POST GLACIAL CLIMATIC CHANGES BASED ON POLLEN FROM GLACIO-LACUSTRINE SEDIMENTS OF GANGOTRI GLACIER, GARHWAL HIMALAYA

Amalava Bhattacharyya and Parminder Singh Ranhotra
Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow, India

ABSTRACT

The Gangotri glacier is one of the largest valley glaciers lying between 30°43' 22" 30°55' 49" N and 79°4' 14" - 79°16' 34" E covering an area of about 143 sq km in the North-West part of the Himalaya, India. This glacier forms the source of river Ganga at Goumukh (4000 m a.m.s.l). In the present paper, temporal climatic changes during last postglacial period have been discussed based on the palynological studies of the sub-surface sediments close to snout of Gangotri glacier.

Around 9,000 yrs B.P climate was warm-moist which was changed to comparatively drier climatic conditions around 8,300 to 7,600 yrs B.P. Around 7,000 to 6,000 yrs B.P, the climate riverted to warm-moist. Subsequently after 6,000 yrs B.P to around 3,000 yrs B.P climate again became drier. Around 2,000 yrs B.P, climatic condition became cooler and moister and further amelioration took place around 1,700 yrs B.P. Around 1,000 to 850 yrs B.P the sharp increase of steppe elements reflect a trend towards drier climatic conditions. During recent time, climate again reverted to warmer condition reflected by the increase of Betula, Pine and other trees. Pattern of climatic changes around Gangotri region discussed here has almost similar trend noticed in several other regions, especially of the northeast part of the Tibetan plateau and Sahara Arabian zone.

STUDY AREA

The Gangotri region (30° 45' - 31° 15' N lat. and 78°54' 79° 17' E lon.), Lies,at the western part of Himalaya .

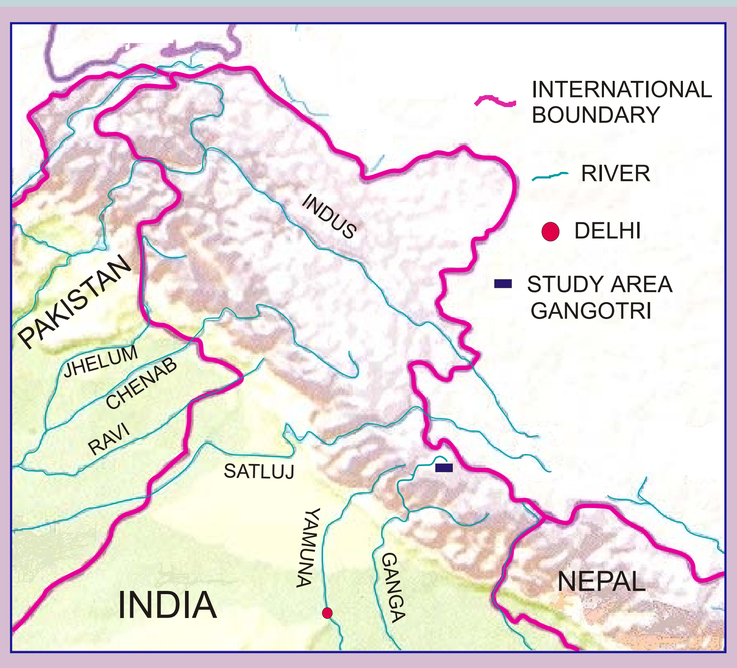
Famous Gangotri Temple at this region, at an altitude of 3,100 m a.m.s.l approx, holds an esthetic importance.

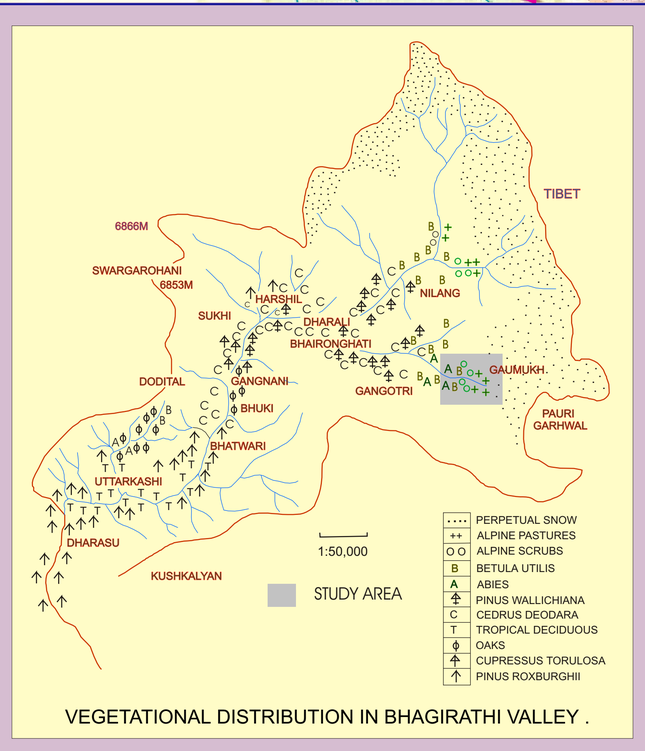
Following the 18 km of mule track from Gangotri Temple upstream along the right bank of river Bhagirathi, one can approach the glacier snout (Goumukh), which is the source of Bhagirathi River.

Bhujbasa, at an altitude of 3,800 m a.m.s.l and about 4 km downstream of present day Gangotr glacier snout. It is a wide valley representing outwash plain deposits with 3 to 4 meters of altitudinal difference from the present level of riverbed at the right bank. The site represents 1-meter thick sedimentary sequence deposited over the morainic boulders probably of main trunk glacier, which once occupied the area. The profile, BH-I was collected from this site.

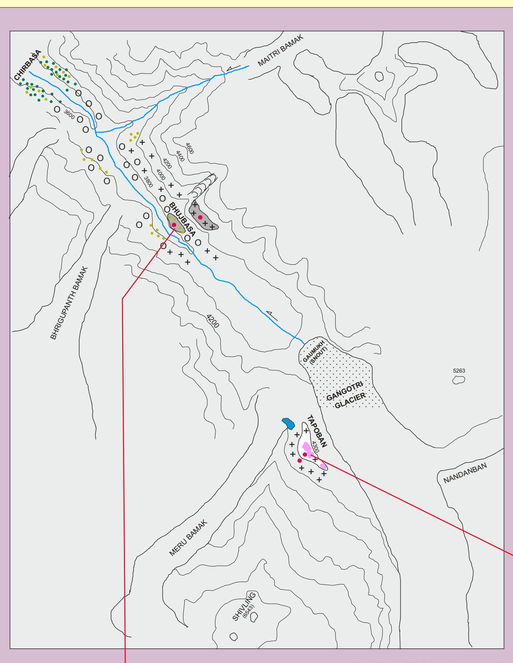
The Bhujbas area also represents 200 meters high and 50 to 80 meters wide kame like features, near the valley wall at the right bank of river Bhagirathi. The top of these deposits represent alpine meadow. Subsurface sediments were collected from the eight trial trenches (BH-A to BH-H) dug at the top of these kame terraces in which BH-F was investigated.

Tapoban (4,300 m a.m.s.l), a palaeolake covers about one square km area at thebase of Shivling Peak at the left bank of the glaciated valley, representing lacustrine sediments caped by 0.5 to 1 meters of glacio-fluvial deposits. The area is presently characterized by marshy and swampy environment Three trenches (TP-A, TP-B, TP-C) were dug from this site in which two profiles TP-B and TP-C were analysed for paleoclimatic studies.





VEGETATIONAL DISTRIBUTION IN BHAGIRATHI VALLEY .



N

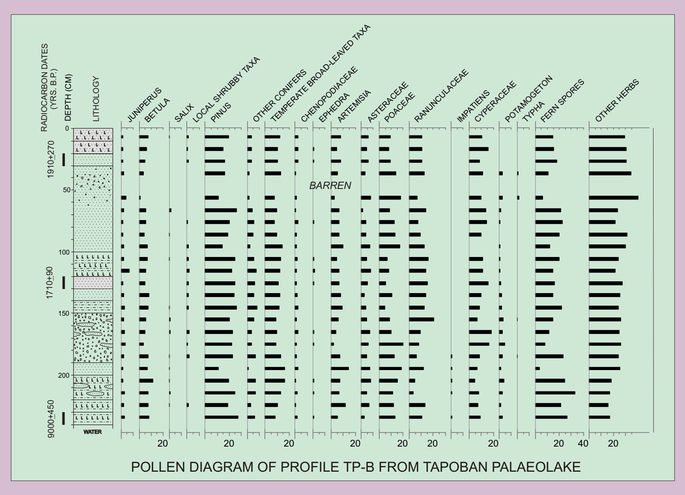
CONCLUSION

These four profiles from Gangotri area together have shown the climatic sequence of entire Holocene. Around 9,000 yrs. B.P (10,200 cal yrs B.P.) the climate was mainly warm and moist as recorded in profiles BH-F and TP-B that continued till around 6,000 yrs B.P with short cooler climate between 8,300 yrs B.P to 7,300 yrs B.P.

The upper part of the profile BH-F shows the continuity of the drier climate since 6,000 yrs B.P. But the very low resolution with one sample covering around 1,800 yrs of time span restrict the near precise date of commencement of dry conditions which might be around 5,000 yrs B.P.

However the profile TP-C from Tapoban has shown moist conditions ~4,200 yrs B.P that reverted back to drier conditions ~ 3,000 yrs. B.P.

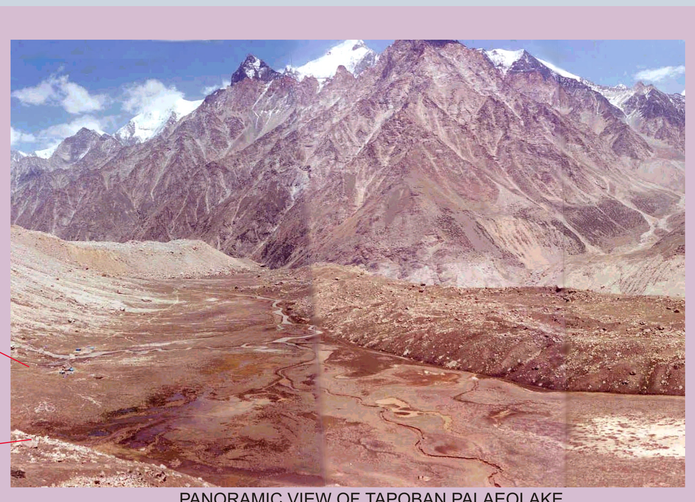
The profile BH-I shows towards increasing moist conditions ~2,000 yrs B.P to ~1,700 yrs B.P subsequent sharp increase of steppe elements around 800 years B.P reflects the trend towards drier and cooler climate. This dry episode can be well correlated with the Little Ice Age signatures.



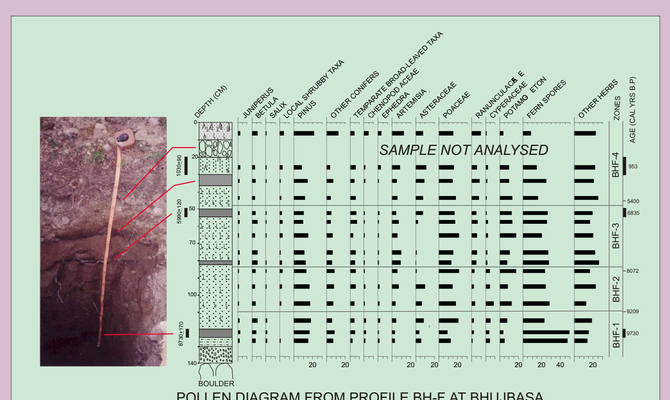
POLLEN DIAGRAM OF PROFILE TP-B FROM TAPOBAN PALAEOLAKE

Here good representation of both marshy/aquatic taxa and steppe elements around 9,000 yrs B.P when climatic conditions seem to be warm-moist. It appears that the Topoban area would have vacated glacier since early Holocene and might have acquired the present prevailing scenario i.e. existence of marshy/swampy and water laden conditions and also the availability of dry land around the lake supporting the growth of steppe elements. Subsequent climatic and depositional history during late Holocene could not be analyzed in finer temporal scale due to inversion of dates. However the finer sediments almost at the middle of the profile, during 1,600 yrs B.P, might support the existence of large lake at Tapoban (B.C. Law 1968) around 7th century A.D. i.e. around 1,300 yrs B.P.

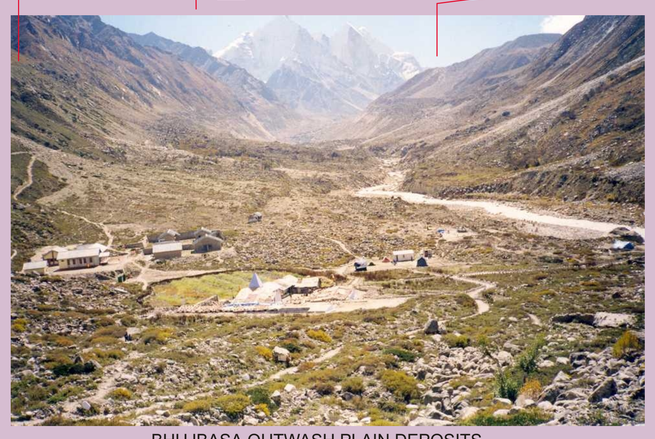
KAME DEPOSITS AT BHUJBASA



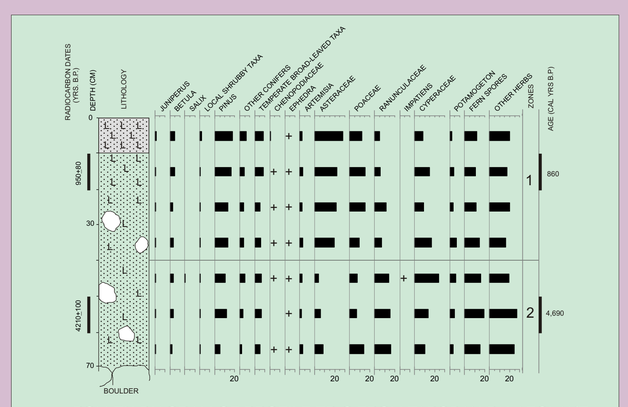
PANORAMIC VIEW OF TAPOBAN PALAEOLAKE



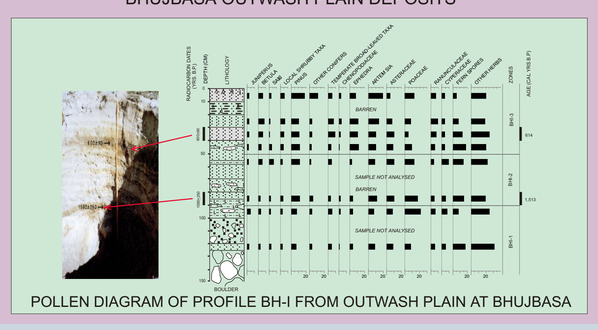
POLLEN DIAGRAM FROM PROFILE BH-F AT BHUJBASA



BHUJBASA OUTWASH PLAIN DEPOSITS



POLLEN DIAGRAM OF PROFILE TP-C FROM TAPOBAN PALAEOLAKE



POLLEN DIAGRAM OF PROFILE BH-I FROM OUTWASH PLAIN AT BHUJBASA

Presence of good amount of local taxa through out the diagram suggests that the site might have been ice-free during Holocene. High amount of Extra local elements along with fair amount of alpine scrubs, *Betula, Alnus*, *Salix* and other broad leaved taxa In the zone F-4 indicate warm-moist conditions around 8,730 yrs B.P. Zone F-3 suggest cooler phase since 8,300 yrs. B.P, when *Betula, Alnus, Salix* and other broad-leaved taxa showed decline with increase in steppe elements as *Artemisia*, Asteraceae, Caryophyllaceae and others. By 7,300 yrs B.P the conditions again turned to be warmer as indicated by the increase in *Betula, Salix* and other broad-leaved taxa along with *Pinus* and other Conifers. After around 6,000 yrs B.P, the decline in *Betula, Salix, Pinus* and other Conifers with the increase in steppe elements as *Ephedra,* Chenopodiaceae, decline in ferns and aquatics suggests the onset of arid phase. Further demarcation of vegetation/climatic changes in the upper part of the profile covering late Holocene is not possible due to slow rate of sedimentation.

During 2,000 yrs B.P, the tree line characterized by open *Juniperus-Betula* was close to site. Poaceae, Artemisia, Brassicaceae, Asteraceae and Ephedra represented the ground vegetation along with good amount of Ferns and Cyperaceae. Altogether presence of these taxa indicates comparatively cooler and moister climate in comparison to prevailing present day climate. In between 1,700 to 800 yrs B.P, increase in *Betula, Salix*, and *Pinus* along with ferns and Cyperaceae indicates comparatively warmer and moister climate than earlier phase. From 800 yrs B.P, a major shift in the vegetational pattern is marked by the increase in *Ephedra* and other steppe elements like *Artemisia* and Asteraceae and decrease of Ferns and Cyperaceae. This indicates that the climate became cooler and drier than earlier phase. However, the increase of extra local elements *Pinus, Cedrus, Picea, Abies* and other local arboreals such as *Betula, Salix, Juniperus* during upper part of this zone suggest that *Pine-Cedar* dry temperate forest might have ascended closer to the study site representing the modern situation.

Around 5,000 yrs B.P, low values of Betula, *Alnus*, and Conifers suggest that these taxa used to grow at comparatively lower elevation than to their present level under cooler conditions. The lower values of Cyperaceae, Ferns and aquatic elements (*Potamogeton*) in the sample at the base of profile also support less moist conditions during this time. Subsequent increase of tree taxa around 4,200 yrs B.P, indicate the shift of tree line towards higher elevation probably under warm and moist climate. Around 3,000 yrs B.P there was deterioration of climate indicated by decline in the *Betula, Alnus,* Conifers and other elements. There was also sharp decrease of ferns, Cyperaceae, and *Potamogeton* which may be suggestive of drier phase indicating the infilling of lake.

LEGEND

SILT · CLAY · COBBLES/ PEBBLES · ORGANIC RICH DARK CLAY · ORGANIC RICH · FINE SAND · COARSE SAND / GRIT