LATE HOLOCENE PALYNOLOGY FROM THE LAKE IN SAT TAL VALLEY, DISTRICT NAINITAL, KUMAON HIMALAYA, U.P.

HARI PAL GUPTA AND ASHA KHANDELWAL

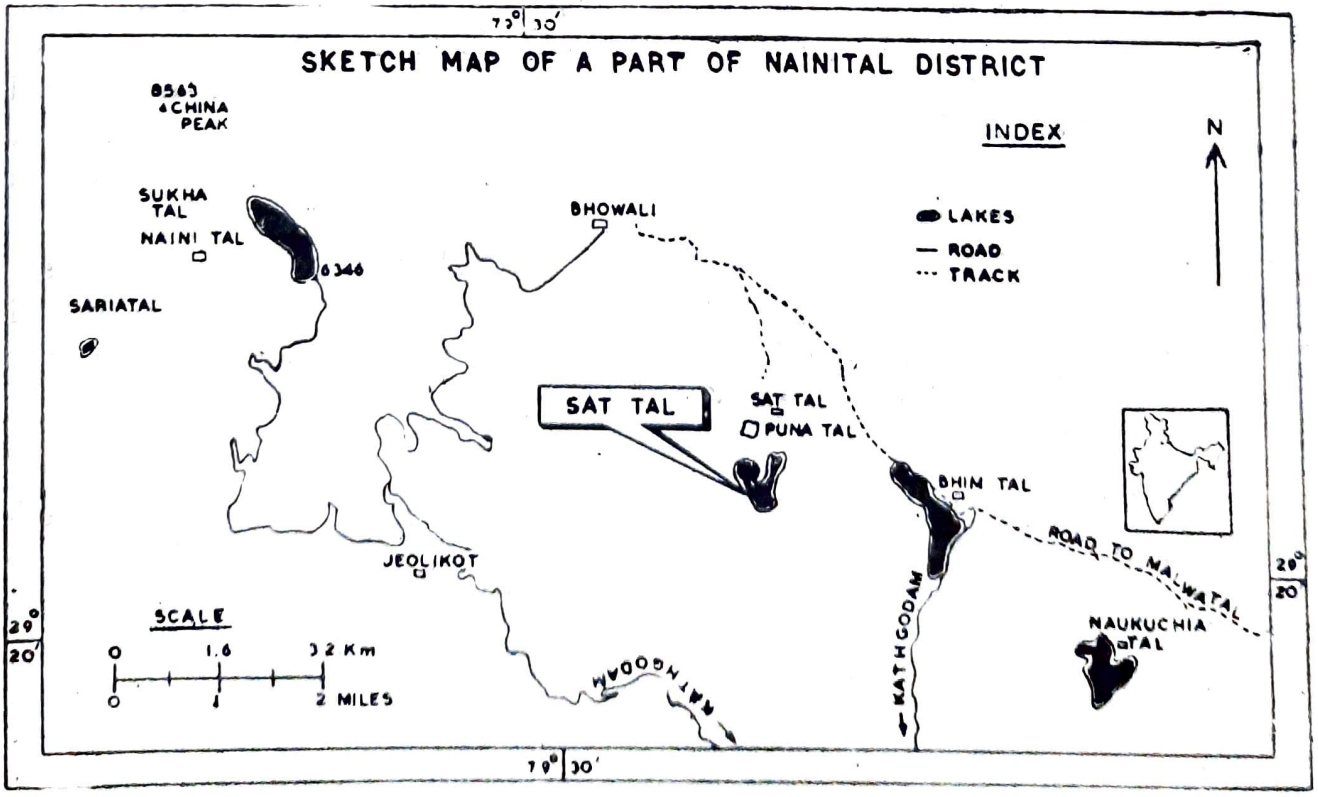
Birbal Sahni Institute of Palaeobotany, Luknow-226 007

ABSTRACT

The paper incorporates the results of pollen analyses of a profile in Sat Tal Valley. The pollen diagram has been translated in terms of past vegetation ; on the basis of changes in plant communities, the biostratigraphical zonation could be possible. Two-fold vegetational succession, i.e. mixed chirpine-oak forest during zone ST-I and dominant oak forest during the zone ST-II reflects on two-fold climatic oscillation. The whole profile, dated *ca* 4,000 years bp covers sub-boreal/sub-atlantic phases. The land occupation and landnam phases have been recognised during the zone ST-II which have been radiologically dated to about 1,300 years bp and 850 years bp, respectively.

INTRODUCTION

Physiognomy—Sat Tal lies about 13 km south-east of Naini Tal and 4 km west of Bhim Tal at 29°23′ N Lat. and 79°32′E Long. (Map 1) between 1,350-1,800 m elevation. The name Sat Tal denotes the existence of seven lakes probably formed by the blocking of the drainage by landslide. Three of the lakes in the Sat Tal Valley still remain in existence while four have been dried up and brought under cultivation. The Sat Tal Valley lies in the depression and is relatively protected from both hot and cold winds encouraging the rich growth of flora and fauna. The annual average rainfall is 85 inches of which about 84 per cent falls during the months June, July, August, and September. The highest summer temperature reaches up to 92°F in May.



Map 1

Vegetation—Two kinds of forest formations are recognised in Sat Tal Valley, viz. Oak formation and Pine formation (KENOYER, 1921) whereas below the ban oak (*Quercus incana*) climax, occurs the *Bauhinia* formation which is principally marked by the dominance of three *Bauhinia* spp., such as *B. variegata*, *B. retusa* and *B. vahlii*. There is good sprinkling of other legumes like *Erythrina*, *Indigofera*, *Ougenia*, *Dalbergia* and *Caesalpinia*.

In oak formation the dominant tree is *Quercus incana* which is recognisable by silver-white lower surface of the leaves. It is the lowest of three altitudinal oak zones extending from upper limit of *Bauhinia* forest (1,200 m to about 2,100 m). The *Rhododendron arboreum* and *Lyonia ovalifolia* are characteristic trees of the climax oak forest. They require shady and moist situations than do the oaks, hence they occur only on north slope of Sat Tal Valley. Thus, the broad-leaved sclerophyllous woodlands are characteristics of warm temperate regions with moist winters and dry summers. The other important components of the oak formation are *Acer oblongum*, *Rhus* spp., *Berberis asiatica*, *Lonicera quinquelocularis*, *Castanopsis tribuloides*, *Ilex excelsa*, *Morus alba*, *Celtis australis*, *Albizia* sp., *Caesalpinia* spp., *Dalbergia* sp., *Loranthus* spp., *Myrica nagi*, *Salix* sp., *Aesculus indica*, *Symplocos crataegoides*, *Murraya* spp., *Toddalia* spp., *Xanthophyllum alatum*, etc.

The pine formation is almost a pure forest in an altitudinal zone lower than oak formation. It occupies an edaphic situation distinct from the oaks and largely confined to the more exposed flanks of the hills and ridges. On peaks between 1,200-1,500m, chirpine usually colonize the highest and exposed position. The important constituents of the pine formation are : *Pinus roxburghii*, *Quercus incana*, *Castanopsis tribuloides*, *Engelhardtia spicata*, *Myrica nagi* and *Aechmanthera tomentosa*.

The herbaceous vegetation irrespective of woodlands constitute three distinct seasonal groups : (i) with the spring rise of temperature come representatives of temperate zone families, such as Ranunculaceae, Brassicaceae, Caryophyllaceae, Violaceae, Geraniaceae, Rosaceae, Crassulaceae and Asteraceae, (ii) with the monsoon come the representatives of tropical families, such as Begoniaceae, Gesneriaceae and Orchidaceae, (iii) with the cooler and less humid conditions following the monsoon come the representatives of autumn vegetation of temperate zone, such as Asteraceae and Lamiaceae.

In Sat Tal Valley, oaks appear to be the climatic climax. Oak seedlings could be seen frequently along the borders of pine forest, whereas pine and *Bauhinia* seedlings do not thrive in the oak forest because of the continual shade. The *Bauhinia* formation attains climax below the oak climax. In the *Bauhinia* climax zone, oaks occur as edaphic hydrach pioneer along the streams, lake depressions and shady slopes. Likewise, *Bauhinia* occurs as xerach pioneer in the oak climax. The chirpine forest is adapted to dry exposures within certain altitudinal range hence, temperature limits its distribution. On the contrary *Quercus incana* forest is adapted to humid situations within altitudes slightly higher than pine formation.

MATERIAL AND METHOD

The material for pollen analysis was picked up by making several bore-holes with the help of Hiller's peat-auger. After a detailed survey over the complete swampy area, the samples were finally collected from the deepest bore-hole at an interval of 10 cm each. All precautionary measures were observed from field collection to laboratory treatment, to avoid any contamination. The samples were first subjected to 10 per cent aqueous KOH solution in order to deflocculate the matrix and to liberate the microorganisms and thereafter, processed through usual technique of acetolysis involving the use of HF after alkali treatment (ERDTMAN, 1943).

Two hundred to three hundred arboreal pollen were counted in each sample and percentages for both arboreal and nonarboreal pollen were calculated in terms of arboreal pollen sum. A single pollen diagram for AP and NAP taxa was plotted.

STRATIGRAPHY

The sediments from 4.15 m deep profile from Sat Tal largely comprised fibrous organic mud full of plant debris and wood fragments. However, at places intercalations of clay, silt and fine sand could be noticed. The details of the bore-hole dug in the middle of swampy area are as below :

0-20 cm	Greyish brown fibrous peat.
21-30 cm	Grey clay. No plant debris.
31-140 cm	Greyish brown fibrous peat.
141-190 cm	Brown fibrous peat. Plant debris and wood fragments frequent.
191-195 cm	Grey clay with silica.
196-315 cm	Greyish fibrous peat. Plant debris and wood fragments abundant.
316-365 cm	Greyish brown mouldered peat. Plant debris and wood fragments frequent.
366-415 cm	Blackish grey mouldered peat with medium to coarse sand. Plant debris and wood fragments frequent.

POLLEN DIAGRAM AND ITS COMPOSITION

The results of pollen analyses are presented in a single 'resolved' type pollen diagram (Text-fig. 1). On the extreme left is the scale followed by litho-column and then the arboreal and nonarboreal pollen taxa are represented in per cent of the total arboreal pollen sum. At the extreme right is the AP/NAP ratio curve. The radiocarbon dates are inserted within the pollen diagram at proper depths.

The pollen diagram from Sat Tal Valley depicts an overall dominance of mixed chirpine-oak forest. However, based on subtle fluctuations in the pollen curves of chirpine and oak, two major pollen zones have been recognized, viz. ST-I and ST-II, in chronological sequence suggesting two-fold vegetational development. The zone ST-II is further divided into two subzones to highlight the Land occupation and Landnam phase. The object behind the zonation of pollen diagram is primarily to enable the easy description of pollen curves and secondarily to translate the finer fluctuations in terms of past vegetation.

Zone ST-I (depth 415-195 cm)—This zone is determined by the maximum development of *Pinus roxburghii* attaining a summit of 54 per cent in the middle of the zone. In the lower half of this zone, the values for chirpine are fluctuating whereas in the upper half it has ± static values maintaining 50 per cent of the total land vegetation. The oaks are co-dominant taxa in this zone and have been recognized under two separate species, viz. *Q. incana* and *Q. dilatata*. *Quercus incana* is the dominant oak in this zone and is recognized by high values (30-32%) in the lower half of the zone, thereafter, decline to 24 per cent throughout the upper half of this zone. *Q. dilatata* maintains comparatively low pollen curve throughout the zone. The curve for *Pinus wallichiana* commenced from the beginning of this zone and continued in fluctuatingly low values throughout the zone except at the close of this zone, the values

rose to about 12 per cent. *Picea* pollen commenced a little below the middle of this zone and continued in fluctuating low values. *Cedrus* appeared in the middle in low values and disappeared from rest of the zone. *Abies* too appeared in the middle and maintained continuous low pollen curve in the upper half of the zone. *Larix* pollen curve is seen right from the base of the zone in good frequencies (12%) showing an upward decline till it reaches the middle and gradually became sporadic in the upper half of this zone. *Taxus* is recognized by stray occurrence only in the lower part of the zone. *Betula* and *Ulmus* are lowly represented in the middle and the upper half of this zone, respectively. *Corylus* commenced with sporadic values at the beginning of the zone but attained good values recording two summits of 4 per cent and 7 per cent at the lower and upper limits during middle of the zone, respectively and therafter, disappeared in the upper part of the zone. *Carpinus*, *Ilex*, *Acer* and *Cardiospermum* are sporadically represented and concentrate more at the base of the zone. *Rhus*, *Glochidion*, *Celtis*, *Symplocos*, *Carya*, etc. are represented by sporadic to low pollen curves in the upper part and lower part of this zone, respectively. *Grewia*, *Albizia*, *Palaquim*, *Myrica* and Myrtaceae are sporadically present throughout the zone. The stray occurrence of *Rhododendron* is seen at the base but it gradually formed a pollen curve at the top of the lower half of the zone attaining 3.5 per cent and again became sporadic upward. Fabaceae and *Salix* formed their pollen curves right from the base but discontinued in the upper phase of the zone. *Fraxinus* and *Alnus* are present throughout the zone either sporadically or in low discontinuous pollen curves.

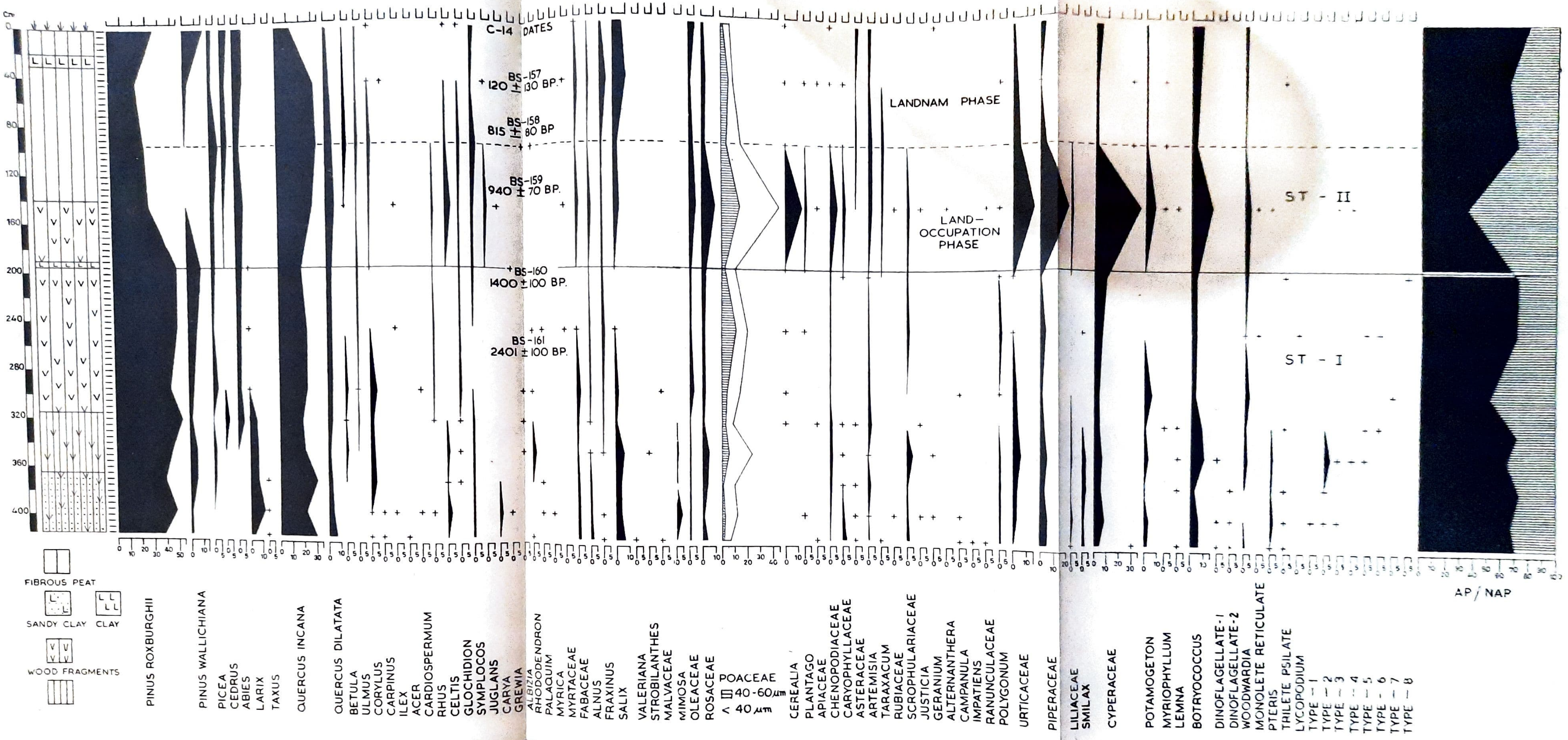
The shrubby vegetation such as *Valeriana*, *Strobilanthes* and Malvaceae are sporadically present. *Mimosa* after attaining good frequencies at the base, tremendously declined upward and finally vanished from the upper half of this zone. Oleaceae and Rosaceae are represented by the low continuous curves throughout.

The herbage is marked by consistently high values of Poaceae whereas cerealia are sporadic. The other non-arboreal components such as *Plantago*, Apiaceae, Caryophyllaceae, Asteraceae, *Taraxacum*, Rubiaceae, *Justicia*, *Geranium*, *Alternanthera*, *Campanula*, *Impatiens*, and Ranunculaceae are sporadic. However, Chenopodiaceae, *Artemisia*, Scrophulariaceae and *Polygonum* maintain very low, continuous curves throughout the zone. Urticaceae, Piperaceae and Cyperaceae are represented by good values whereas Liliaceae and *Smilax* form very low curves in the lower half of the zone.

Amongst aquatics, *Botryococcus* is dominant followed by *Potamogeton*, whereas *Myriophyllum* and *Lemna* are sporadic. However, *Nymphaea* and *Typha* are represented by one and two grains, respectively. Pteridophytes are poorly represented. A few dinoflagellate cysts and some unidentified pollen, etc. have been also recorded from this zone.

The face value evaluation of AP/NAP ratio has revealed the overall dominance of arboreal taxa maintaining 70 per cent of the total land vegetation throughout except that the AP curve experienced a short-phased setback in the middle of this zone corresponding to 295 cm depth in the litho-column.

Zone ST-II (depth 195-0 cm)—This zone is recognized by the steep decline in the chirpine pollen curve and corresponding rise in oak pollen curve than the preceding zone. The pollen curve of *Pinus wallichiana* disappeared in the middle but regained exceedingly high values at the close of this zone. There is a general improvement in the values of *Picea*, *Cedrus* and *Abies* than the preceding zone *vis-a-vis* *Larix* and *Taxus* are totally absent from this zone. The pollen curves for *Betula*, *Ulmus*, *Rhus*, *Glochidion*, *Symplocos*, Fabaceae and *Alnus* behaved more or less in the



TEXT-FIG. 1—POLLEN DIAGRAM FROM SAT TAL (NAINITAL)
(Percentages calculated in terms of Arboreal Pollen)

same pattern as in the preceding zone. *Corylus* pollen curve has dwindled down than before and ultimate'y became sporadic towards the top of the zone. *Carpinus* and *Ilex* are registered by sprinkling values whereas *Acer* and *Cardiospermum* are absent in this zone. *Celtis* curve remained ± unchanged except it gained comparatively high values in the lower half of this zone. *Juglans* made its appearance in the beginning of this zone, continued in low values in the lower half of the zone and became sporadic upward. *Carya*, *Grewia*, *Albizia*, *Rhododendron*, *Palaquim*. *Myrica* and Myrtaceae remained sporadic throughout the zone. *Fraxinus* and *Salix* after remaining low in the lower half gained momentum in the upper half of this zone.

The shrubby vegetation in this zone is represented only by Oleaceae and Rosaceae showing high values in the lower half and continued in low pollen curves in the upper half of this zone.

This zone is further demarcated from the preceding zone by the contrast change in the nonarboreal vegetation. The values for Poaceae enhanced drastically in the lower half of this zone but declined abruptly during the upper zone limit. Similarly considerable rise in Urticaceae, Piperaceae and Cyperaceae pollen curves has been recorded which after enjoying the maximum in the lower half showed a sharp decline in the upper half of the zone. The other members of herbage group, such as Rubiaceae, *Justicia*, *Geranium*, *Alternanthera*, Ranunculaceae and *Polygonum* are recognized by their sporadic occurrence.

There is a noticeable change in the values of cerealia pollen curve enjoying up to 13 per cent in the lower half and thereafter the values became sporadic in the upper half of the zone. The associated members of the steading, such as *Plantago*, Chenopodiaceae, Caryophyllaceae, and *Artemisia* have registered almost the similar behaviour as that of cerealia pollen curve.

The aquatic vegetation represented by *Potamogeton* and *Botryococcus* too enjoyed comparatively higher values in the lower half of this zone than the preceding zone but their values declined considerably in the upper half of the zone. However, *Myriophyllum* and *Lemna* remained sporadic throughout. Amongst pteridophytes, *Woodwardia* maintained continuous, low pollen curve whereas other members are known by stray occurrence. The total arboreal pollen taxa in the lower half of this zone are reduced tremendously to about 30 per cent in contrast to 70 per cent of nonarboreal taxa. The AP values rose gradually and maintained 70-80 per cent of the total AP/NAP values in the upper half of this zone.

COMPARISON WITH OTHER POLLEN DIAGRAMS IN KUMAON

The palynological investigations of lake sediments from Naukuchiya Tal were first taken up by VISHNU-MITTRE *et al.* (1967). Thereafter, GUPTA (1977) made a survey of the area and collected a large number of surface samples from Naini Tal to Bhim Tal and then to Sat Tal along with two profiles one each from Naukuchiya Tal and Bhim Tal. The statistical evaluation of pollen and spores from a series of moss cushions and surface samples have revealed that the relative percentage of pollen and spores trapped in moss cushions match to a great extent with the present day floristic composition of the area, in particular the Sat Tal pollen rain marked by high values of oaks and chirpine depicting a mixed chirpine-oak forest. On comparison of Sat Tal pollen diagram with the Naukuchiya Tal and Bim Tal pollen diagrams it is found that vegetation pattern is not very different rather it is in concordance to Bhim Tal and upper part of Naukuchiya Tal pollen diagram covering a part of stage b and stages c and d.

The Naukuchiya Tal pollen diagram shows a three-fold vegetational succession reflecting upon three-fold climatic oscillations, viz. the period of increasing warmth, warmth optimum and the period of decreasing warmth whereas Sat Tal pollen diagram has reflected upon two-fold vegetation development reflecting upon warmth maximum and decreasing warmth climatic phases.

Based on the evidences of cerealia pollen and other culture pollen like *Plantago*, Apiaceae, Chenopodiaceae, etc. in Naukuchiya Tal pollen diagram the commencement of prehistoric steading has been ascertained at the close of zone c which flourished throughout the zone d corresponding to the sub-boreal/sub-atlantic phase. However, Sat Tal pollen diagram has brought about entirely a different picture of steading and this may be accounted as localized factor.

DISCUSSION

Forest history and lake succession—The Sat Tal pollen diagram has brought about two-fold vegetation development where the vegetational history begins with subtropical chirpine-oak mixed forest. The face value evaluation of the pollen curves during zone ST-I tips towards the predominance of chirpine but when assessed through their pollen production and pollen dispersal, one is ought to believe the co-existence of chirpine and oaks in more or less equal frequencies. The vegetational pattern during zone ST-II had considerably changed. In the climax oak forest which was now fully established, chirpine woods reduced sharply. Blue pine, spruce, deodar and fir are present from the zone ST-I in low values but registered a general improvement in the succeeding zone. The Indian larch, on the other hand, was more abundant in the lower half of the zone ST-I and gradually reduced to stray upward and ultimately vanished from the succeeding zone. The pollen grains of these taxa are considered to be drifted from higher altitudinal zones as they do not hold any association with the subtropical climax oak forest. Similarly broad-leaved elements, like birch, elm, hazel and hornbeam, are also drifted from higher altitude and, therefore, their pollen frequencies in this pollen diagram are either sporadic or represented by low discontinuous pollen curves.

Ilex, *Acer*, *Cardiospermum*, *Rhus*, *Celtis*, *Glochidion*, *Symplocos*, *Albizia*, *Myrica*, Myrtaceae and Fabaceae are the important components of the oak formation but are sporadic in zone ST-I improving a little in the succeeding zone. Oleaceae and Rosaceae, present in good frequencies throughout, are the sole representatives of shrubby vegetation associated with climax oak forest. Amongst ground vegetation, Poaceae, Urticaceae, Piperaceae and Cyperaceae had high values and still higher during zone ST-II whereas other members of herbage are either sporadic or lowly present. The lake vegetation along the shores was dominated by *Salix* with some sprinklings of *Alnus*. The submerged vegetation was overwhelmed by *Botryococcus* and *Potamogeton*.

Vegetation pattern and climate—Judging from the face value of broad vegetational pattern attained during zones ST-I and ST-II hardly any distinct evidence of a significant change in climate could be inferred. Some interesting indications of change over are, however, noticeable in the AP and NAP pollen curves. The chirpine-oak mixed woodlands remained dominant during zone ST-I whereas other arboreal elements of this zone are either drifted or insignificant to attribute the climatic phases with precision. The vegetation dominated by chirpine-oak woods suggest the prevalence of warm and moist climate, and perhaps attained the optimal conditions.

At the start of zone ST-II, abrupt depression in the chirpine pollen curve and sharp rise in the oak pollen curve points towards a change in the climate culminating the

climax oak forest. Thus the climatic conditions during zone ST-II became more moist and less warmer. The non-arboreal pollen curves especially the succession of aquatics and sedges, however, provide some clue regarding the changes in the lake vegetation from the preceding zone. The submerged vegetation, like *Potamogeton* and *Botryococcus*, increased considerably indicating maximum wet conditions and expansion of lake margin. This is further corroborated by much higher values of sedges, Piperaceae and Urticaceae.

A glance at the close of the pollen diagram, where blue pine, fir and deodar increased, provides some indication of slight deterioration in the climate. The zone ST-I is marked with mixed oak forest followed by the peak development of oak forest during zone ST-II and thereafter blue pine, fir and deodar increased. Thus, the Sat Tal pollen diagram reveals a succession of climate, i.e. warmth maximum and less humid in zone ST-I and less warmth and wet climate in zone ST-II reflecting on sub-boreal and sub-atlantic types of climate, respectively.

Past pastoral and arable economy—Evidence of Neolithic or sub-boreal settlement in the Sat Tal pollen diagram is, however, not very clear. At the same time this entails that forest as a whole remained untouched throughout the sub-boreal period. It would be erroneous to presume that areas showing indications of Neolithic settlement were cleared of forest instantaneously. The pollen analysis suggests that the arable activities did receive momentum to small extent only during the middle of Zone ST-I corresponding in time to about 3,000 years b p and continued at slow pace till the end of this zone. It is congenial to assume that greater part of the utilized areas must have been covered with forest where the domestic animals grazed for their food.

The shrinkage of the forest is recorded in the pollen diagram in the lower half of the zone ST-II where it could be visualized through AP/NAP pollen curves placed at extreme right of the pollen diagram. In this episode, chirpine is the worst sufferer where an abrupt fall is recorded in its pollen curve. The zone ST-II representing the sub-atlantic climatic phase, and based on the marked advance for the pollen of herbaceous plants and abrupt fall in arboreal taxa, has revealed important features that concerns the 'Land occupation phase' and 'Landnam phase.'

Land occupation phase—The beginning of zone ST-II signifies a turning point in the development of Sat Tal vegetation where virgin forest was transformed into cultural land. Practically all the curves drawn in NAP section of Sat Tal pollen diagram have turned out to indicate a marked cultural phase. The phase opens at the depth of 220 cm with the preponderance of cerealia, *Plantago*, Asteraceae, Chenopodiaceae and Caryophyllaceae which favoured the grazing of domestic animals as well as farming. In addition, perhaps the significant sign of grazing, a noticeable rise in the wild grasses took place corresponding to the maxima of cerealia and culture pollen curves. Thus, the dominance of this category of pollen throughout the lower half of the ST-II zone corresponds to the sub-atlantic period where less warm and wet conditions prevailed favouring the ancient steading.

Landnam phase—The cereal pollen curve after attaining a summit in the lower half of the zone ST-II ceased to continue during the upper half of the Zone ST-II where the values became sporadic. Similar trend is noticeable in the curves of all other culture pollen except for *Artemisia* and other Asteraceae which register high values than before. *Artemisia* and Asteraceae are the pioneers to encroach the abandoned land. The decline in the farming corresponds with the overall increase in the values of arboreal taxa which further corroborates the view that the land was abandoned and consequently succee-

ded by arboreal taxa. The abandonment of the area by prehistoric farmers is designated as landnam phase which has been recognized in Sat Tal Valley about 850 years bp.

CONCLUSION

It is, therefore, concluded that :

1. The division of the pollen diagram in two zones, i.e. ST-I and ST-II shows two-fold vegetational succession, i.e. mixed chirpine-oak forest during zone ST-I and dominant oak forest during zone ST-II reflecting on two-fold climatic oscillations, i.e. the period of warmth maximum with less humid and the period of decreasing warmth and wet, respectively.
2. The high altitude plant taxa, such as blue-pine, deodar, fir, etc., have been recorded in consistently low values throughout the pollen diagram. The pollen of these taxa which have been considered as drifted from the higher altitude since they do not grow in whole of the Sat Tal Valley today and their occurrence has also been recorded from pollen rain of the area.
3. The occurrence of *Larix* pollen in good frequencies is well documented till middle of the zone ST-I corresponding in time to about 3,000 years bp. Thereafter, its curve received a setback and became sporadic and ultimately vanished from the zone ST-II. The climate as well as man is held responsible for its disappearance from the valley.
4. Based on pollen evidences the Land occupation phase and the Landnam phase have been recognized during the zone ST-II which have been dated to 1,300 bp and 850 bp, respectively.
5. The C^{14} dates coupled with some extrapolations have revealed *ca* 4,000 years bp for the whole profile covering the sub-boreal and sub-atlantic phases.
6. The AP/NAP ratio curve indicates the enhanced values for arborescent taxa throughout except at the lower half of zone ST-II. Since the decline in the tree taxa coincides with the pastoral and arable activities, it is congenial to assign destruction of trees at man's door.

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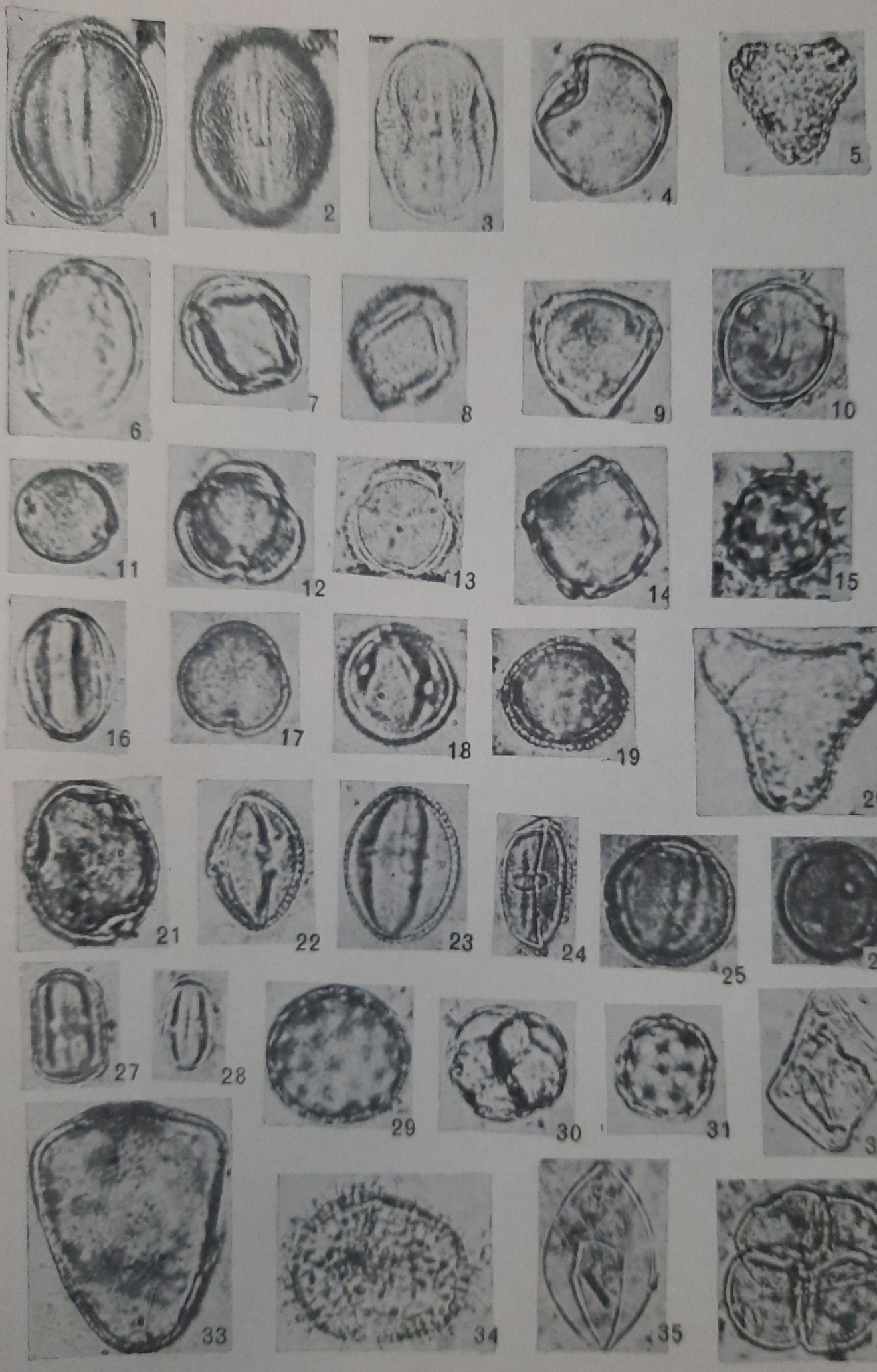
EXPLANATION OF PLATES

PLATE 1

1-2. *Rhus*, ×1000 ; 3. *Justicia*, ×1000 ; 4. *Urticaceae*, ×1000 ; 5. *Symplocos*, ×500; 6-8. *Quercus*, ×750 ; 9. *Corylus*, ×500 ; 10. *Betula*, ×500 ; 11. *Morus*, ×1000 ; 12-13. *Artemisia*, ×750 ; 14. *Alnus*, ×750 ; 15. Asteraceae, ×500 ; 16. Rosaceae ?, ×500 ; 17. Ranunculaceae, ×500 ; 18.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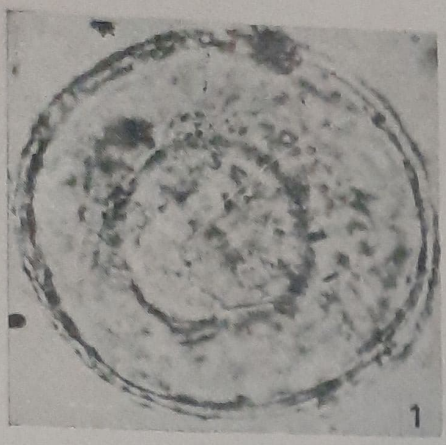
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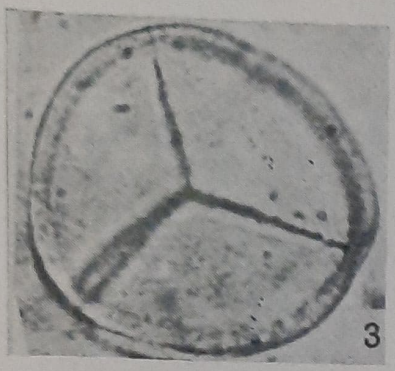
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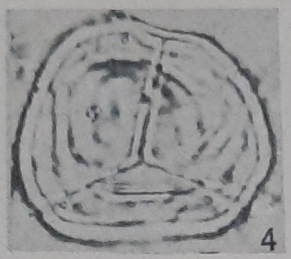
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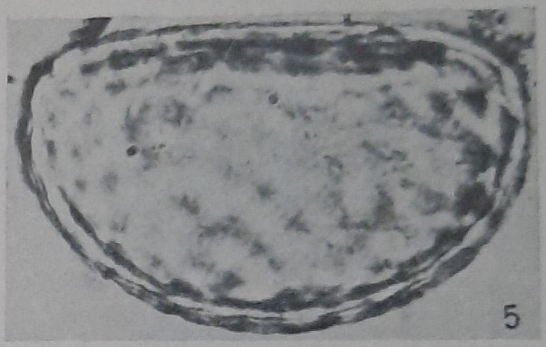
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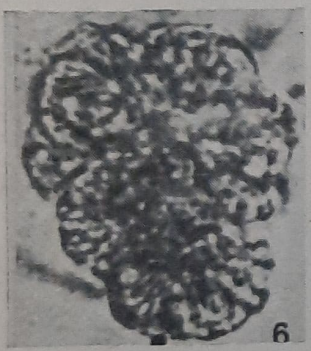
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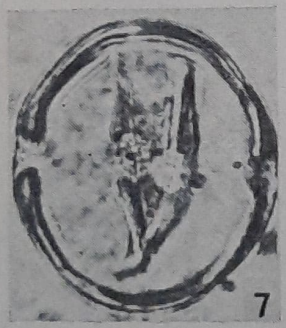
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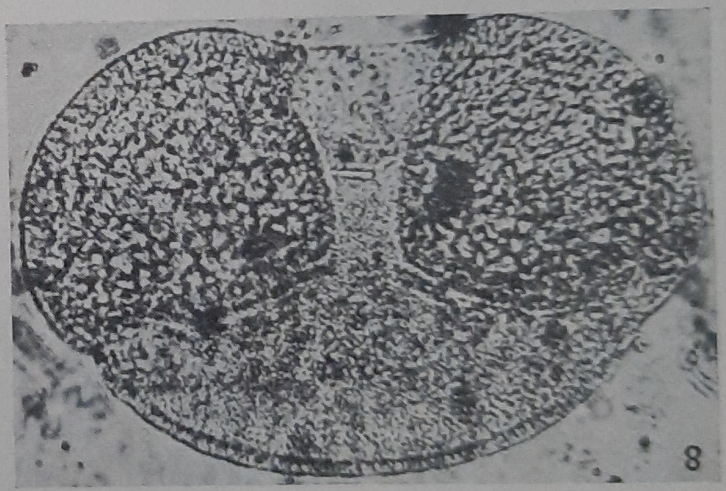
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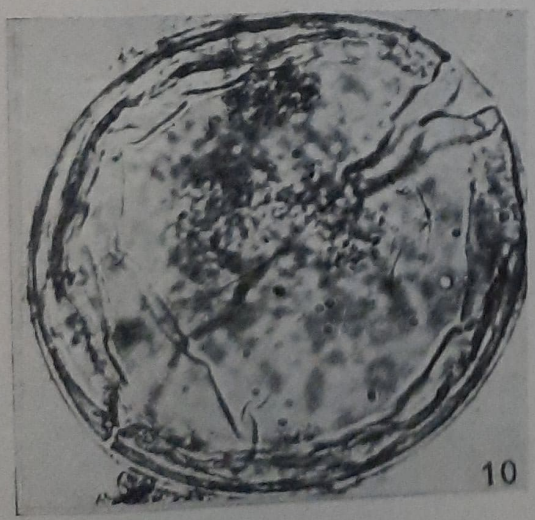
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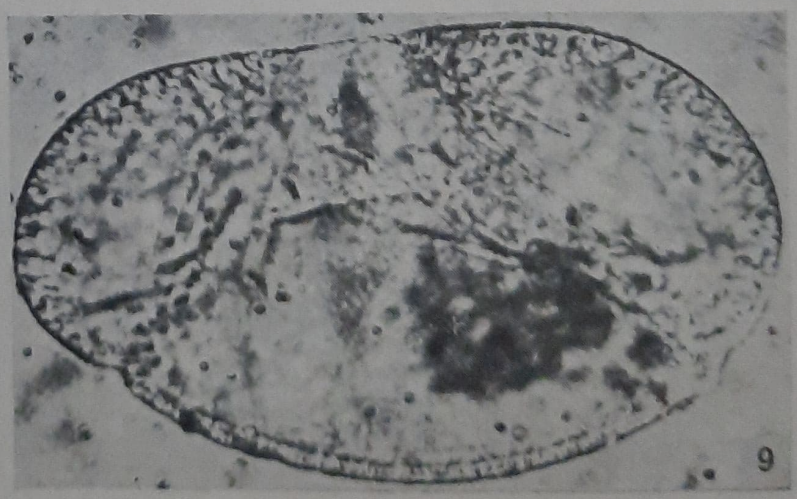
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Gupta & Khandelwal—Plate 2

Glochidion, ×750 ; 19. Oleaceae, ×750 ; 20. *Cardiospermum*, ×750 ; 21. Type II, ×500 ; 22-23. *Salix*, ×1000 ; 24. Type III, ×500 ; 25. Type IV, ×500 ; 26. Urticaceae, ×500 ; 27. *Polygonum plebejum* ×1000 ; 28. Rosaceae ? ×1000 29. Chenopodiaceae/Amaranthaceae, ×1000; 30. *Rhododendron*, ×500 ; 31. Chenopodiaceae/Amaranthaceae, ×500 ; 32-33. Cyperaceae, ×1000 ; 34. *Nymphaea*, ×1000 ; 35. Poaceae, ×1000 ; 36. *Typha latifolia*, ×750 ;

PLATE 2

1. Dinoflagellate cyst ?, ×1000 ; 2. *Pinus roxburghii*, ×1000 ; 3-4. Trilete fern spore, ×750 ; 5. Monolete fern spore ; ×750 ; 6. *Botryococcus*, ×750 ; 7. Meliaceae ?, ×750 ; 8-9. *Picea*, ×750 ; 10. *Larix*, ×750.