 2, figs. 16-25). Besides, some unidentified fungal spores were also noticed. The assemblage of fungal spores is indicative of warm and humid climatic conditions around the study area (Gupta 1970, Sharma 1976, Limaye et al. 2007, Mandaokar et al. 2008, Chaurasia et al. 2008, Quamar 2015). Although, the Ladakh region is a cold arid desert, however, the presence of fungal spores suggests warm and humid climate. In all probabilities, the environment along the river valleys is warm and humid during the summer season (as the samples were collected during the month of July) and is in contrast to the regional climate of the area. Moreover, their record and flourishing behaviour in the Ladakh region suggests either their adaptability to such a harsh climatic regime or it could be the result of abundant moisture and high day temperature in the valley regions. In addition, some unidentified aerobiota have also been recorded (Plate 2, figs. 26-28).

The dominance of the local flora over extraneous ones clearly indicate their adaptability to the local/ regional harsh climate of the Ladakh region. Adaptation to the environment by the potential flora of a region leads to certain changes in underground and aerial parts of plants for their survival. The vegetation of the cold desert Trans-Himalayas consists of a highly specialized group of plants having characteristic metabolic and reproductive strategies suited for maximizing their activity in xeric climatic conditions (Chaurasia et al. 2008). In view of this, the present study could be aerobiologically helpful in assessing the allergenic property of various pollen grains/spores in the area of investigation. It may be mentioned here that allergens of pollen grains and spores are responsible for bronchial asthma, hay fever (allergic rhinitis/pollinosis), naso-bronchial allergy and other respiratory disorders alongwith conjunctivitis, contact dermatitis, eczema, food allergies and other health disorders as various plant taxa have been identified as the potential allergens (Ghosh 1989, Khandelwal 1992, 2001, Khandelwal et al. 1996, Bhattacharya et al. 1999, Quamar & Chauhan 2011, Hussain et al. 2012, Rangaswamy et al. 2013, Ahlawat et al. 2014, Quamar & Bera 2015b).

CONCLUSION

The present record of palynomorphs may be helpful in building the database on the distributional pattern of aerobiota in the study area. This study is also significant for the identification of palynomorphs from the Quaternary sediments that ultimately may lead to the accurate interpretation of pollen diagram for the reconstruction of past vegetation and climate of the study area and other areas having similar vegetational scenario. Systematic studies throughout a calendar year are further required to explore the possibility of air catches samples in aerobiological studies, which has immense societal value. The information gathered from such studies can be used in palaeoecological, palaeoenvironmental and palaeoclimatic reconstructions. Further using specialized air sampler for longer time may be more useful in order to have adequate pollen recovery.

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