Studies on Mansar Lake deposit, Jammu-Pollen analysis and palaeoclimatic changes-part I

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The vegetational pattern and the palaeoclimatic changes during the Late Holocene have been studied from a 1.5m deep core profile of the Mansar lake, Jammu. 36 types of taxa have been identified from the pollen assemblage. The dominant among them are *Pinus roxburghii, Quercus, Dodonaea, Artemisia, Alnus, Mallotus, Oldenlandia,* pollen of Amaranthaceae/ Chenopodiacea complex, Cyperaceae and Caryophyllaceae. Continuous presence of *Cerealia* type pollen indicate establishment of cultivation in the area.

Key-words—Mansar lake, pollen analysis, palaeoclimate, vegetational pattern.

INTRODUCTION

MANSAR lake is situated about 45 km (32° 42' N, 75° 9'E) from Jammu and lies at an altitude of 666 m above the sea level. The lake sediments consists of clay, sandstone and conglomerates which extend from the flanks of lower Siwaliks (Outer Himalayas) on its north. It is spread over ca 0.75 km^2 with a maximum length of ca 1.0 km, width ca 0.75 km and a water depth ranging from 28 to 30 m. Except for a small river that curves out from it on the northwest and flows to the southeast there is no other drainage system.

The site was selected not only for the palaeofloristic studies but also to look for the evidence of cultivation (Gupta & Nautiyal 1997). Recently there have been reports of cultivation from other regions of the Kashmir Valley on the basis of palynological evidence by Vishnu-Mittre and Sharma 1966; Dodia *et al.,* 1985 and archaeological excavations (Buth, Bisht & Gaur 1982; Sharma 1982). Borehole cores were obtained from two different sites of the lake *viz* MS-5 and MS-7. The results of MS-5 will be published elsewhere.

MATERIAL AND METHOD

In the present paper the pollen analysis from MS-7 is being included. This site lies on the northwest part of the lake. The observations are based on analysis of core samples taken at a regular interval of 1 cm. 145 samples from a 1.5 m deep core were studied. The material was obtained from PRL (Physical Research Laboratory) through the kind courtesy of Professor D.P. Agrawal. One of us (CG) visited the institute (PRL) personally to sort out the cores which were stored under a regulated temperature. Samples of 1cm^3 were taken out with a spatula and kept in air tight vials. The cores representing chunks of mud are soft grained, light brown in colour and get distintegrated quickly in water. The age of the core is determined to be Late Holocene, dating back to 2000 B.P according to the ^{14}C method carried out at the PRL, Ahmedabad.

PALYNOSTRATIGRAPHY

Pollen Spectrum

The pollen spectrum of MS-7 as shown in Fig. 1 depicts the following assemblage :- *Pinus (Pinus roxburghii)* (Plate 1, fig. 6) 33.4%, *Abies* (Plate 1, fig.

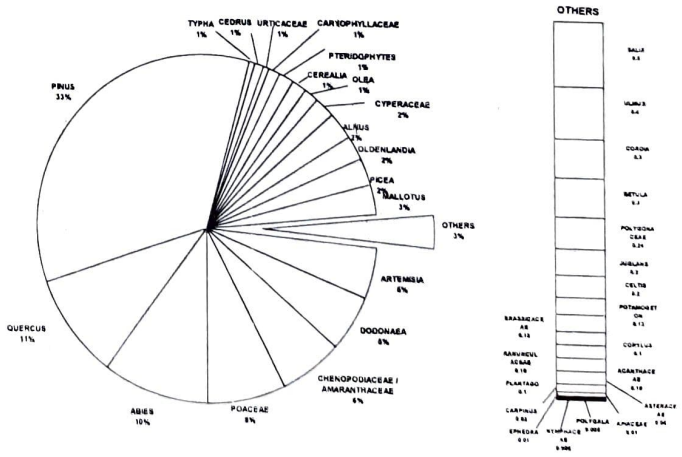

Fig 1. Pollen spectrum of Mansar lake (MS-7)

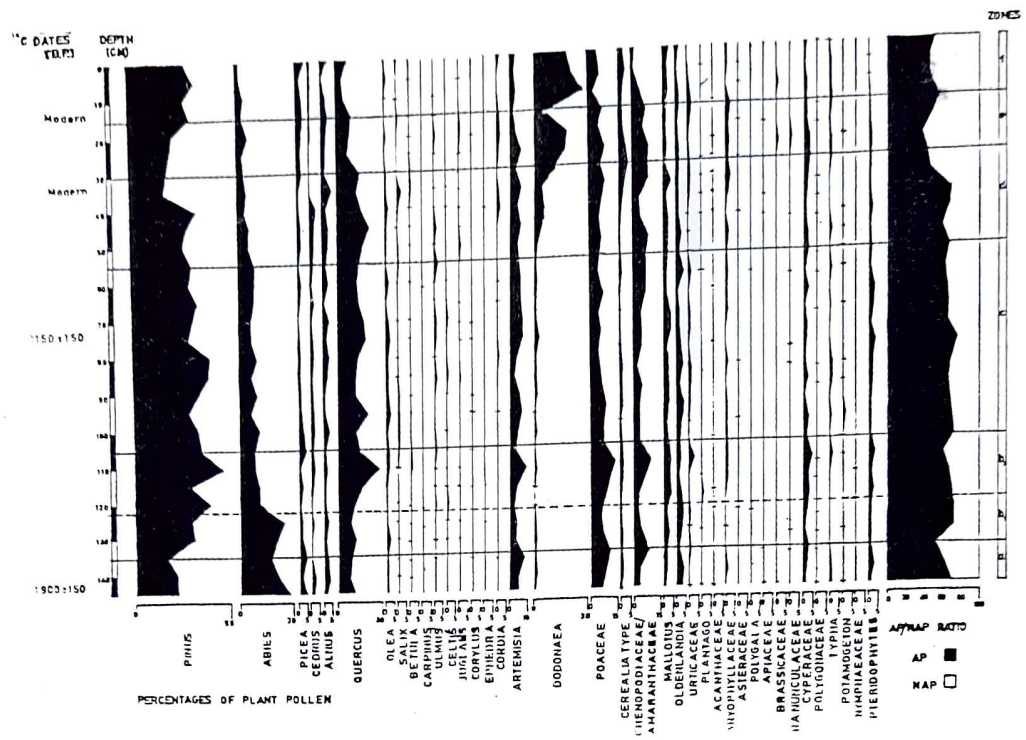

Fig. 2. Pollen diagram of Mansar lake MS-7

1) 9.7%, *Quercus* (Plate 1, fig. 17) 11.1%, Poaceae (Plate 2, figs. 1 & 12) 7.5%, Amaranthaceae-Chenopodiaceae complex (Plate 2, fig 5) 5.7% *Dodonaea* (Plate 2, fig. 2) 5.2%, *Artemisia* (Plate 1, fig. 11) 47%. A low percentage of a number of other pollen morphotypes was recorded as shown in the pollen spectrum. These include pollen of *Picea* (Plate 1, fig. 2) 2.4%, *Cedrus* (Plate 1, fig. 3) 0.68%, *Alnus* (Plate 1, fig. 10) 2.3%, *Olea* (Plate 1, fig. 9) 1.4%, *Cerealia* (Plate 2, fig. 1) 1.3%, Caryophyllaceae 1.1%, Urticaceae (Plate 2, fig. 6) 0.7%, Cyperaceae 2%, *Mallotus* (Plate 1, fig. 13) 2.8%, *Oldenlandia* (Plate 1, fig. 12) 2.3% and pteridophytes (Plate 2, figs 10 & 11) 1.2%. The pollen grains of *Betula* (Plate 1, fig. 4), *Carpinus, Ulmus* (Plate 1, fig. 16), *Celtis, Juglans* (Plate 1, fig. 5), *Corylus* (Plate 1, fig. 15), *Ephedra* (Plate 1, fig. 7), *Cordia, Plantago* (Plate 1, fig. 8), Acanthaceae (Plate 2, figs 13 & 14), Asteraceae (Plate 2, fig. 3 & 7), Brassicaceae (Plate 1, fig. 14), Ranunculaceae, Apiaceae (Plate 1, fig. 18), Polygonaceae (Plate 2, figs 8 & 9), *Typha* (Plate 2, fig. 4) and *Potamogeton* recorded relatively a low percentage ranging from 0.1-0.5%. The pollen grains of *Polygala* and Nymphaeaceae showed the minimum percentage (0.006%) in the total pollen diversity of the soil profile.

Pollen Diagram

As depicted in Fig. 2 the pollen diagram of MS-7 reveals the rise and fall of a taxon over a period of time. Six pollen zones defined on the basis of the pollen dominance are identified. Each zone comprises pollen of both arboreal and nonarboreal plants at the specified depth of the soil profile. These zones are described below in the ascending stratigraphical sequence starting from the base of the palaeosoil profile. The figures within the parenthesis indicate the depth.

PLATE 1 →

(All photomicrographs are x 1200 except where stated)

Fig. 1 *Abies* x 480, Fig. 2 *Picea* x 480, Fig. 3 *Cedrus* x 480, Fig. 4 *Betula*, Fig. 5 *Juglans*, Fig. 6 *Pinus* x 480, Fig. 7 *Ephedra* x 480, Fig. 8 *Plantago*, Fig. 9 *Olea*, Fig. 10 *Alnus*, Fig. 11 *Artemisia*, Fig. 12 *Oldenlandia*, Fig. 13 *Mallotus*, Fig. 14 Brassicaceae, Fig. 15 *Corylus*, Fig. 16 *Ulmus*, Fig. 17 *Quercus*, Fig. 18 Apiaceae

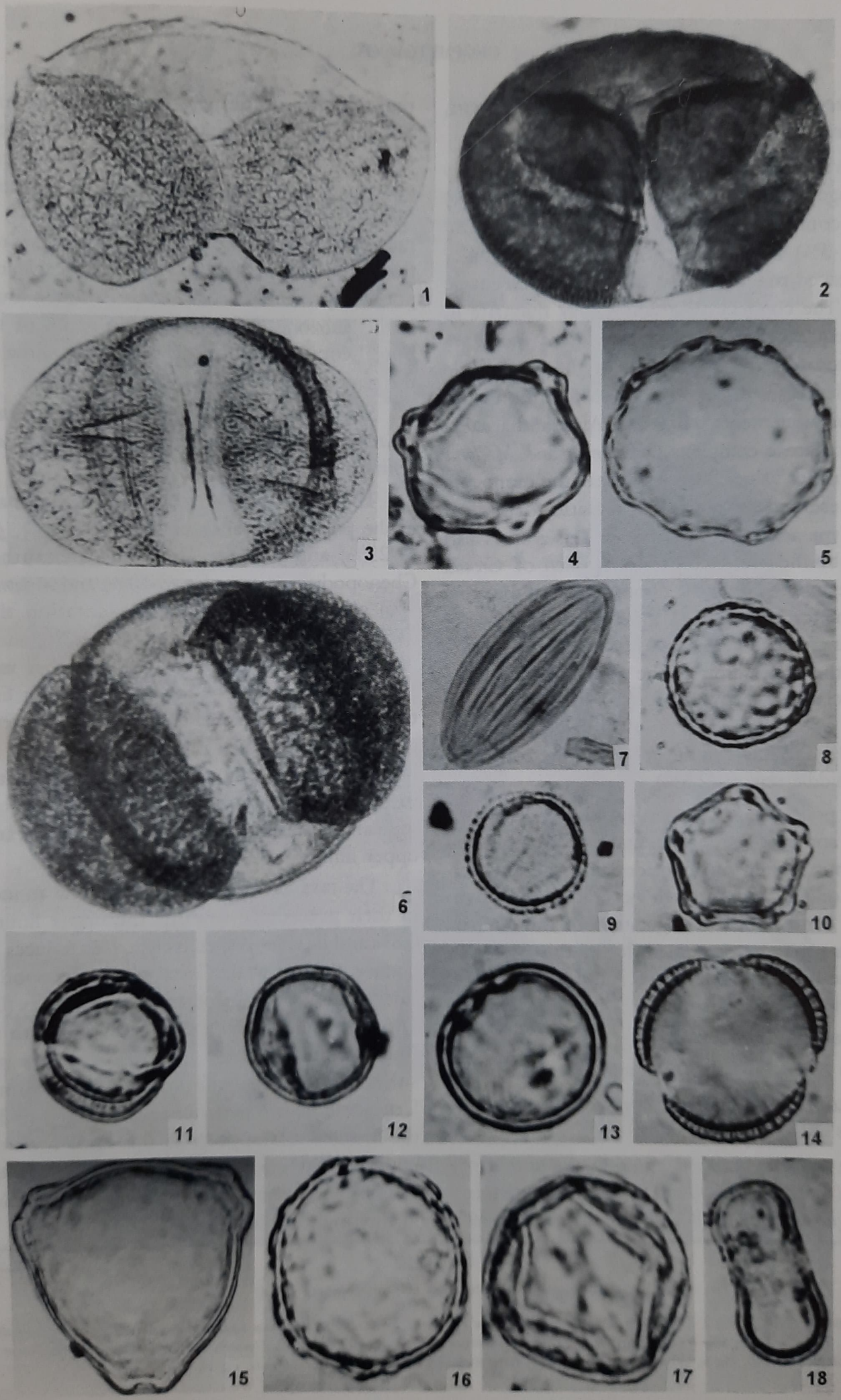

PLATE 1

Zone-a* (1.50-1.35m) : *Abies, Pinus, Quercus, Poaceae.

This zone is characterised by the high frequency percentage of *Abies* (18-28%) and *Pinus* (18-24%) among conifers and that of *Quercus* (7-9%) and *Alnus* (1-3%) among the broad leaved trees. Other broad leaved tree taxa show a very low percentage (1-8%). The conifers *Picea* and *Cedrus* fluctuate in their frequency within the zone. *Picea* increases (3.9%) towards the upper part of the zone while *Cedrus* decreases from 2% to 0.5%. Among the nonarboreal elements *Artemisia,* Amaranthaceae - Chenopodiaceae complex, *Oldenlandia* and *Mallotus* show a higher value. Except Poaceae the monocots are represented by pollen of aquatic forms like *Typha,* Cyperaceae and *Potamogeton.* This zone is also marked by the presence of stray pollen of *Crealia* in the beginning but in the upper region of the zone its frequency increases (1.1%). Poaceae shows a gradual increase (7-11%). *Plantago* makes an appearance in the upper limit of the zone. *Dodonaea* also shows relatively a low value (0.3-1%). The pteridophyte assemblage show a lower value in the upper (1.1%) and lower limits (0.9%) of the zone than in the middle region (2.5%).

The pollen diagram reveals a higher density of conifers and a poor representation of broad leaved trees. Thus taking into consideration the low percentage of the undergrowth vegetation the possibility of dense arboreal vegetation of the temperate climate may be presumed during this period of time. The B/C ratio is 0.2 to 0.3 and the AP/NAP ratio varies from 1.1 to 2.3.

***Zone-b* (1.35-1.05m)**

This zone consists of two subzones b1 and b_2:

Subzone - b_1* (1.35-1.22m) : *Pinus, Abies, Quercus

The subzone is characterised by the dominance of *Pinus* (18-38%) and *Abies* (18-25%). The percentage of *Quercus* pollen (8-10%) increases marginally than in *Zone-a.* The percentage of *Abies* and *Picea* remains almost unchanged but the frequency of *Cedrus* (0.5%-0.8%) is reduced to a low value as compared to the preceding zone. The percentage of *Alnus* (1-2%) decreases while *Olea* (1-2%) shows marginal rise in its frequency but it decreases towards the upper limit. Other broad leaved trees which were poorly represented in *Zone-a* also show a low value in this subzone (0.1-0.5%). Pollen grains of non-arboreal components of the vegetation show almost the same frequency as in *Zone-a.*

Subzone-b_2* (1.22-1.05m) : *Pinus, Quercus, Poaceae, Amaranthaceae/Chenopodiaceae, Artemisia

The *Subzone-b_2* is characterised by the sharp rise in the pollen frequency of *Pinus* (32-51%), *Quercus* (8-23%) and Poaceae (7-14%). Amaranthaceae Chenopodiaceae complex (3-10%) and *Artemisia* (2-9%) also show a better representation than in *Subzone-b_1.* The taxa like *Ulmus* (0.2-1.2%) and *Celtis* (0.1-1%) which are present with a higher value in the lower strata decline towards the upper limit of this zone but the frequency of *Ulmus* increases marginally. *Plantago* which is poorly represented in the lower zones abruptly increases in its concentration in the initial stage of this subzone (0-1%) but no indication of its presence was found towards its upper limit.

The taxa like *Salix* and *Betula* show an increase in their percentage towards the upper limit (0.2-0.8% and 0-0.7%, respectively). *Abies* reduces in frequency (9-11%) while *Cedrus* which was poorly represented in *Subzone-b_1* increases in frequency (0-2%). *Picea* continues without change except with minor fluctuations (1-3%). *Dodonaea* appears in this subzone towards the upper limit. Similarly Urticaceae whose occurrence is irregular (0-3%) in the lower zones appears in this zone towards the upper limit. Pteridophytes also show no change (1-3%). Other taxa are represented with low values as in the preceding zone.

PLATE 2 →

(All photomicrographs are x 800 except where stated)

Fig.1 Poaceae (*Cerealia*), Fig 2. *Dodonaea* x 1200, Fig 3. *Taraxacum,* Fig 4. *Typha* x 1200, Fig 5. Amaranthaceae/Chenopodiaceae complex x 1200, Fig 6. Urticaceae x 1200, Fig 7. Asteraceae, Fig 8. *Polygonum lapathifolium* x 480, Fig 9. *Polygonum plebeium* x 1200, Fig 10. *Osmunda,* Fig 11. *Pteridium,* Fig 12. *Poaceae* x 1200, Fig 13. *Adhatoda*, Fig 14. *Justicia*

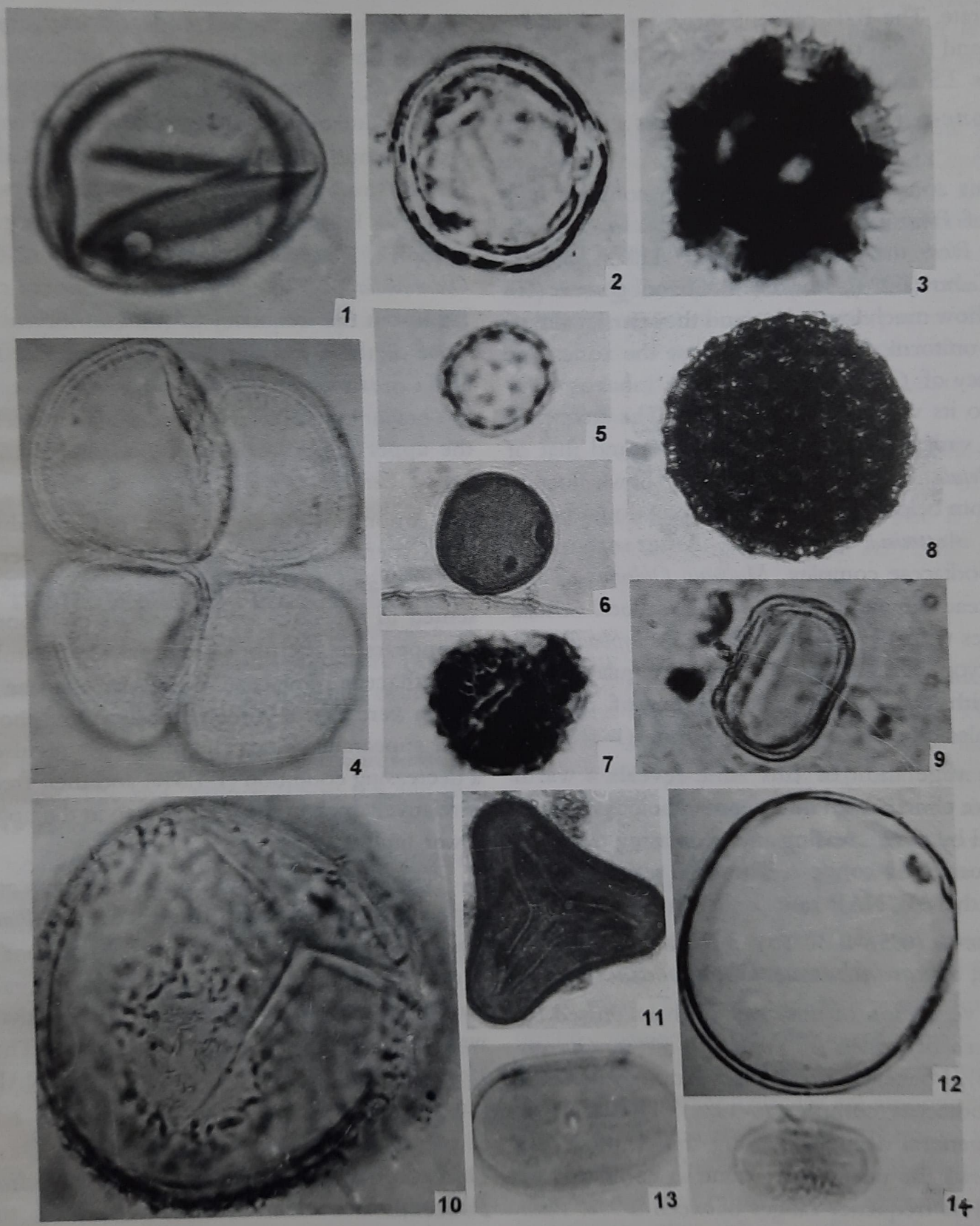

PLATE 2

The beginning of the zone is marked by cooler climate with dominance of conifers but in the later phase the conditions seem to have become warm temperate. The B/C ratio of the *subzones* b_1 and b_2 is 0.2 and 0.2 to 0.4 respectively and the AP/NAP ratio is 2.5 and 1.5 to 2.6 respectively.

***Zone-c* (1.05-0.55m) : *Pinus*, *Quercus*, *Abies*.**

This zone is characterised by a constant high value of *Pinus* ranging from 32-44%. In comparison to *Pinus* the taxa like *Abies* (7-11%), *Picea* (1-3%), *Cedrus* (1-2%), *Alnus* (1-4%) and *Quercus* (10-16%) show much low values and they persist almost with a uniform density throughout the zone. The frequency of *Quercus* shows a lower value as compared to its value in the *Subzone-b*$_2$. The frequency of *Olea* varies within the zone (1-3%) and that of *Salix, Betula, Ulmus* and *Juglans* also shows fluctuations from below 0.5% to 1%. Among non-arboreal forms *Artemisia,* Poaceae, Amaranthaceae-Chenopodiaceae complex, *Mallotus, Oldenlandia* and Cyperaceae show uniformity in their values. *Cerealia* continues with a low value (0.1-0.8%). *Typha* (0-1%) and Caryophyllaceae (0-1%) show irregular occurrence with low values. The frequency of pteridophytes also fluctuates within the zone (1-3%).

The vegetation of this zone reveals a warm temperate climate with intervening cooler phases as indicated by the increasing and decreasing trends in the frequency of conifers. The B/C ratio is 0.3 to 0.6 and the AP/NAP ratio is 1.7 to 2.3.

Zone-d* (0.55-0.30 m) : *Pinus*, *Quercus*, *Poaceae*, *Amaranthaceae/Chenopodiaceae

The vegetation of this zone is characterised by dominance of pollen of *Pinus* (18-34%), *Quercus* (11-18%), Poaceae (5-9%) and Amaranthaceae-Chenopodiaceae complex (5-12%). The conifers show a general decline. Among the conifer taxa *Abies* shows the next higher value as compared to *Pinus* and its frequency ranges between 3-9%. *Picea* reduces in frequency towards the upper limit from 2 to 1% and *Cedrus* shows a very low percentage at the close of this zone (0.5%). *Alnus* was also found among the dominating taxa of the tree forms and its frequency ranges from 2-5%. The frequency of *Olea* shows a low percentage in the beginning (1%) but it increases towards the upper limit (2%). *Salix* also shows the same trend and its frequency increases towards the upper limit to 2.5%. Pollen of *Ulmus* (0.2-0.5%) and *Juglans* (0.2-1%) show marginal fluctuations in their frequencies. *Cordia* shows its presence in the assemblage towards the upper limit. Among the herbaceous members such as those of Poaceae, Amaranthaceae-Chenopodiaceae complex, *Artemisia* (4-6%), *Mallotus* (2-6%) and *Oldenlandia* (2-3%) show almost uniform representation but the frequency of *Mallotus* increases at the close of the zone. Similarly the taxa like *Dodonaea* and *Cerealia* which exhibit a very low frequency in the beginning show relatively a high percentage in the upper region (pollen of *Dodonaea* 4-16%; pollen of *Cerealia* 1-5%).

Among other non-arboreals Caryophyllaceae and Cyperaceae show relatively a higher percentage (0.5-2% and 1-2% respectively). *Typha* is represented in the flora at the base of the zone but it disappears in the upper region. The members of Acanthaceae, Apiaceae and Polygonaceae whose pollen were absent in the preceding zone show their stray appearance here. The pteridophytes also show a decreasing condition (1-1.5%) and their frequency is relatively high in the middle than in the upper and lower limits.

The above pollen assemblage depicts an open type of vegetation with dominance of *Pinus* and *Quercus* among the tree forms. From the poor occurrence of aquatic forms and reduced value of pteridophytic elements it may be inferred that there was a dry condition during this period. The B/C ratio varies from 0.5 to 1.0 and the AP/NAP ratio ranges from 0.8 to 2.0.

Zone-e* (0.30m-0.15m) : *Pinus*, *Quercus*, *Dodonaea*, *Amaranthaceae/Chenopodiaceae*, *Poaceae

This zone closely resembles *Zone-d* in its palynoassemblage but it is characterised by a sharp rise of non-arboreal taxa like *Dodonaea* and Amaranthaceae-Chenopodiaceae complex. *Pinus* in

the beginning shows a low frequency (20%) but towards the upper limit its frequency increases from 20 to 34%. The frequency of *Abies* varies from 2.5 to 6%. *Picea* in the initial stage of the zone shows a low value (1.6%) but upwards its frequency gradually increases (4%). *Cedrus* is absent in the beginning but its presence is marked towards the upper limit. *Alnus* and *Juglans* also increase towards the upper limit but there is a decline in the frequency of *Betula, Olea* and *Cordia.* Except for a stray occurrence *Salix* which is an inhabitant of a watery environment is absent in the initial phase of this zone.

The herbaceous members are chiefly dominated by *Dodonaea* (4-17%), Poaceae (6-9%), Amaranthaceae-Chenopodiaceae complex (7-11%) and *Artemisia* (2-6%). *Cerealia* shows a better representation (4-6%) in the basal region of this zone than in its upper part where its frequency was determined to be 2%. Other herbaceous taxa vary between 1 to 4% eg. Caryophyllaceae (2-3%), Cyperaceae (1-4%), *Mallotus* (2-3%) and *Oldenlandia* (1-2%). Those which show a low value belong to Asteraceae (0.4%), Brassicaceae (0.3-0.9%) and Ranunculaceae (0.7%). Pteridophytes are poorly represented and their percentage gradually decreases in the upper region (0.64%).

The pollen diagram reveals warm temperate to cooler phase. The B/C ratio is 0.3 to 0.5 and the AP/NAP ratio ranges from 0.6 to 1.2.

Zone-f (0.15m-0m): *Pinus, Dodonaea, Amaranthaceae/Chenopodiaceae, Poaceae*

In this zone *Pinus* shows a greater dominance exhibiting a high value (31-37%) while the broad leaved trees show a general decline as compared to previous zones. Among the conifers *Cedrus* is present throughout the zone (0.8-1.3%). Other conifer taxa like *Picea* and *Abies* show higher values (2.4-4.6% and 0.5-2.7% respectively) than *Cedrus* but the value of *Abies* decreases towards the upper limit (0.5%). Amongst the herbage components *Dodonaea* shows the maximum rise upto 30.4%. Amaranthaceae-Chenopodiaceae complex show a higher value (4.5%) in the beginning but its frequency declines towards the upper limit (1.3%). Poaceae also shows a higher value in the beginning (7.7%) but later it declines to 3.3 % and again its percentage increases to 7.2% in the upper limit. *Artemisia* and *Mallotus* show uniformity (2-3% and 3-5% respectively). Urticaceae which shows a high value at the lower level of the zone (2.0%) reduces in its frequency towards the upper limit (0.8%).

Aquatic elements on the whole show a poor representation. Among these *Typha* and Cyperaceae were noted with a low value (0.5-1.0% and 1.3-2.0% respectively) while Ranunculaceae and *Potamogeton* were found absent. *Salix* whose pollen was recorded in the lower part of this zone (0.7%) seems to vanish towards the upper part of the zone except at the top level where its pollen show stray occurrence (0.3%). Pteridophytes also show a highly reduced value (0-0.3%).

The vegetational composition reveals a dry temperate climate with reduced value of broad leaved trees and wetland plants. The B/C ratio varies from 0.1 to 0.3 and the AP/NAP ratio is 0.9 to 1.0.

DISCUSSION

The vegetation of Mansar MS-7 is categorized into six pollen zones and two subzones. The early phase of the pollen profile i.e. *Zone-a* which dates between 2000-1800 B.P. and represents the base of the present sedimentary core profile reveals a high value of the conifer *Abies.* The broad leaved constituents like *Quercus, Alnus* and *Olea* show a better representation than *Salix* and *Betula. Corylus, Carpinus, Juglans, Ulmus* and *Celtis* are absent. The preponderance of *Abies* among the conifer flora and a low value of thermophilous species during this period indicates a cool temperate climate. *Artemisia, Cerealia,* Amaranthaceae/Chenopodiaceae, *Mallotus* and Caryophyllaceae are among the herbaceous taxa which are present in the zone with low values. Only Poaceae shows a high value. The aquatics are well represented. Cyperaceae shows a higher value than other aquatic species like *Typha,* Polygonaceae and *Potamogeton.* The presence of a good number of aquatic taxa indicates a high level of the lake. The occurrence of *Phragmites* which

grows along the margins of the lake alongwith Cyperaceae and *Typha* denote the reed swamp community. Pteridophytes are also represented moderately in this phase.

In the *Subzone-b*$_1$ which covers a period of 1800-1700 B.P. the values of *Abies* and *Pinus* show a decline but there is again an increase. The pollen assemblage shows dominance of broad leaved tree taxa. This indicates that the climate had started warming in this zone although it was still relatively cool as suggested by the continuous presence of conifers in good frequency. *Quercus, Alnus* and *Olea* which were already present become well established alongwith *Salix, Betula, Ulmus, Celtis, Juglans, Ephedra, Carpinus* and *Corylus* are represented sporadically. No change is recorded in the herbage component of the zone except that *Artemisia,* Amaranthaceae/Chenopodiaceae and Poaceae show a decline in their values. *Oldenlandia* is well represented followed by *Mallotus* and Urticaceae. *Oldenlandia* pollen is generally indicative of higher precipitation of sub-humid and humid regions. Other forms like *Plantago,* Acanthaceae, Caryophyllaceae and Asteraceae are sporadic. Aquatics maintain their unchanged representation.

The environment seemingly became warmer in the succeeding phase *Subnzone-b*$_2$ around 1650 B.P. and the pollen frequency of *Abies* declined while that of *Pinus* and *Quercus* increased. The climate became favourable for the growth of *Alnus, Olea, Salix, Betula, Ulmus, Celtis* and *Juglans.* The sharp rise in the values of *Artemisia,* Amaranthaceae/Chenopodiaceae, Poaceae and Urticaceae and a marginal increase in the values of aquatics like Cyperaceae and *Typha* and the pteridophytes also indicate the existence of a warm and humid climate.

A relative increase in the values of *Alnus, Quercus, Salix, Cordia, Dodonaea, Artemisia* and Amaranthaceae/Chenopodiaceae is noted in the *Zone-c* around 1300 B.P. which suggests that the climate might have been warm but less humid which affected the growth of aquatic plants leading to their absence like *Potamogeton* or those which survived showed a reduced value. Besides *Artemisia* and Amaranthaceae/Chenopodiaceae the other herbaceous taxa were either absent or poorly represented. On account of drier conditions the pteridophytic flora also show a decline during this phase although a rise in its frequency is noticeable towards the top of the profile.

Further stage of climatic change is marked in *Zone-d* around 800 B.P. where a sharp rise of a warm dry subtropical climate is noted favouring a better representation of herbage like *Artemisia,* Poaceae, Amaranthaceae/Chenopodiaceae, *Mallotus, Oldenlandia,* Urticaceae, Caryophyllaceae. Other taxa which indicate a warmer condition are *Plantago,* Acanthaceae, Asteraceae, Apiaceae and Ranunculaceae are also present. Brassicaceae also make an appearance in this zone. The climatic conditions were suitably developed for *Dodonaea* and *Cerealia* which also show a marked rise in their values. The tree species which had a better representation in this zone were *Alnus, Olea, Quercus* and *Salix.* Due to development of warmer climate the conifers like *Abies* and *Cedrus* declined to a lower value and became relegated from their dominating position. Among the aquatics although the taxa like *Typha* and Cyperaceae show a better representation but Polygonaceae and *Potamogeton* almost disappear which may also account for a dry condition and a fall in the level of the lake. The decline of pteridophytic flora also provides further support to the existence of the warm and dry climate during this period.

The subsequent vegetation which flourished hereafter in the *Zones e* and *f* as indicated in the pollen diagram reveal that the warm climate had marginally cooled and it prevailed almost upto the top of the soil profile, i.e. upto the present times and the climate became favourable for the growth of *Pinus, Cedrus, Picea* and *Alnus* which are represented in the flora with a higher frequency.

Correspondingly there was a decline in the thermophilous species like those of *Quercus, Ulmus, Celtis, Ephedra* and *Corylus.* The herbage flora also show a decline and the forms like *Artemisia,* Amaranthaceae/Chenopodiaceae, *Plantago,* Urticaceae, Acanthaceae and Asteraceae show relatively a low value but Poaceae and *Dodonaea* show

a better representation. The aquatic flora shows no significant change.

Cerealia pollen show a low but continuous presence in the profile right from the base upto the *Zone-d*. After this zone there is a sharp rise in the pollen curve around 600-500 B.P. alongwith other crop weeds like *Plantago,* pollen of Asteraceae, Acanthaceae, Amaranthaceae/ Chenopodiaceae, Apiaceae and Brassicaceae and this high value continued upto the top of the profile. The higher representation of *Cerealia* and decline in the values of tree pollen throughout these later periods suggest possibility of a rising tendency of cultivation. The decline in the frequency of tree species may also suggest clearance of forest for the purpose of cultivation.

The arboreal, non-arboreal pollen ration was found higher in *Zones a, b, c* and *d* which covers the depth between 150 to 40 cm from the top of the sedimentary profile. After this the ratio becomes nearly one except in the beginning of *Zone-e* (25 cm from the top of the profile) where the ratio becomes less than one.

The B/C ratio of the topmost layer of the soil profile whose age corresponds with the modern period is 0.3. Values less than this indicate a cooler climate and values greater than 0.3 indicate a warmer climate as compared to the prevailing present day climate. The B/C ratio was found to vary in the different zones of the soil profile which may indicate climatic fluctuations. In *Zone a* and the early phase of *Zone b* this ratio was determined to vary between 0.2-0.3 indicating the presence of a cooler climate but in the following zones *(Zone c)* the B/C ratio showed a higher value (0.3-0.6) which suggests the occurrence of a warmer condition. Looking at these variations the maximum warmth occurred in the *Zone d* of the soil profile where the B/C ratio is determined to be 0.5-1. In the upper stratigraphical sequence covering *Zones e* and *f* there was a return of the cooler phase with B/C ratio ranging from 0.1-0.5.

The vegetation and climate of Mansar shows a comparison with the climate and vegetation which was prevailing at Rewalsar in Himachal Pradesh (Sharma & Singh 1974; Sharma & Chauhan, 1988) and the Naukuchia Tal (Vishnu-Mittre *et al.* 1967; Dodia 1988; Sharma & Chauhan, 1988; Sharma 1992) in the composition of conifer and broad leaved forest comprising of *Pinus roxburghii, Cedrus, Quercus, Alnus, Juglans, Salix, Celtis, Betula* as well as the non-arboreal species like *Artemisia, Plantago , Justicia, Oldenlandia, Polygonum,* Poaceae, Chenopodiaceae, Cyperaceae.

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