HOLOCENE PALYNOLOGY FROM MEANDER LAKE IN THE GANGA VALLEY, DISTRICT PRATAPGARH, U.P.

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ABSTRACT

The pollen analytical investigations of a 3·30 m deep profile from a horse-shoe lake in the Ganga Valley have been carried out. The lake is situated closeby to an archaeological site Sarai-Nahar-Rai in Pratapgarh District. The pollen frequencies were calculated in terms of total land plants and a pollen diagram has been constructed.

In the last 8000 years, there have been four phases of vegetational developments reflecting directly on four brief phases of climate such as Very Arid, Arid, Semi-Arid and Semi-Humid. The abundance of grasses throughout the pollen diagram has revealed the existence of an open savannah forest. The arboreal vegetation is poor and represented by a few scattered trees and shrubs.

The commencement of arable and pastoral economy chiefly based on cereal pollen has been recognized during *ca.* 4500 b.p. which prospered in the succeeding phases.

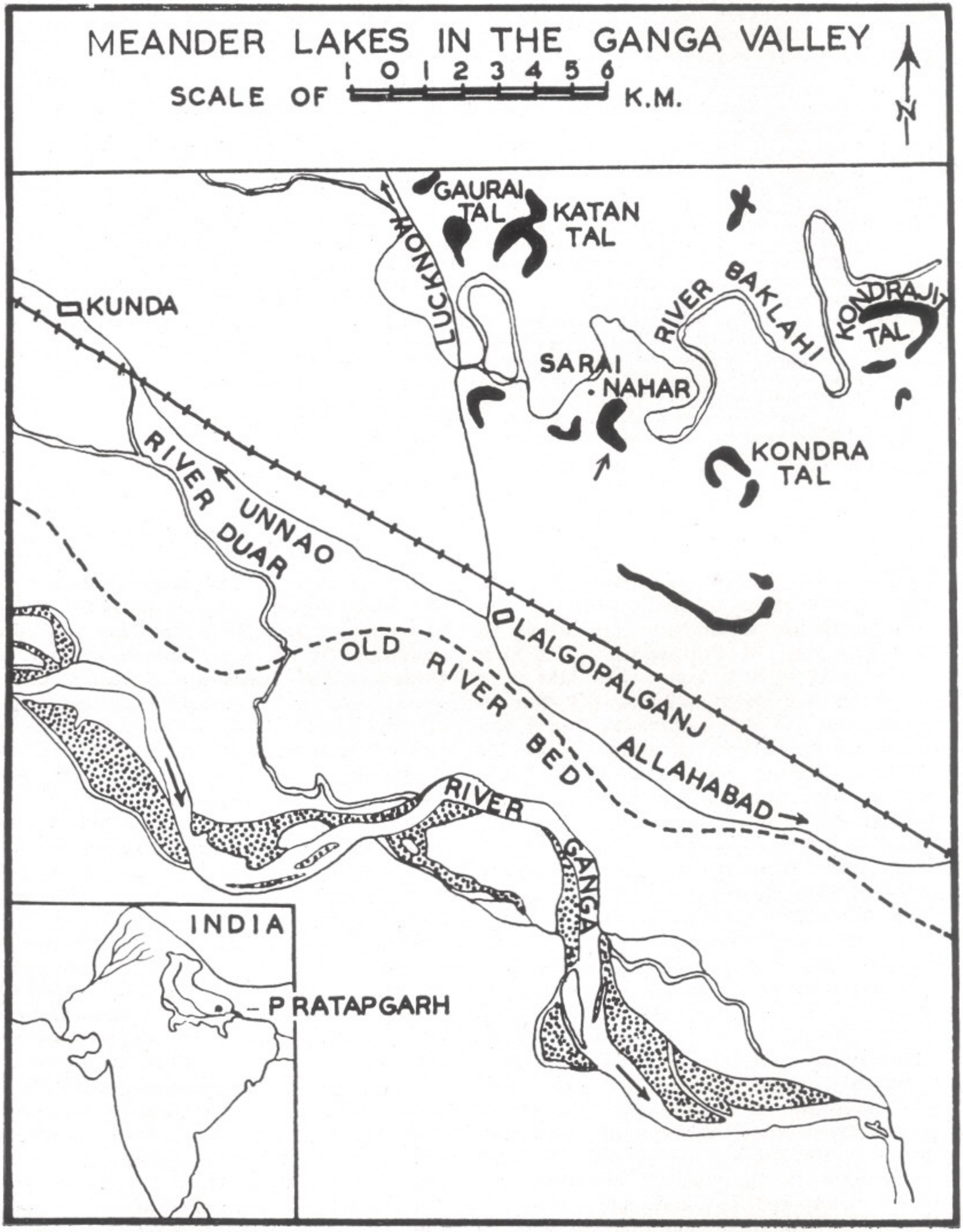
INTRODUCTION

THE horse-shoe lake marked with arrow (Map 1) lies about 65 km north of Allahabad and about 15 km south-west of Pratapgarh at 25°41′N Lat. and 81°39′20″E Long. The lake is of moderate size approximately 3/4 km in length and 1/4 km in breadth and 1 km north-eastward flows a river known as Baklahi. During hot summers the lake almost dries up but in rainy season the lake overflows by the rains and river water. The lake seems to be natural and ancient. It is quite important from archaeological point of view since the mesolithic site has been recently excavated four kilometres apart at Sarai-Nahar-Rai (Sharma, 1973). Besides microliths industry, human skeletons in a 21 cm deep pit have been recovered and radiometrically dated to 8000 B.C. Amongst microliths, the most common tools so far recognized are flakes, blades, scrapers, triangles, lunates etc. The tools are made up of cherts and these cherts were carried from the adjoining Vindhyan rocks by the pre-historic people.

The soil is all younger alluvium and chiefly composed of sand, silt and clay. The older alluvium contains deposits of calcium carbonates in the form of irregular nodules known as *kankars*. The soil is at most places saline and ground is floristically barren where concentration of salts is excessive.

The climate is periodical characteristic of tropical region. The temperature reaches to its maximum (106°F) in May-June and is marked by hot winds known as '*lu*'. In December, the temperature reaches to its lowest limit (47·7°F) and experiences two or three cold spells. The area receives rainfall from both the Bay of Bengal and Arabian Sea branches of south-west monsoons. The mean annual rainfall is 39″ and 95% of the total rainfall occurs from June to September. The humidity is almost nil during summer but reaches 85% in July and August. Climatologically the area comes under Semi-Arid zone.

Floristically, the area forms a subdivision known as Upper Gangetic plain. The annuals dominate over the trees especially during rainy and winter seasons but in summer the number of annuals reduces considerably. The area is characterized by Tropical Dry Deciduous Savannah Forest (Champion & Seth, 1968). The characteristic vegetation type is open savannah with predominance of grasses and only scattered stands of trees and bushes over low grasses are seen. The arboreal vegetation is represented by *Prosopis spicigera* Linn., *Salvadora oleoides* Decne, *S. persica* Linn., *Anogeissus* sp., *Butea monosperma* Kumtze., *Azadirachta indica* A. Juss.,


MEANDER LAKES IN THE GANGA VALLEY
1 0 1 2 3 4 5 6
SCALE OF K.M.
N
GAURAI TAL
KATAN TAL
LUCKNOW
KUNDA
RIVER BAKLAHI
KONDRAJIT TAL
SARAI NAHAR
KONDRA TAL
RIVER DUAR
UNNAO
LALGOPALGANJ
OLD RIVER BED
ALLAHABAD
RIVER GANGA
INDIA
PRATAPGARH

Map 1

Mitragyna parvifolia Korth, *Acacia* spp., *Cassia* spp., *Syzygium* sp., *Salmalia* sp. and *Holarrhena antidysentrica*. The shrubs and bushes are represented by *Lantana camara* Linn., *Nyctanthes* sp., *Olea* sp. and *Capparis* spp. The above listed plants do not seem all to be indigenous. They are either planted or semi-planted.

The herbage is largely predominated by the grasses of which *Themeda quadrivalvis* Forsk., *Echinochloa colona* Link., *Cynodon maritimus* H. B. & K., *Apluda mutica* Linn., *Aristida hystrix* Linn., *Desmostachys bipinnata* Planch., *Sporobolus marginatus* Hochst., *Chloris montana* Roxb., *Paspalidium favidum* Stapf., and *Sehima nervosum* Linn., are the common types. Sedges are very few such as *Alysicarpus bupleurifolius* Wall., *Cyperus aristatus* Rottb., and *C. compressus* Linn. The other herbaceous elements are *Ocimum americanum* L., *Echinops echinatus* L., *Murdannia nudiflorum* Royle, *Cyanotis axillaris* D. Don, *Corchorus aestuans* Blanco., *Portulaca oleracea* Linn., *P. tuberosa* Roxb., *Oldenlandia diffusa* Roxb., *Chenopodium album* Linn., *Tribulus terrestris* Muhl. Cat., *Justicia simplex* D. Don, *Impatiens* sp., *Alternanthera* sp., *Mimosa* sp. and a few members of Caryophyllaceae and Malvaceae.

The marshy and aquatic plants are mainly represented by *Typha* spp., *Nymphaea* sp., *Potamogeton* sp. and *Myriophyllum* sp.

The main crops grown here are wheat, barley, paddy, pulses and sugarcane. Potato cultivation is very extensive in this belt.

STRATIGRAPHY

The horse-shoe lake profile is 3·30 m deep and below is subsoil water which did not enable to dig further. Based on texture and colour of the sediments, three distinct lithozones have been recognized (I-III). The lithozone-II (between 0·70 to 2·50 m) is characterized by dark black organic mud with very fine grade of silt. It underlies lithozone-I (70 cm thick grey clay + fine silt), and overlies lithozone-III (1·80 m thick gray sticky clay with sand and scattered nodular kankars). The kankars are generally formed by the accumulation of calcium carbonate through capillary mechanism and indicate the increased salinity.

The lithozone-II seems to be lacustrine in nature and formed by ponding of water under quiet conditions. The bottom sediments (lithozone-III) are the chemical deposits in seasonal lacustrine environment together with wind blown stuff. The uppermost deposits (lithozone-I) were deposited under quiet conditions in the lake which at the same time received excessive water from the catchment area during rainy season. The lithological details of the sedimentary profile is as given below:

0- 70 cm — Compact grey clay with fine sand and silica.

71-250 cm — Dark black organic mud mixed with very fine silt.

251-330 cm — Grey sticky clay with loose and coarse sand and silica. Irregular nodular kankars are present and more frequently found towards the lower limit.

MATERIAL AND METHODS

In all, 28 samples for pollen analysis were collected at an interval of 20 cm each from lithozone III and 10 cm each from lithozones-II and I in a 3·30 m deep pit dug in the middle of the lake. Besides these samples, three samples for radiocarbon datings were collected at the depth between 3·30-3·20 m, 2·10-2·00 m and 1·10-1·00 m. The samples from lithozones-I and II have yielded quite a good number of pollen grains and spores but from lithozone-III the micro-organisms are either very scanty or almost absent. The absence of pollen and spores from the base of the lithozone-III can be assigned due to the increased salinity as exemplified by the occurrence of kankars.

The samples were first subjected to 5% KOH so as to deflocculate the matrix and liberate the micro-organisms and then processed through usual technique of acetolysis involving the use of HF after alkali treatment (Erdtman, 1943). Since the pollen frequency in most of the samples is quite low and therefore, four to six slides were examined for each sample in order to make a total of 150-200 pollen. In lithozone-III, the pollen and spore contents were too less and only 50-100 pollen could be totalled. The percentage of each taxon was calculated in terms of total land plants pollen.

POLLEN DIAGRAM AND ITS COMPOSITION

The whole pollen sequence has been divided into four major local zones and the zones III and IV have been subdivided into three and two subzones respectively. This has been done primarily to facilitate the description of palaeoflora and secondarily to elaborate the significant events during Holocene epoch. The zonation of pollen diagram is chiefly based on subtle changes in biostratigraphic units (pollen assemblage zones). These local zones are named after the Horse-Shoe Lake (HS) and numbered from below upwards.

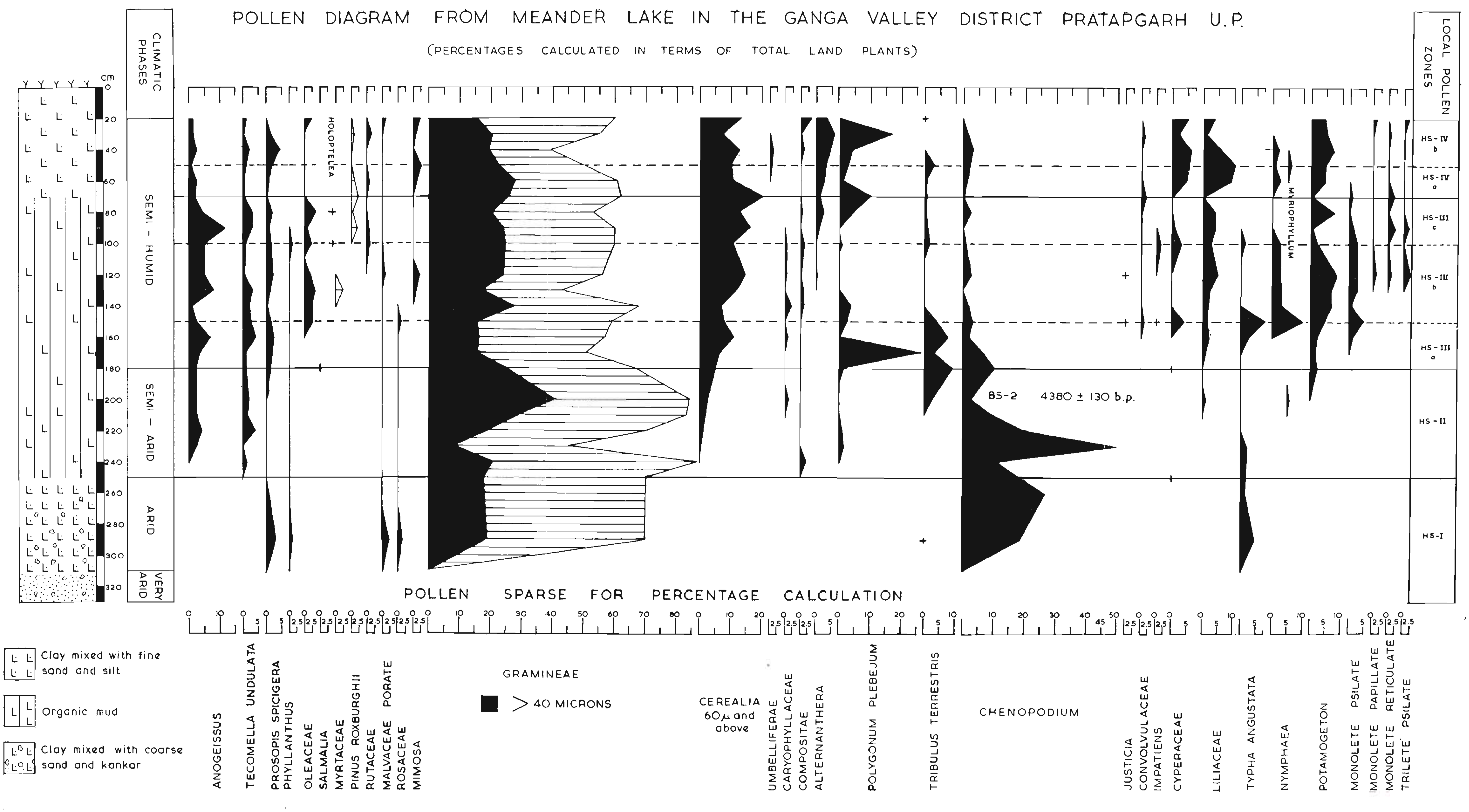
Zone HS-I (330-250 cm) — This zone is marked by increased salinity as evidenced by the presence of irregular nodules (kankars) formed by the accumulation of calcium carbonate. Pollen are very scarce for percentage calculation in lower most samples 1 and 2. The scattered pollen seen in the first two samples belong to Gramineae and *Chenopodium* only. The absence or scarcity of pollen indicates that this period of sedimentation was most unfavourable for the preservation of pollen and spores. In the subsequent sample nos. 3-5, Gramineae and *Chenopodium* dominate. *Typha angustata* pollen are encountered but do not exceed more than 4·5% of the total counts. In sample no. 3, the pollen of Rosaceae, Malvaceae (porate & spinate) and *Phyllanthus* have been recorded in low frequencies. *Prosopis spicigera* pollen are present in sample nos. 3 and 4 attaining a maximum of 3% in sample 3.

The pollen assemblage of zone HS-I depicts a picture of open grasslands characteristic of very arid climate where *Chenopodium* grew in great profusion particularly on the dry saline lands. *Typha angustata* inhabitated on the shores of lake which is also salt resistant. The tree and shrubby vegetation is very low and the total arboreal values do not exceed more than 8%.

Zone HS-II (250-180 cm) — It is characterized by the onset of arboreal vegetation such as *Anogeissus* and *Tecomella* which were totally absent in the preceding zone. The values for the above two taxa do not exceed more than 4% but they continue in low frequencies throughout the zone. *Prosopis* shows its appearance towards the close of the zone. Gramineae after making a sharp decline in the beginning regains quite high values throughout the zone. The decline in the Gramineae curve is marked by high values of *Chenopodium* and the commencement of cerealia-type pollen grains. The values for Caryophyllaceae, Compositae and *Polygonum plebejum* are sporadic throughout this zone. *Tribulus terrestris* commences in the middle and attains a summit of 9% at the close of the zone. *Typha angustata* continues in low values and disappears in the middle of the zone. Cyperaceae and *Myriophyllum* remain sporadic. *Potamogeton* shows its first appearance in the upper part and continues in low values till the close of this zone.

The age for upper zone limit has been radiologically dated to 4380 ± 130 years b.p. and the age for the beginning of this zone is extrapolated at *ca.* 5500 from the one C-14 date (BS-2). This zone is quite important in view of the commencement of cerealia pollen (pollen with 60 μm or more, ± psilate and prominent annulus have been considered as cerealia) and signifies the Atlantic-Sub-Boreal boundary.

Zone HS-III (180-70 cm) — The zone is marked by the general increase in the pollen frequencies of the *Anogeissus*, *Tecomella* and *Prosopis* and the first appearance of Oleaceae and *Mimosa* which gained with values in the middle of the zone. The pollen frequencies of Gramineae show an overall decline in contrast to the preceding zone. The cerealia pollen curve shows an increasing trend attaining four maxima of 11%, 14·5%, 16·5% and 20% from lower to upper zone limit. *Polygonum plebejum* curve registers tremendously high values (26·5%) in the beginning of the zone but soon dwindles down to the low values except it regains moderately high values at the close of the diagram. Caryophyllaceae and Compositae are lowly present and *Alternanthera* shows its first appearance in the middle with the increasing trend towards the close of the zone. *Tribulus terrestris* continues in high values in the lower zone limit. Thereafter, it disappears in the middle and reappears in the upper zone limit exhibiting low values. *Chenopodium* registers low discontinuous values throughout the zone. Liliaceae, although lowly present in the lower zone limit, shows a



POLLEN DIAGRAM FROM MEANDER LAKE IN THE GANGA VALLEY DISTRICT PRATAPGARH U.P.
(PERCENTAGES CALCULATED IN TERMS OF TOTAL LAND PLANTS)
CLIMATIC PHASES
LOCAL POLLEN ZONES
cm
SEMI - HUMID
SEMI - ARID
ARID
VERY ARID
HS - IV b
HS - IV a
HS - III c
HS - III b
HS - III a
HS - II
HS - I
HOLOPTELEA
MYRIOPHYLLUM
BS-2 4380 ± 130 b.p.
POLLEN SPARSE FOR PERCENTAGE CALCULATION
Clay mixed with fine sand and silt
Organic mud
Clay mixed with coarse sand and kankar
ANOGEISSUS
TECOMELLA UNDULATA
PROSOPIS SPICIGERA
PHYLLANTHUS
OLEACEAE
SALMALIA
MYRTACEAE
PINUS ROXBURGHII
RUTACEAE
MALVACEAE PORATE
ROSACEAE
MIMOSA
GRAMINEAE
> 40 MICRONS
CEREALIA 60µ and above
UMBELLIFERAE
CARYOPHYLLACEAE
COMPOSITAE
ALTERNANTHERA
POLYGONUM PLEBEJUM
TRIBULUS TERRESTRIS
CHENOPODIUM
JUSTICIA
CONVOLVULACEAE
IMPATIENS
CYPERACEAE
LILIACEAE
TYPHA ANGUSTATA
NYMPHAEA
POTAMOGETON
MONOLETE PSILATE
MONOLETE PAPILLATE
MONOLETE RETICULATE
TRILETE PSILATE

Histogram 1

gradual increasing trend upwards. *Typha angustata* and *Nymphaea* are present in quite high values in the beginning but discontinues in the upper zone limit. The pollen frequencies for *Potamogeton* are quite high throughout the zone registering an increased trend upwards. The monolete polypodiaceous fern spores, distinguished into three types on the basis of ornamentation, are recorded for the first time in the lower zone limit and after attaining moderately high values in the middle zone tend to decline upwards. The trilete pteridaceous pollen are recorded in low discontinuous curve during the middle of this zone.

This zone has been subdivided into three subzones:

Subzone HS-IIIa (180-150 cm) — The pollen frequencies for *Polygonum plebejum, Tribulus terrestris, Typha angustata, Nymphaea* and Cyperaceae exhibit a tremendous rise whereas that of *Chenopodium* declines proportionately. Gramineae declined and cerealia curve increased. *Potamogeton* and fern spores make their appearance for the first time.

Subzone HS-IIIb (150-100 cm) — The pollen curves for arboreal taxa such as *Anogeissus, Tecomella undulata, Prosopis spicigera*, Oleaceae and Myrtaceae are marked by the steady rise in the values. The Gramineae curve exhibits minor fluctuations but the pollen frequencies for *Chenopodium* are highly reduced. The curve for cerealia shows steady rise. *Polygonum plebejum* is extremely reduced particularly in upper zone limit but Liliaceae shows increased values. The values for Caryophyllaceae, Compositae, *Alternanthera, Impatiens, Cyperaceae* and *Typha angustata* are fluctuatingly low. *Nymphaea* has reduced values whereas *Potamogeton* pollen frequencies are increased in contrast to preceding subzone.

Subzone HS-IIIc (100-70 cm) — It is determined by the overall increase in the arboreal vegetation. The pollen frequencies of Gramineae remain almost constant with minor downward fluctuations. The curve for cerealia exhibits steady rise whereas *Chenopodium* shows a consistent fall. The curve for *Polygonum plebejum* registers high values and *Alternanthera* shows increased tendency. The values for Caryophyllaceae, Compositae, Cyperaceae, Liliaceae, *Impatiens* and *Nymphaea* are reduced but for *Potamogeton* which attain high values. The pollen frequencies of ferns are declined in general.

Zone HS-IV (70-00 cm) — The zone commences with the abrupt fall in the arboreals, cerealia and *Polygonum plebejum*. The pollen frequencies of Cyperaceae, Liliaceae, *Nymphaea* and *Potamogeton* show an overall increase.

This zone has been subdivided into two subzones:

Subzone HS-IVa (70-50 cm) — During this subzone the pollen of arboreals such as *Anogeissus, Tecomella undulata, Prosopis spicigera* and Rutaceae experience reduced values. Oleaceae is absent. *Mimosa* shows high values. Gramineae remains almost same as in the preceding zone except for the steep decline at the close of this subzone. Cerealia pollen and *Polygonum plebejum* are comparatively reduced than in the preceding zone but for *Alternanthera* which tends to increase right at the beginning of this subzone. *Tribulus terrestris* and *Chenopodium* are present in fluctuatingly low values. The pollen of Cyperaceae, Liliaceae, *Nymphaea* and *Potamogeton* attain high values.

Subzone HS-IVb (50-10 cm) — The pollen values of Gramineae and Cyperaceae fall whereas those of Cerealia, Umbelliferae, Compositae, *Alternanthera, Polygonum plebejum* rise once again in the middle of this subzone. The values of tree pollen in general remain almost same except for the slightly increased trend in the lower half of this subzone.

DISCUSSION AND CONCLUSIONS

Vegetation and Climate

The climatic sequence, as determined from the biostratigraphy and lithostratigraphy of the lake-basin, has been grouped into four phases (I-IV). The general vegetation pattern is rather uniform and is tipped more towards open Savannah forest with vast stretches of grasslands and a few scattered stands of arboreal vegetation. Some changes during the vegetational developments have been noted which are largely assigned as due to the climatic variations and the biotic interferences.

Phase-I — The base of the phase-I is marked by the excessive presence of kankars in the loose sand which is sub-aeolian in origin, although the possibility of it being riverine can also not be ruled out. It is also characterized by the absence of pollen grains except for the meagre occurrence of *Chenopodium* and Gramineae pollen. Thus the evidences gathered suggest the high degree of aridity which led to destruction of pollen. The middle-upper zone limit is marked by the first infilling of the lake basin by inundation as attested by the lamination of clays. The occurrence of kankars continued although less frequently than in the lower limit. The middle-upper limit of this zone is characterized by the exceedingly high values of Gramineae and *Chenopodium*. The pollen percentage for *Typha angustata* is quite high in the middle and upper zone limit. The *Typha angustata* is a fresh water marshy plant and generally found on the banks of lakes and other water sources. It has high degree of adaptability to the changed conditions especially against the salinity. The occurrence of *Typha angustata* in good frequencies suggest the overflowing of the lake margins and thus confirms the lithological evidence for the first infilling of the lake by inundation.

Phase-II — It is defined by the *Anogeissus-Tecomella undulata* Gramineae-*Chenopodium* assemblage zone. The general vegetational pattern symbolizes an open-land steppe in which grasses were predominant. *Polygonum plebejum*, *Tribulus terrestris*, *Typha angustata*, Compositae, Caryophyllaceae, Cyperaceae, and *Potamogeton* have been recorded in low frequencies. Most of the above mentioned taxa showed their first appearance in the upper zone limit which corresponds to the decline in the pollen values of *Chenopodium*. The tremendous reduction in *Chenopodium* and the commencement of other taxa suggest the humid and aqueous environments. The commencement and establishment of arboreal vegetation characteristic of semi-arid belt such as *Anogeissus* and *Tecomella undulata* further reflects on a change in the microclimate from arid to semi-arid conditions. Thus the occurrence of trees and the plants of marshy and aquatic habitat indicate an increase in the annual rain fall than in the preceding zone.

Phase-III — This is marked by the Tree-Gramineae-*Polygonum*-*Tribulus*-Liliaceae-*Nymphaea*-*Potamogeton* assemblage zone. This phase begins with the rise in the pollen values of the arboreals such as *Anogeissus*, *Tecomella undulata* and *Prosopis spicigera*. The Oleaceae commenced with good values in the upper half of this zone. *Pinus roxburghii*, *Holoptelea*, *Salmalia* and Myrtaceae are represented by one or two pollen grains and they could be accounted as the transported pollen. The another important feature of this phase is the sizeable increase in the marshy and aquatic vegetation such as *Polygonum plebejum*, Cyperaceae, Liliaceae, fern spores, *Nymphaea* and *Potamogeton*. Nevertheless, this rise corresponds with the decline in the *Chenopodium* pollen curve. The cerealia pollen curve increased at the cost of Gramineae. *Typha angustata* occurred in good frequencies during arid zone in phase-I and thereafter it declined and diminished in the upper half of the phase-II corresponding to the semi-arid zone. It reappeared in high frequencies in this phase and its high pollen curve coincides with the peak point of *Nymphaea* pollen curve. The adaptability of *Typha angustata* against the ecological changes gives an explanation for its varied occurrence in different climatic zones. The occurrence of *Impatiens* pollen in this zone is the marker for relatively high precipitation. This fact is further corroborated by the occurrence of fern spores which otherwise could not have been survived. Thus the high values for semi-aquatic, aquatic and fern on one hand and the steep decline in the pollen values of *Chenopodium* on the other hand suggest the further increase in the annual precipitation.

Phase-IV — This is characterized by Gramineae-*Polygonum*-*Alternanthera*-Cyperaceae-Liliaceae-*Potamogeton* assemblage zone. In this phase the development of Cyperaceae and Liliaceae is maximum in contrast to the preceding phases. The pollen values of trees are overall fluctuatingly low whereas the shrubs are sporadic. The pollen values for Gramineae show a steep decline in the middle of this phase. The decline in Gramineae curve is marked by the sharp rise in the values of Cyperaceae, Liliaceae, *Alternanthera* and *Potamogeton*. This temporary fluctuation in the curves of the above mentioned taxa reflects to the innundation of lake.

ANCIENT FACTORIES AND PLANT ECONOMY

The absolute data as regards to the inhabitation of land by mesolithic people and their tool factories have recently come forth by the discovery of human skeletons and the associated tool factory at Sarai-Nahar-Rai, Pratapgarh (Sharma, 1973). The area was most suitable for the purpose, as the horse-shoe lake was situated at a stone throw distance, for the fulfilment of daily requirements of the people. The area flourished in the tool factory as the rock provenance was within the reach. The plant economy in the area commenced a little later at about 4500 b.p. corresponding to the Atlantic-Subboreal boundary zone. The basis for determination in the development of arable economy is the pollen evidence. The recognition of cereal pollen is much debatable particularly when the size criterion alone is taken into consideration for demarcating the cultivated grasses with those of wild grasses. Nevertheless, this was only the criterion for establishing the plant economy in Europe until the discovery of scanning electron microscopy (Firbas, 1937). Recently, Vishnu-Mittre (1973) has opined that in the tropical countries like India it is not a safe criterion since there is too much of overlapping of size characters. The findings made by Vishnu-Mittre indicate 50:50 possibilities being wild and cultivated in the size range of 60 μm and above and 57-60 μm. This could have been more precise if he would have combined size characters with sexine stratification. It is generally found that in the advanced form of grasses (cultivated) the sexine pattern is generally psilate (Vishnu-Mittre & Gupta, 1966).

I have, however, considered pollen having 60 μm and above with psilate pattern and prominent annulus as cereal pollen for assessing the plant economy. The commencement of the cereal pollen is noticed at the lower zone limit of the phase-II. The commencement of the cereal pollen is marked by the steep decline in the pollen value of Gramineae. The decline in the grasses is chiefly ascribed as the clearance phase for making the cultivable land ready. The development in the *Chenopodium* pollen curve shows how the *Chenopodium* intruded and flourished in the bare lands. Similar features although less significant have been observed throughout the pollen diagram. The inverse behaviour in Gramineae and *Chenopodium* curves can be well accounted as due to the grazing of grasses by cattle and clearance of land for cultivation. The occurrence of associated fossil bones of cattle, sheep etc. confirms the domestication of animals (Sharma, 1973).

The plant economy continued at the slow pace till the beginning of phase-IIIb. Another episode denoting the clearance of grasslands is noticeable during the phase-IIIa resulting the tremendous reduction in grass values which could as well interpreted due to inundation of the lake. The date for this incidence could be extrapolated to *ca.* 3500 b.p.

The plant economy prosperously increased during subzone-IIIb and subzone-IVa. The rise in the cultivation as evidenced by cerealia pollen is associated by the appearance of culture pollen such as Caryophyllaceae, Compositae and *Alternanthera*. These plants are presumed to be associated with cultivation. There is a general decline in pollen values of Gramineae by about 25% than the preceding zones. The reduction in the Gramineae is evidently due to the annual clearance of the grasslands. The arboreal vegetation in general shows an inclination to spread after the clearance of grasslands.

The pollen values for cereal pollen curve continued throughout the subzone-IVb although comparatively reduced than the preceding phase. This reduction does not enable to think about the abandonment but indicates temporary slump in the arable economy due to the overflowing of the lake margins.

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EXPLANATION OF PLATE

PLATE 1

1. *Salmalia*. × 1000.
2. *Pinus roxburghii*. × 1000.
3-5. *Tecomella undulata*. × 1000.
6. Myrtaceae. × 1000.
7. *Anogeissus*. × 1000.
8-10. *Tribulus terrestris*. × 1000.
11. *Mimosa*. × 1000.
12-13. *Alternanthera*. × 1000.
14. Gramineae. × 1000.
15. *Polygonum plebejum*. × 1000.
16. *Chenopodium*. × 1000.
17. Caryophyllaceae. × 1000.
18. Malvaceae. × 1000.
19. Trilete fern-spore. × 700.
20. Monolete fern-spore. × 700.

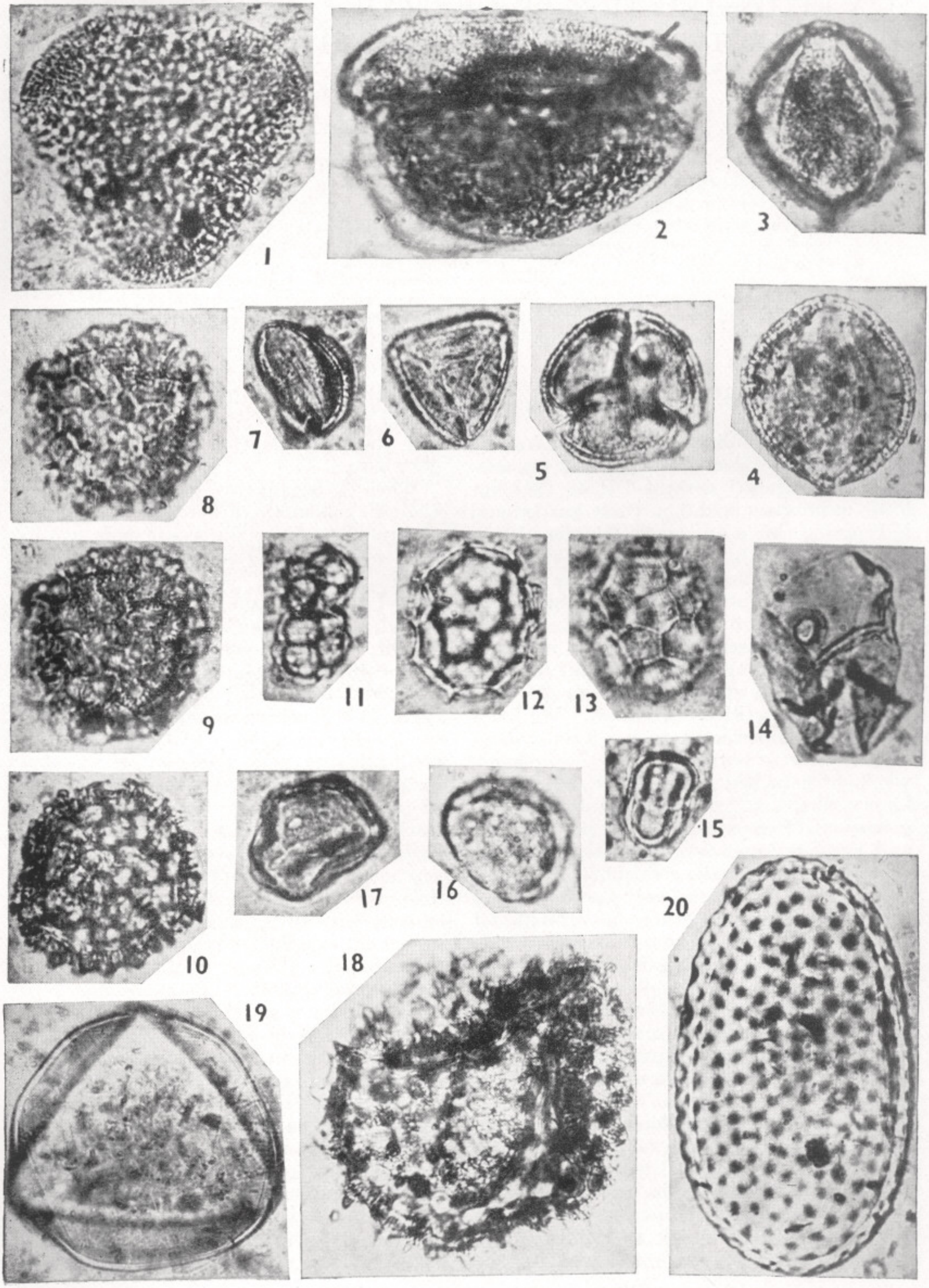

PLATE 1