Figure 2. Ultra potassic rock underlying the Indravati sediments at Tirathgarh waterfall.

characterized by the above classification. Similar attempts on igneous rock classification diagram of Cox *et al.*[6] and on modified total alkali–silica (TAS) diagram of Le Bas *et al.*[7] have also failed to specifically assign its position. However, on TAS diagram, the ultrapotassic rock of Bastar indicates a tendency to foidite field. Volcanic rocks with Al_2O_3 content of $\simeq 32\%$ are a rarity. It is contended that this ultra-aluminous character is acquired through assimilation of meta-argillites and their components within the Bengpal gneisses, forming basement of the Indravati basin. The major normative minerals formed in all the samples are orthoclase (62–70%), corundum (18–21%) and haematite (2–3%) with apatite, ilmenite and magnetite as accessories (Table 1). Two samples show undersaturated minerals such as leucite and nepheline, indicating their alkaline character. However samples show sericitization in thin sections, which is a subsequent alteration phenomenon and could be attributed to the formation of normative quartz. From the above discussion, it is obvious that chemically or petrochemically the volcanic rock of Bastar has unique features.

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Dendrochronological reconnaissance of *Pinus wallichiana* to study glacial behaviour in the western Himalaya

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Tree ring analysis of *Pinus wallichiana* growing in the subalpine region of the Kinnaur, north-west Himalaya has been discussed in this paper. A chronology of this species extending from 1621 AD to 1990 AD has shown that tree ring data could be used to study the glacial behaviour in this region. It has been recorded that the annual ring widths of this species are low during the years having positive glacial mass balance recorded from some glaciers of this region and with glacial advances reported during the recent past in the Himalayan and Trans Himalayan region.

RECENT studies reveal that tree ring data derived from either of several annual ring characters, viz. width, density, cell size, isotope contents and others are unique sources of proxy records to deal with the various aspects of environmental studies[1–3]. Using tree ring data, fluctuations of recent glaciers have been analysed from the Alps[4], Mount-Baker[5], Canadian Rockies[6] and others.

In India, a great deal of geomorphological studies in the Himalayan glaciers have been done[7–10]. But, except for two synthesized extrapolated long records based on data from several glaciers[8,9], no studies on the history of glacial fluctuations in terms of absolute time scale are available from the Himalayan region. In the present study, the prospect of tree ring study to understand glacial fluctuations in terms of calendar years from the Western Himalayan Region has been discussed. This study is based on ring width data of *Pinus wallichiana* growing in the dry subalpine regions of Kinnaur, in the Western Himalayas.

Several conifers in the Himalayan region have been found to be a potential source for tree ring studies[11–18]. To extend database from diversified climatic zones, the present study was undertaken on *Pinus wallichiana* growing in subalpine forest at Kinnaur, Himachal Pradesh in western Himalaya. This taxon is widely distributed between latitude 25°N–36°N and longitude 68°E–100°E throughout the Himalaya at an altitude ranging from 1200 m to 3800 m, in both monsoon and non-monsoon regions[19].

In Kinnaur, this tree is reported to grow in diverse ecological conditions. At lower elevations, it prefers sites with a moderate monsoon rainfall but at higher elevations it requires heavy and long-lying winter snowfall[20]. For the present study, tree ring samples were collected from, Pooh, a high level pine site, Kinnaur, Himachal Pradesh (Figure 1). Here *Pinus wallichiana* forms an open forest growing in almost table-land in between dry temperate tree zone of *Pinus gerardiana*-

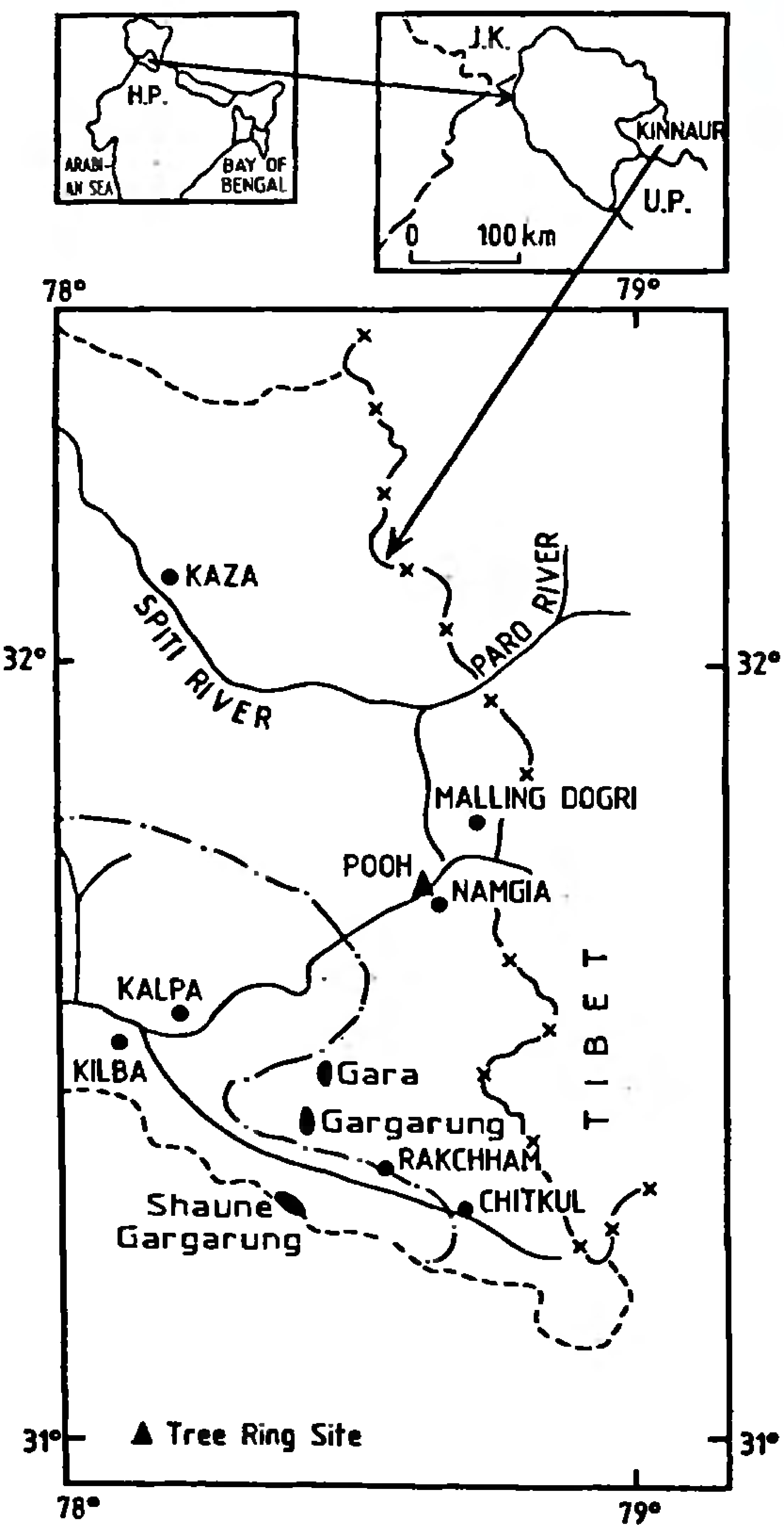

Figure 1. Location of tree ring site, Pooh, Kinnaur, Himachal Pradesh.

Figure 2. Photograph showing open pine forest at Pooh, Kinnaur, Himachal Pradesh.

Cedrus deodara and subalpine tree zone of *Betula utilis* at an altitude of 3500 m. The forest has been highly disturbed and almost denuded in the recent years by the local inhabitants to meet the demands for timber and fuel. The remnant comprises mostly medium and a few large-sized pine trees (Figure 2) with patchy outgrowths which are represented by patches of tall grasses, *Artemesia, Berberis* and wild roses.

For tree ring analysis, eight cores from four trees of *Pinus wallichiana* were collected during September, 1990 by one of the authors (A.B.). Trees which were comparatively large in size and girth within the lot were selected for sampling. Generally, two cores in opposite directions from each tree were collected through increment corer. Most of the cores were not up to the pith or centre of the trees because of the huge girth of the trees and the short length of the increment corer.

These cores were mounted, polished and cross-dated following the standard procedure used in tree ring analysis[1,2,21]. The growth rings of all these cores were dated to the calendar year of their formation through Skeleton Plot Technique of cross dating[21]. False or double rings were very commonly found in the beginning years of these cores. However, they are clearly distinguishable by their faint boundary. Absent rings have also been noticed in two cores as trees here are confined in stressed environment of dry arid climate. The years of these absent rings are easily located by cross-dating. Dates of these cores range between 1621 AD and 1990 AD. A good cross-dating has been noticed in these rings studied both from the same tree or in the different trees. The ring widths of dated tree ring sequences were measured under increment measuring machine with a precision to 0.01 mm. A further check on the quality of dating was then carried out by using program COFECHA[22]

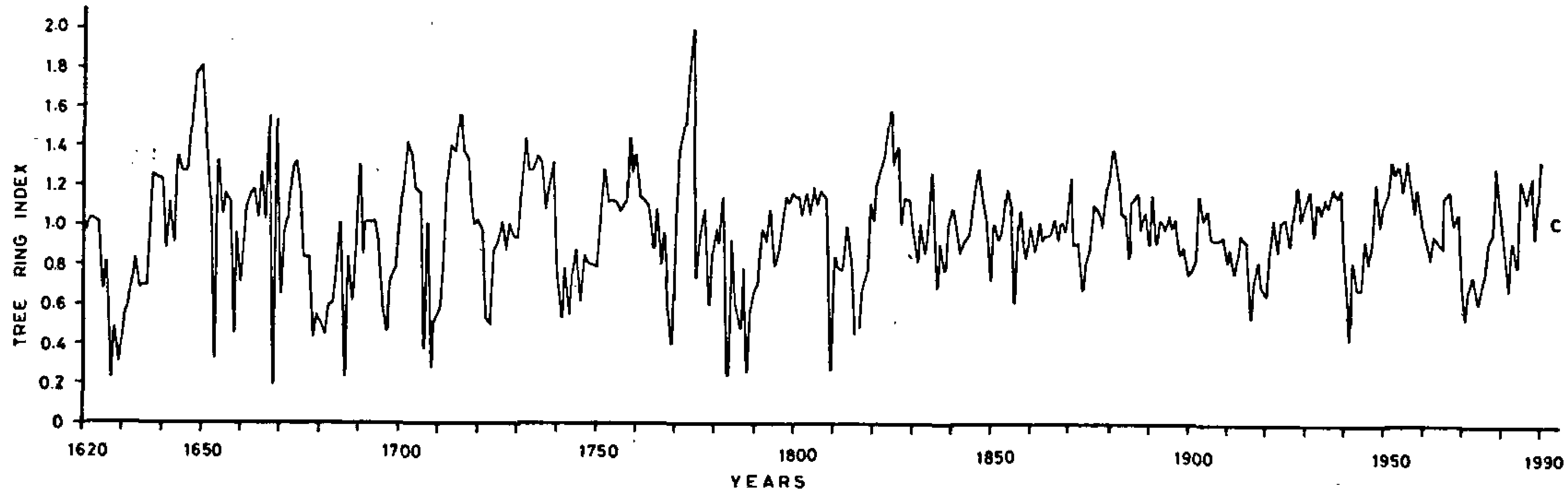

Figure 3. Tree ring chronology of *Pinus wallichiana* extending from 1621–1990 AD.

Table 1. Descriptive statistics of detrended tree ring series

Sample	Interval	Years	Mean sens.	Autocorrelation order
KIR39A	1807–1990	184	0.233	0.727
KIR38A	1859–1990	132	0.178	0.813
KIR38B	1862–1990	129	0.161	0.838
KIR37B	1719–1979	261	0.251	0.858
KIR36A	1638–1982	345	0.266	0.750
KIR36B	1621–1990	370	0.287	0.635

Table 2. Common interval 1723–1729 AD (257 years) analysis for residual chronology based on two trees and three radii

Mean correlation	
among all radii	0.407
between trees	0.237
within trees	0.754
Signal-to-noise ratio	0.611
Percentage of variance in the first eigenvector	62.63%

which uses ring width measurement series in getting identified the segments of a core, cores or group of cores where dating problems might exist. The dated ring width series were then transformed to dimensionless ring width indices after removing the growth trend by using program ARSTAN[22,23]. In this case, each core series was detrended using a spline, each series was prewhitened using an autoregression model, the series for each chronology was combined using a bi-weight robust time series model for the site to obtain Arstan chronology. Spline with 50% variance reductions at the two-third years chronology length was used for smoothing. A pine chronology extending from 1621 AD to 1990 AD for the site Pooh, Kinnaur, Himachal Pradesh has been made (Figure 3). Statistical data of detrended chronology (Table 1) indicate low mean sensitivity and standard deviation, and high autocorrelation which suggest that this chronology is not an ideal one for climatic analysis[22]. Statistics for common interval (1723 AD to 1979 AD) from two trees and three radii shown in Table 2 show both low common variance and signal-to-nose ratio which also support for poor quality. However, striking similarities in statistical characters of present chronology with those of many analysed from subalpine region[11,12,14] suggest that the conifers growing in subalpine Himalayan region might not be ideal for dendroclimatic analysis using ring width data.

Evidence of fluctuations of glaciers both past and present is important to understand past climatic changes. During studies of glaciers in the Himalayan region in connection with glacial and hydrological problems, several workers recorded observations on geomorphological aspects of glaciers which indicated past fluctuations of glaciers. However, non-availability of absolute dates to these glaciogenic evidences is a major handicap in most of these studies to assign glacier fluctuations in terms of absolute time scale. Even in modern glacial studies, except for some glaciers in the western Himalaya, no year-wise long data on glacial behaviour or on mass balance budget are available for a particular glacier. So far, available records, covering only 10 year's are reported from Gara glacier (1973–83), Gor Garang (1975–85) and Shaune Garang (1981–91). Although, these glaciers like other Himalayan glaciers are noted cumulatively to be in the state of recession since the beginning of the present century, positive mass balance has been recorded during 1974–75, and 1975–76 in Gara glacier, 1981–82, 1982–83 in Gor Garung glacier, 1982–83 and 1989–90 in Shaune garang glacier[25]. Only two reports on the basis of percentage of advancement, retreating and stationary positions of several glaciers in the Himalaya, and Trans Himalayan regions show year-wise fluctuations of glaciers which are extrapolated since 1812 AD (refs 8, 9).

Year-wise variations of tree growths and their relationship to corresponding year's glacial fluctuation or to the glacial mass balance budget and climate are very complicated. Several non-climatic variables play a significant role in both tree growth and budget of glacial mass balance. However, it is obvious that major climatic conditions required for tree growth and glacial advancement in the mountainous region are inversely related. High winter snowfall, and short, cool, cloudy summer generally favour positive mass balance[26], which on the other hand retard tree growth by inhibiting photosynthetic activity during growing period of a tree. In the Himalayan region, no data regarding climatic factors controlling various physiological activities of conifers growing at timber line are available. Data in this regard, under an almost similar situation in Alps, may provide generalized information on tree growth and climatic relationship near tree line. It has been recorded that under such climatic conditions photosynthesis declines with the decrease of temperature, light intensity and photoperiod from September onward and true dormancy starts from November, and during February to April there is no photosynthesis to compensate for respiration[27]. This dormancy ends from the end of April and leaf buds open during May. These new needles are found to be very much sensitive to frost and often they get damaged with late frost[27]. Thus, it is clear that in the subalpine region, temperature has a significant role in limiting the growth. Here, generally precipitation rarely becomes critical for the growth. In general, trees have good growth (wider rings) during warmer summer and low growth (narrower rings) in cooler summer.

The growth behaviour of *Pinus wallichiana* growing in the arid subalpine region of the Western Himalaya has been compared with the available data on glacial fluctuations, mass balance, precipitation and temperature data of this region. Low ring indices recorded during 1970–76, 1981–84 and 1989 have been found to coincide with the years of positive glacial mass balance reported[25] in some glaciers in Kinnaur, H.P. (Figure 4). It has been noted that temperature in Srinagar[13] is also low during these years. Temperature and tree growth relationship reveals that most of the narrow rings correspond with or immediately succeed periods of low temperature. Low growth in the succeeding year of low temperature suggests that the previous year's stored food is responsible for the growth of the current year which is revealed by the high first order autocorrelation in this chronology. This might be due to the fact that the low net photosynthate during the extreme cold years not only reduces the current year's tree growth but also acts as trigger for the next year's growth. Moreover, reduced tree growth might also result due to late frost when old leaves become inactive and new needles get damaged. This reduced tree growth may have carryover effect for 2 to 4 years depending upon the intensity of cold. Tree growth in moist subalpine region of Kashmir, western Himalaya has also been found to have good correlation with summer temperatures[13,14]. Simple comparison with

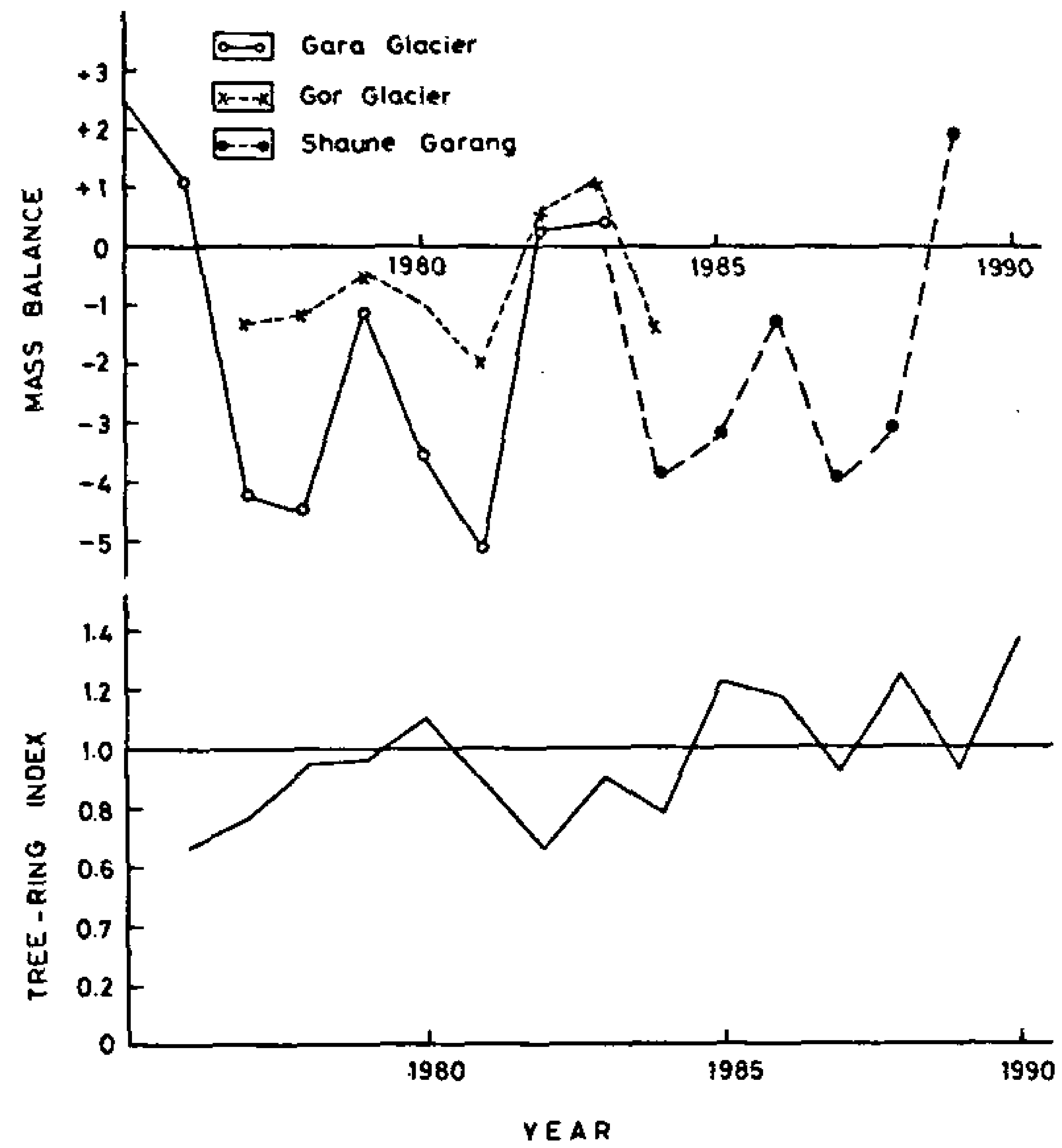

Figure 4. Relationship between tree ring index and glacial mass balance data (after Puri *et al.*[25]) of some Himalayan glaciers.

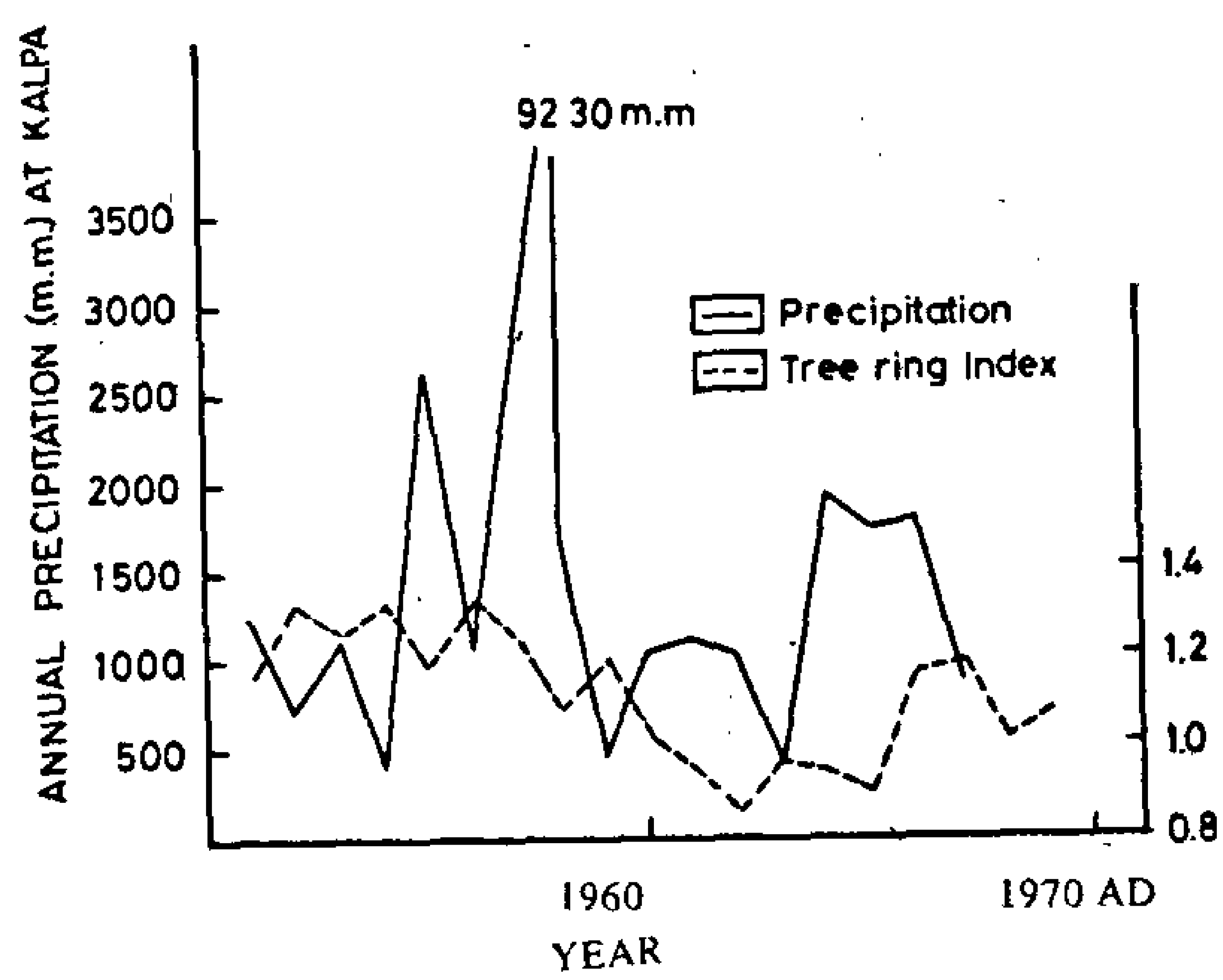

Figure 5. A portion of tree ring chronology of *Pinus wallichiana* and its relationship with precipitation at Kalpa, Kinnaur.

the available short records of precipitation of Kalpa, Kinnaur shows that tree growths are low during the years of high precipitation (Figure 5). Low tree growth trend in *Pinus wallichiana* during 1890 AD–1920 AD has been reported to be correlated with the advancing glaciers during 1890 AD–1920 AD (Figure 6). Meteorological data recorded from Srinagar also show that summer temperature during 1900–1910 AD and 1920–1925 AD was low and at the same time precipitation during 1890–1910 AD was high. Increased rainfall during this period was also reported from Leh, Ladakh[28].

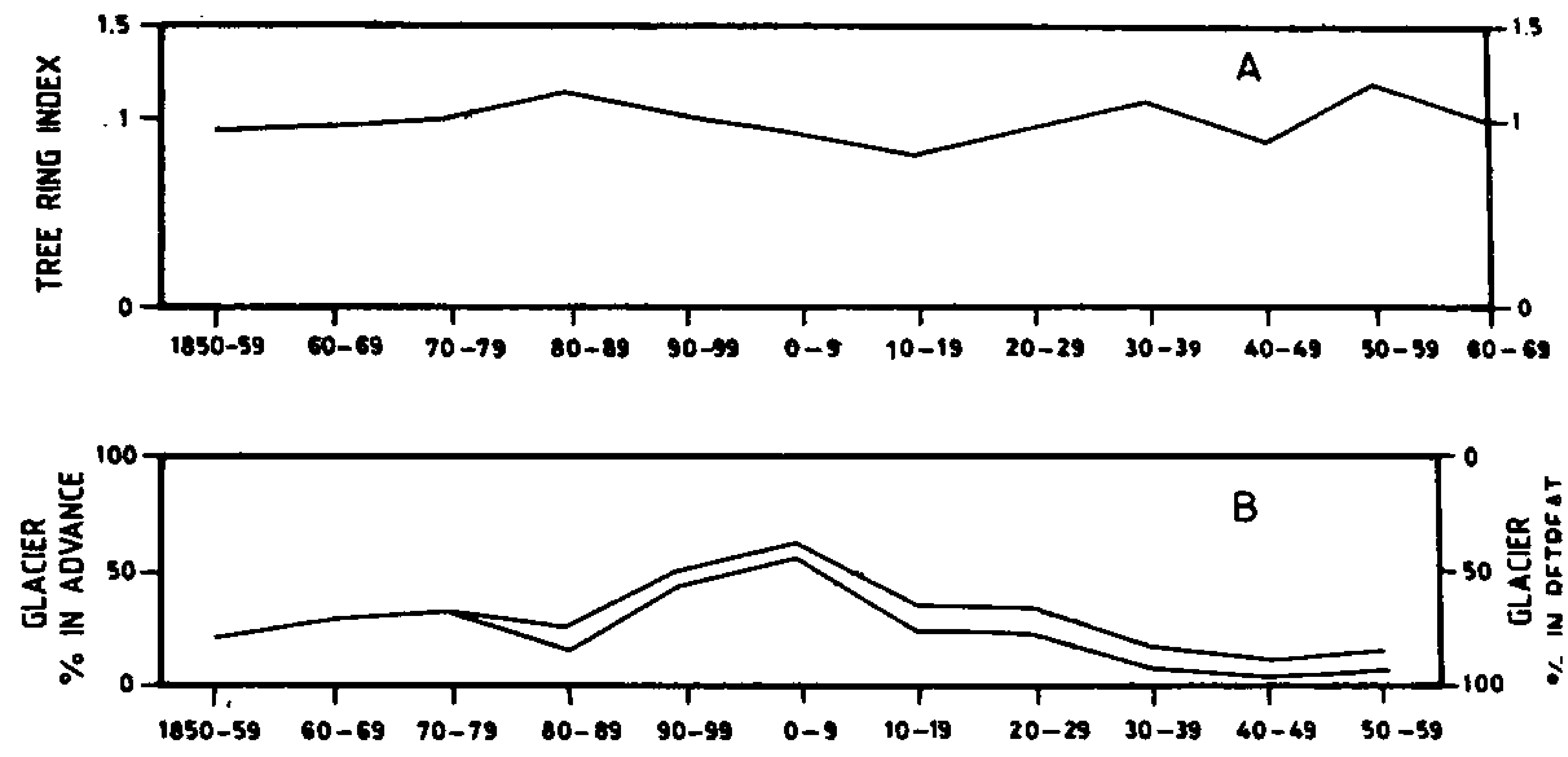

Figure 6. A portion of chronology based on decadal percentage of tree ring index values and its simple relationship to decadal percentages of Himalayan glacier fluctuations. Decadal percentages of retreating, stationary and advances, glaciers. (After Mayewski *et al.*[9]). Top line – advances; bottom line – retreats; Percentage of stationary glaciers represented by separation of lines.

Earlier, it was also reported that monsoon was high during the peaks of glacier fluctuations[8]. These conditions, low temperature and high precipitation, might be the reason for the temporal advancement of glaciers and retard action of growth of trees near the tree line. However, it was observed that the peak of glacial advancement and tree growths (Figure 6) do not coincide well. This might be due to differences of lag effects in tree growth and glacier advancement in response to climatic changes. Tree ring chronologies made from each of *Abies pindrow, Pinus wallichiana* and *Picea smithiana* growing in the subalpine forest of the Kashmir Himalay[11] have also noted low growth during years of glacier advancement. This clearly indicates that such behaviour of tree growth related to glacial advancement is a regional phenomenon and not due merely to local effect.

Pinus wallichiana growing in the subalpine Himalayan regions would be an excellent candidate for the tree ring study to understand past glacier behaviour in the Himalayan region. However, the present study is a preliminary attempt in this aspect as a detailed study could not be possible due to the lack of both climate and glacial mass balance budget data adjacent to the tree ring sampling site and small sample size. Available fragmentary data on glacial movements or mass balance budget in the Himalayan region inhibit quantifying the interrelationship between mass balance budget, tree growth *vis-à-vis* climatic changes. This handicap in the present study could be resolved with the making of a regional *Pinus wallichiana* tree ring chronology from the subalpine region of the Himalaya which might be linked with the regional climatic variation and glacial fluctuations. Analysis of climatic data from a few meterological observatories located in the high altitude of the Himalaya may provide the required regional climate data. But the glacial data in terms of absolute time scale requires detailed geomorphological studies in the modern glaciers to identify suitable material from the sedimentological evidences of glacier advances and retreats which could be dated through various radio isotopic methods.

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Etiological characterization of acute infectious abdominal dropsy outbreak affecting Indian major carp, *Cirrhinus mrigala* in South Andaman

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The causative agent of severe acute infectious abdominal dropsy outbreak in Indian major carp, *Cirrhinus mrigala* was investigated. The etiological agent was identified as a highly virulent strain of *Aeromonas hydrophila*. No virus could be isolated from the affected fishes in homeothermic cell lines, viz. BHK_{21}, Vero, L929 and NIH3T3 and poikilothermic cell lines namely RTG-2 and RTH-149. The abdominal transudate of the affected fishes and the culture filtrate contained heat-stable hemolytic proteolytic, amylolytic and dermonecrotic exotoxin activity. Ammonium sulphate precipitated partially purified extracellular preparations (ECPs) were highly cytotoxic when tested in same cell lines. The flagellar 'H' antigen was common to other moderate and avirulent strains of *Aeromonas* sp. as well as *Edwardsiella tarda* and *Yersinia rukeri*, whereas the somatic 'O' antigen was very specific to the isolated strain only when tested by agglutination test using polyclonal antisera against these organisms. Soluble antigens of the strain were cross-reacting with these organisms when tested for humoral response by agar gel immunodiffusion (AGID) test. The partially purified ECPs showed Type IV hypersensitivity in rabbits immunized with homologous and heterologous antigens, when tested for cell mediated immune response (CMIR).

ACUTE infectious abdominal dropsy, a condition characterized by an abnormal accumulation of fluid in the whole body, specially in abdomen or localized in some organs of European carps causing severe epidemics is well recorded[1,2]. Gopalkrishnan[3] was the first to observe the disease in Indian carps and found *Catla catla*, *Cirrhinus mrigala* and *Labeo rohita* in descending order of susceptibility. The ulcerative form of *Aeromonas hydrophila* infection in *C. catla* was reported[4] with white cutaneous lesions on the snout, loose scales and disintegration of fin margins. An acute septicemic infection in Indian major carps of west Godavari district of Andhra Pradesh was also reported[5]. Factors contributing to virulence of *A. hydrophila* such as haemolysin, protease[5–12], haemagglutinin[5,12], amylase[7,8,12–15], cytotoxin[12], dermonecrotic factor[12], etc. have been demonstrated. Many workers[12,15–18] claimed the predisposing factor of dropsy and some ulcerative syndrome of fish as Rhabdovirus infection.

During March–April 1995, there was a severe outbreak of infectious dropsy in farmers' ponds in South Andaman, which recorded very high mortality in Indian major carp *C. mrigala*. The pond sizes ranged from 0.08 ha to 0.12 ha and had 1.5 to 2.2 m water level. Most of the ponds were stocked with all the three species of Indian major carps, viz. rohu, catla and mrigal as per standards under the supervision of Department of Fisheries, A&N Islands. 20 to 80% of mrigal were infected. Interestingly enough, rohu and catla were negligibly affected. The infected fishes weighing approximately 400 g showed loose scale, distended abdomen (Figure 1), lethargy, swirling movement, muscular degeneration and petechial haemorrhage on the epidermis just under the loose scales. On casting the net in the ponds, fresh skeleton of the fishes was also found, possibly resulting from severe generalized muscular degeneration and death, since there were no carnivorous fish species stocked and the ponds were free of crabs. Moribound fishes were washed with sterile distilled water, sacrificed and were cut open through the abdomen. This showed a slight reddish-coloured fluid accumulation approximately 30 ml in each fish (Figure 2). The fluid was collected from a number of fishes and preserved. Samples for isolation of bacteria and virus were obtained aseptically from liver, heart, kidney, gills and intestine from 22 affected fishes. Fish infusion nutrient agar (FINA), tryptone soya agar (TSA) and *Aeromonas* isolation agar (Himedia, Bombay) with supplement were