POLLEN-ANALYTICAL INVESTIGATIONS OF THE LOWER KAREWAS

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THE pollen-analytical investigations of the Lower Karewa deposits exposed at Sedau, Laredura, Nichahom, Botapathri and Raithan along the north-eastern slope of the Pir Panjal in the south-west of Kashmir Valley have recently been carried out. Separate pollen diagrams for the trees and shrubs and for the aquatics and the herbs have been constructed. By superimposing the individual diagrams, a composite pollen diagram has also been prepared. The widely-spaced pollen-analysed samples and the uninvestigated big gaps in the profiles present an incomplete vegetational sequence, despite that some interesting phases of vegetational history have been noted which are known for the first time from the Lower Karewas.

FOREST HISTORY

The vegetational history begins with the Oak woods interrupted by a brief phase of the Alder woods. The conifer constituents of the forest comprise *Cedrus deodara*, *Abies*, *Picea* and *Pinus wallichiana*. The extremely low frequencies of the non-arboreal elements is suggestive of the closed woods.

The Oak woods are replaced by the open Pine mixed-woods which are preceded and followed by a phase each devoid of vegetation. Here the constituents of forest vegetation have extremely low frequencies and the ground vegetation is extremely scarce. These phases obviously indicate catastrophic changes in the vegetational history resulting in the destruction of the woods and creating such unfavourable conditions that inhibited the colonizers to occupy the bare area. These two phases are referred to as the Lower and the Upper Transition Zones respectively.

The open Pine-mixed woods are dominated by Pine (*Pinus wallichiana*) while the other forest constituents are very lowly represented. High values of Cyperaceae, Gramineae and Chenopodiaceae further characterize this phase. The extremely high values of the herbs here are intercalated by a phase where the non-arboreal elements are reduced to extremely low values and the Pine pollen frequencies fluctuate as high as 80-90 per cent : the frequencies of the other forest constituents remain comparatively reduced. Thus the non-arboreals in the Pine-mixed woods phase show two fluctuations the lower and the upper — the upper one differs from the lower by extremely high values of *Artemisia*, Gramineae and Chenopodiaceae, low values of Cyperaceae and the absence of Polypodiaceae.

The Upper Transition Zone is succeeded by a brief phase of Oak-mixed woods followed by a phase of *Picea*-oak woods which are replaced towards the top of the profile by the *Juglans*-elm phase. While the Polypodiaceae record high values in the *Picea*-oak woods phase, Cyperaceae and Gramineae show high values during the *Juglans*-elm phase.

Single pollen diagrams have so far been prepared from the sediments of the same age. For the Pine-mixed woods phase the pollen diagrams have been prepared from three sites but not from the synchronous deposits. It is, therefore, not possible at the moment to assess the influence of the local vegetation on the recorded vegetational phases.

FLUCTUATION IN LAKE LEVEL

The aquatic pollen grains belong chiefly to those of the swamp species — *Typha*, *Nymphaea*, *Trapa*, etc., those of the submerged species are either entirely absent or very scarce. The absence or scarcity of the pollen of the submerged plant species may be due largely to the unfavourable conditions for their growth. The presence and absence of the swamp species is, therefore, used as a guide to determine the fluctuations in the water level of the lake. Based on this it appears that the lake level was very high during the phase of Oak woods and the Lower Transition Zone. The lake became shallow at the base and the top of the Pine-mixed woods phase while in the middle of this phase it fluctuated to high level again. During the Upper Transition Zone and the succeeding vegetational phases, the water level was neither very low nor high.

STRATIGRAPHY

The Lower Karewas comprise about 2160 ft. thick sediments made up of clays, sandstones, conglomerates and lignitic beds. From the lithological studies of these sediments, De Terra & Paterson (1939) have been able to recognize as many as 5 Lithozones.

The Lithozone 1, the estimated thickness of which is about 600 ft., consists of folded and faulted, thick, dark and grey laminated clay layers overlying the gravelly sand. The lamination is due to alternate grey silty and fine sandy layers or to the greenish grey sandstone layers. The nature of the sediments suggests deposition under quiet conditions disturbed occasionally by flooding or by seasonal erosion and denudation.

The Lithozone 2, the lower lignite zone, is about 440 ft. thick with one or more thin lignitic seams overlain by brown sand, dark clays and conglomerates. The sediments suggest the occurrence of swampy conditions and fluvial activity. The petrographic analysis by Krynine (1939) of the grayish black gritty fine silty sediment from this zone at Laredura and named as the microconglomerate lignite reveals its formation from the weathered, eroded and fluvially transported material deposited abruptly in the swampy shores of a lake fed by swiftly flowing small streams. The climate was temperate humid.

The Lithozone 3, about 670 ft. thick, the upper lignite zone, is under and overlain by cross-bedded clayey sand or sandstone indicating stream action and turbulent conditions. The intercalated sandy and carbonaceous clay within the lignite and shaly nature of the lignite itself suggest swampy conditions and erosion and denudation by eolian and fluvial agencies. Climate dry temperate.

The Lithozone 4, the upper clay zone, about 450 ft. thick, is made up of blue and light grey laminated clays intercalated with silty and sandy layers. Lamination is suggestive of varves. At Laredura the clay is more silty with abundance of sandy shale. The petrographic analysis suggests the material (plant-bearing clay at Laredura) to be largely made up of reworked material and water laid under lacustrine conditions. Mild temperate or preglacial conditions prevailed.

The Lithozone 5 comprises the upper sand and gravel accummulation, obviously the fan deposition.

The stratigraphy reveals that the fluvial inwash and eolian drift presumably provided for changes in sedimentation. There is evidence of the interruption of clay deposits by repeated occurrence of the fluvial deposits, 4-5 of which can be recognized. It is interesting to find that these fans are accompanied by the folding and faulting of the underlying beds suggesting their relation with the phases of mountain building and the rejuvenation of the river courses. The repeated deposition of the fans suggests that they were deposited when the rivers were cutting and clays were deposited when they were filling. The alternating silty sandy layers constituting the laminations seen in the clays are suggestive of the conditions promoting the seasonal supply of both clay and sand — probably the monsoon climatic conditions. Phases of erosion, denudation and inundation have been rampant during this period, but erosion was more intense during the Lithozones 2 and 3 when a lot of material was reworked and redeposited.

The climate was temperate, wet during the Lithozones 1 and 2, dry in the Lithozone 3 and moist during Lithozone 4. Thus the vegetational succession in this region must have been influenced by the above changes in climate, erosion, denudation and inundation and the intermittent uplifts during the deposition of the Lower Karewas.

STRATIGRAPHICAL AND VEGETATIONAL CORRELATION AND THE CLIMATIC INFERENCE

In the nature of their lamination and alternate sandy layers the sediments at Sedau (Lithozone 1) suggest monsoon climatic conditions and occasional flooding, erosion and denudation, which were also responsible for the high water level of the lake, hence the climate during the period of Oak woods was wet. The correspondence of the brief Alder woods phase with sandy layer in the profile bears out the flooding episode.

The beginning of the Pine-mixed woods phase is marked by the shallowing of the lake as the frequencies of the *Trapa* pollen at this level would indicate suggesting indirectly a change in climate from wet to dry. Thus change in climate together with weathering and erosion was probably responsible for the destruction of the oak woods and their replacement by open Pine-mixed woods. The decline of the reedswamps during the middle of the Pine-mixed woods phase resulted from the flooding of the lake by the fluvial activity.

The Lower Transition Zone corresponds to the top of Lithozones 1 and 2. The sediments in Lithozone 2 are suggestive of weathering, erosion and fluvially transported material. Though the genesis of the sediments from top of Lithozone 1 is not known the similarity in the pollen sequence of the two besides the poverty of the pollen grains would indicate the sediments to have been deposited under similar conditions of weathering and erosion. Thus the probable cause for the catastrophic change in the vegetational succession here would be besides the drier climate weathering and erosion accompanied by inundation that was responsible for the large-scale destruction of the woods and general loss of vegetation cover which prevented the colonization of the open areas by even the herbaceous elements. The weathering and erosion continued during Lithozone 3 as is evidenced by the shaly lignite layers and intercalated sandy clay deposits. Erosion and denudation helped in the reworking of the material when the swampy conditions prevailed.

More or less similar conditions prevailed during the Upper Transition Zone which includes the base of Lithozone 4.

During the upper part of Lithozone 4, the monsoon influence, though present, was less intense. Temperature requirements of the *Picea*-oak woods suggest that a comparatively moist and cool climate prevailed.

An interesting feature of the fluctuations of non-arboreal elements during the Pine-mixed woods phase has been found to be correlatable with the lignite beds; their local influence, therefore, cannot be overlooked.

The erosion and weathering during Lithozones 2, 3 and a part of 4 would suggest that a large part of the pollen flora in the Pine-mixed woods and the Transition Zones might be of secondary nature.

Together with the operation of the other factors the intermittent uplifts during the Lower Karewas also appear to have excercised considerable influence on the succession of the Oak woods to the Pine-mixed woods and later from the mixed Oak woods to *Picea*-oak woods and to *Juglans*-elm woods.

None of the vegetational phases so far recognized suggest the prevalence of arctic or subarctic climate in any part of the profile. The climate was temperate throughout. The dominant blue Pine appears to be the low level pine as its associates at high levels have extremely low values. Thus the composite profile suggests the sequence in the climatic change from wet-dry-moist with progressive cooling while the climate as a whole continued to be temperate.

AGE OF THE LOWER KAREWAS

The age of the Lower Karewa deposits is very much disputed. They are looked upon of Plio-Pleistocene age by some (WADIA, 1951; MIDDLEMISS, 1911) and are assigned to the first Interglacial by others (DE TERRA & PATERSON, 1939; PILGRIM 1944). The underlying brown to pink gravels and sands are believed by the latter school to be the outwash deposit of the first glaciation. This contention is really open to question. The fluvial origin of the fans and their disturbed position together with the tilted nature of the overlying sediments is suggestive of the tectonic movements. Such tectonic movements have been intermittent during the deposition of the Lower Karewas.

It is largely held that the Pliocene climate was of the subtropical nature and a marked refrigeration of the climate characterized the beginning of the Pleistocene. The pollen-analytical sequence dealt with here shows that the climate during the deposition of Lower Karewas was temperate. The two Pines in the Western Himalayas — *P. roxburghii* and *P. wallichiana* could be easily taken to be the determiners of subtropical and temperate climates respectively. It must be pointed out that not a single pollen grain of *P. roxburghii* has so far been noticed anywhere in the profiles investigated. The reported occurrence of *Pinus roxburghii* in the Lower Karewas by Nair (1960) is due to insufficient determination as has become apparent from the re-examination of his slides.

It, therefore, appears that the investigated Lower Karewa deposits could neither be referred to the first interglacial nor to the Pliocene. For the moment they are assigned to the Preglacial. Whether they would be above the Plio-Pleistocene boundary as they probably seem to be, or the Lower Transition Zone or any of the vegetational phases from the uninvestigated gaps indicate the boundary between the Pliocene and Pleistocene is a problem of prime importance which needs extensive and detailed work for its elucidation.

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