

Preliminary Lichenometric Studies in Eastern and North-Western Himalaya

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Abstract: Lichenometry is an extremely useful technique in dating moraine ridge and recent glacier retreat in polar and alpine regions. The study relates the size of the lichen thallus to the minimum age of the exposure of the surface on which it grows which consequently helps in assessment of the age of the boulders. The Lichenometric studies are carried out in Kupup and Thangu area of eastern Himalaya in Sikkim and Thajiwas glacier in Ganderbal district of north western Himalaya of Jammu and Kashmir with the help of diameters of a common crustose lichen *Rhizocarpon geographicum* growing luxuriantly on exposed boulder. The Thajiwas glacier showed retreat of 200 m in 279 years while in Thangu and Kupup area of eastern Himalaya the retreat was estimated as 200 m in 100 and 91 years respectively. The rate of retreat was slightly more faster in eastern Himalayan (20 mm/century) than the north-western Himalaya region (18.5mm/century).

Keywords: Lichen radius, *Rhizocarpon geographicum*, North-western and eastern Himalaya.

INTRODUCTION

Lichenometry, a most frequently used technique for dating rock surface by the geologists, is also used to date the moraine ridge on recent glacier forelands in polar and alpine regions. The method was originally developed and used by Beschel (1973), and since then it has been widely applied in dating recently exposed rocky sub-strates (Harrison and Winchester, 2000; Smith and Desloges, 2000; Solomina and Calkin, 2003; Armstrong, 2005; Joshi and Upreti, 2010) and measure of natural hazardous (Joshi et al., 2012). The micro and macrolichens used for lichenometric purposes have a circular or elliptical growth form in their first growth phases. The size of the thallus forms an index of the growth of lichens and gives information about the age of the substrate. This relationship constitutes the basic principle in the dating technique. Longest axis measurements are to be preferred to the more subjective measurements of the area of the thallus, the mean axis and the largest inscribed circle (Solomina and Calkin, 2003).

The percentage cover of the lichen can also be used as growth index, but this approach is rather time consuming and usually based on fairly rough estimates (Hansen, 2008). Innes (1988) provided a list of micro-and macrolichens used in lichenometry. The macro lichens *Stereocaulon*, *Usnea*, *Ramalina* have mainly a vertical or fruticose growth form

and accordingly are irrelevant in the lichenometry. The *Umbilicaria* are somewhat special with their umbilicate thallus form, attached to the substrate by a central umbilicus. However, the remaining species have a more or less typical centrifugal pattern of growth and may be recommended for dating purpose.

Some micro lichens such as *Aspicilia*, *Acarospora*, *Lecanora*, *Rhizocarpon* can be recommended for dating of rock substrates of which most often used in scientific studies is *Rhizocarpon geographicum*, because of bright colour, circular growth and worldwide distribution. In alpine environments, *R. geographicum* have a very slow growth rate of 0.2 mm/year and lives to a considerable age. Morphologically, the *Rhizocarpon geographicum* species can be easily recognised in nature, as it has fluorescent dark yellow thallus with black fruiting bodies and dark black cracks in between areoles. The discrete areolae that contain cells of alga *Trebouxia*, located on a fungal medulla, which is attached to the substratum and extends into a black algal-free marginal zone around the thallus called hypothallus. Primary areolae near the edge of the hypothallus may develop from free-living algal cells on the substratum that are trapped by the hypothallus whereas secondary areoles may develop from zoospores produced within the thallus, thus ultimately resulting in the radial growth of *Rhizocarpon*.

In Indian Himalayan region *Rhizocarpon geographicum* has luxuriant growth both in eastern and western Himalaya in and around altitude of 3000m, on boulders and stones. The species of *Rhizocarpon* are found growing mostly on exposed rocks in association with species of *Acarospora*, *Caloplaca*, *Buellia* and *Lecanora*.

In the present study, lichen species *Rhizocarpon-geographicum* having known growth rate is selected to estimate the age of the boulders exposed in three hill top between altitude of 3000-4000 m in both eastern and western Himalayan region.

MATERIAL AND METHODS

In order to study the colonization and growth of lichen *Rhizocarpon geographicum* and date the rock surfaces, on which they occur, the diameter of thalli were measured with the help of Vernier callipers (Fig. 1A&B). *Rhizocarpon-geographicum* exhibit a radial slow growth rate of 0.2 mm/year. In western Himalayan region the study was conducted near Thajiwas glacier, Ganderbal district of Jammu and Kashmir (N34°16'25.09" E 75°17'05.09" altitude 3100m). The glacier covers about 15-20 km² with several outlets, drained towards the Sonmarg via a board glacial stream running in northern direction through a proglacial valley. A trek of 8 km from Sonmarg towards glacier was covered up to 3000m. The measurement of thalli was recorded at 500 m distances with three replicates each. Since the study area in eastern Himalayan region have small elevation variation both at Thangu (N 27°53'54.4" E 88° 32'05.1") and Gnathang area (N27°17'40.3" E88° 49'57.9"), therefore the measurements of the thalli were recorded at 50 m distance with three replicates each between altitudinal range of 2800-3000 m.

RESULTS AND DISCUSSION

The diameter of *Rhizocarpon geographicum* at two localities in eastern Alpine Himalayan region of Sikkim and one locality of Jammu and Kaskmir were measured for conducting preliminary lichenometric studies in the area. The diameter of *Rhizocarpon geographicum* thalli between intervals of 50 m in eastern Himalaya and 250m in north-western Himalaya were measured between altitudes of 2200-3500 m. The study is based on lichen size/age correlation and lichen population distribution and involves the measurement of large specimens growing on large boulders that are supposed to be unaffected by the prevailing climatic conditions as well as human and animal interferences. From Table 1 it is clear that the Thangu and Kupup area showed average diameter range of 28-53 mm of lichen thallus along a distance of 200 meter at intervals of 50 m between altitudes of 2800-3000 m. The altitudes away from glacier (2800m) have the maximum average diameter range of 48-53 mm while near glacier (3000m) the diameter shows minimum range of 28-34.8 mm. The age of the boulder exposed in Thangu and Kupup area calculated as 200 m retreated in 100 and 91 years respectively.

In Thajiwas area the lichen thalli at 2800 m have the average diameter of 101.3 mm while near the glacier at 3000m it has minimum diameter of 45.5 mm only. At different intervals of 50 m within the distance of 200 m from 2800-3000m, the lichen thalli exhibit a decreased trend of average diameter of 92>78>73>45. Based on the thalli diameter the age of exposure of rocks due to retreat in Thajiwas glacier is calculated as 200 m in 279 years (Fig.2). In a similar lichenometric study in central Himalayan region of Uttarakhand, the rate of glaciers retreat at Pindari glacier was recorded as one km in 575-600 years (Joshi and Upreti,

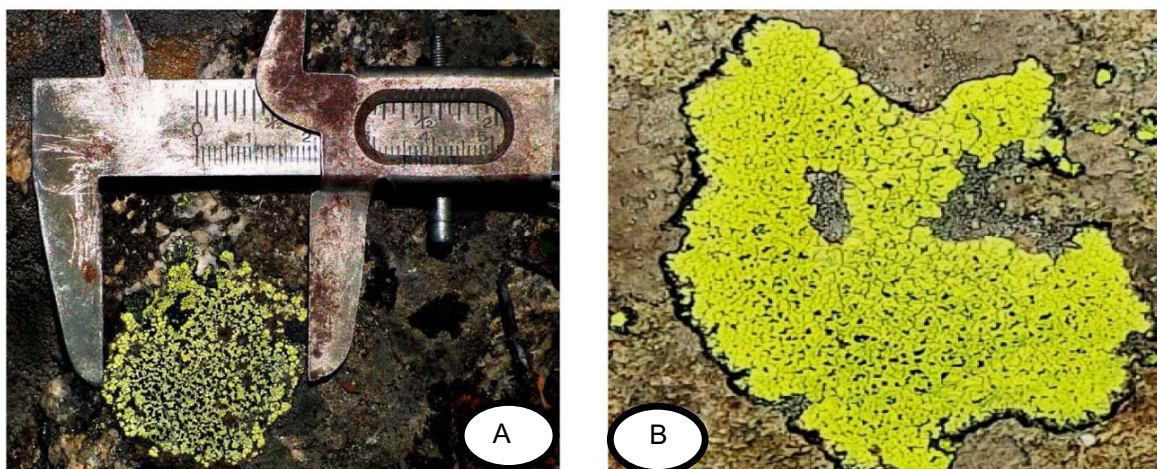


Fig.1. (A) Measurement of lichen thallus with callipers (B) Thallus of *Rhizocarpon geographicum*

Table 1. Measurement of *Rhizocarpon geographicum* thallus at various sampling sites

Altitude (mt)	Thangu		Kupup		Thajiwas Glacier	
	Diameter (mm)*	Age (years)	Diameter (mm)*	Age (years)	Diameter (mm)*	Age (years)
3000	28.5	142.5	34.8	174.0	45.5	227.5
2950	31.0	155.0	37.9	189.5	73.4	367.0
2900	39.5	197.5	47.2	236.0	78.8	394.0
2850	47.5	237.5	49.8	249.0	92.1	460.5
2800	48.5	242.5	53.1	265.5	101.3	506.5

*Mean of (n=10) thallus diameter.

2010). The colonization of *Rhizocarpon geographicum* are varied on different type of rocks studied on Gangotri glacier (Gupta et al. 2014). A range of 6-9 m/year retreat of Chorabari glacier in Uttarkhand, was estimated by Mehta et al. (2014) in Central Himalayan region while the present study showed the rate of retreat within the range 18.5 to 20.0 mm/century in north western and eastern Himalaya.

Hansen (2008) provided average growth of some lichen species to study glacier retreat in Mittivakkat glacier on Ammassalik Island in southeast Greenland and suggested that the macrolichens are comparatively fast growing shows a maximum radial growth of 6.5 mm among the highest measured values. Among the different lichen species studied, *Rhizocarpon geographicum* showed an average growth rate of 12 mm per century however, in Indian context *Rhizocarpon geographicum* in both the eastern and western Himalayan region showed an average growth rate of 18±2 mm per century. The variation in growth rate, depends largely on the environmental factors prevailing in the areas. The decreased trends of lichen diameter at different intervals of 50 meters were observed because of the exposure time of the rock for colonization and growth of lichen species since the rocks near the Glacier summit are covered with snow.

CONCLUSION

On the basis of the above study it is concluded that the rate of retreat was slightly more faster in eastern Himalayan than the north-western Himalaya region. By this approach it is possible to estimate the age of the boulders faces on the different moraines in the proglacier valley. It is clear from this study that the lichenometric technique would certainly work as a stepping stone in knowing the age of rock exposure and the data will be useful

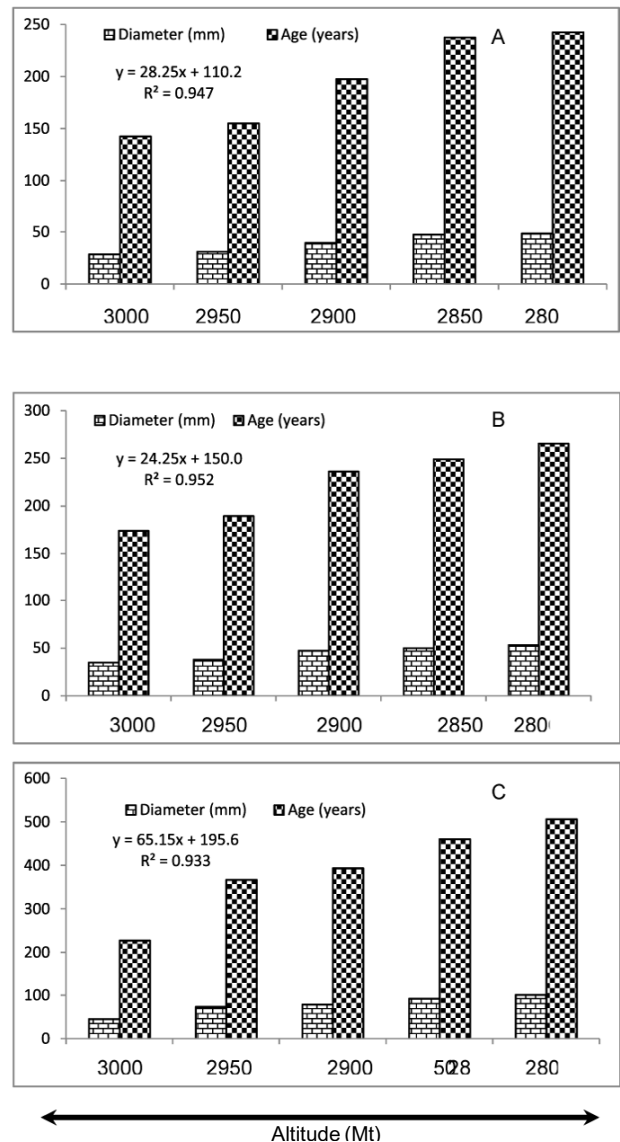


Fig.2. Lichenometry at A. Thangu, B. Kupup, C. Thajiwas Glacier

in climate change studies and shift of vegetation in the near future.

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