Lichenometry and rock art

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When I mentioned lichenometry during a paper presentation at the dating symposium of the Third AURA Congress, it prompted a sceptical commentary from Paul Taçon who was surprised that a 'usually rigorous scientist' such as I would refer to this method. I thank him for his compliment, and for the opportunity of some clarifications about lichenometry.

The term lichenometry refers to a calibrated-age dating technique attempting to provide minimum dating of rock surfaces using measurements of lichen thallus size or other indices of lichen growth. The use of lichens in the dating of archaeological remains was initially proposed by Renaud (1939) in Spain. Developed by Austrian Roland E. Beschel half a century ago, and first applied in the European Alps (Beschel 1950, 1957), this dating technique has been widely used in estimating the ages of recent geomorphic exposures, particularly glacial moraines (Worsley 1990). Apart from central Europe, its applications have been most common in Scandinavia,

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Iceland, New Zealand, U.S.A., Canada, Greenland and Antarctica, but there have also been applications in Kenya, Peru, Britain, Russia, China, central Asia and the Caucasus. Its use in archaeology has rarely been explored (Follmann 1961; Laundon 1980; Benedict 1975, 1985; Bettinger and Oglesby 1985; Broadbent and Bergqvist 1986; Broadbent 1987; Winchester 1988), and besides myself no researcher has ever sought to apply lichenometry to rock art. I investigated its use in the age estimation of relatively recent Austrian Alpine petroglyphs in 1965, but later neglected to develop my experience further, particularly as I found any knowledge of the method lacking in Australia when I began to study rock art there in 1966.

The extensive literature of geomorphic applications of the technique conveys the impression that the applicability of this method is limited to subarctic or alpine conditions, i.e. environments of limited rock art occurrence. This is not the case. The preferences of geomorphologists are attributable merely to the method's rather short effective time range: it can only be expected to provide valid data from the most recent millennia, and is particularly precise for ages in the order of up to some centuries. Although in favourable cases the method has been suggested to be effective to 9000 years BP and possibly even beyond (Miller and Andrews 1972), it is commonly only precise up to 500 or so years (Innes 1985). In geomorphological terms this makes it particularly useful for recent glacial deposits. However, most rock art of the world presumably falls within the effective range of the method, and much of it does occur together with lichen. Therefore the complete lack of interest rock art researchers have shown in lichenometry is astounding, bearing in mind its high reliability, outstanding simplicity and obvious economy, together with its non-intrusive nature.

This neglect is particularly frustrating when we consider the superb potential of lichenometry to be used in tandem with other dating methods, such as amino acid racemisation or radiocarbon analysis of thalli (Bednarik 1996a) — another potential approach never used so far. Moreover, this method involves no interference at all with the rock art itself, and if samples were taken of dead lichen matter their removal would not have any adverse effect, in contrast to sample removal for other dating methods. Clearly, for rock art of recent periods that can physically be related to lichen growths, lichenometry is one of the most desirable methods to use, and yet it is not used at all in this. Indeed, for decades archaeologists have been engaged in a worldwide campaign to destroy lichen at petroglyph sites, claiming that they might affect the conservation of rock art, and these activities have resulted not only in the denuding of thousands or petroglyph sites, but also in the destruction or chemical contamination of accretionary deposits (Childers 1994), removal of mineral mass, and acceleration of deterioration, while the degradation lichens are claimed to cause remains largely unproven (Cochran and Berner 1993; Drever 1994). Rock art researchers have begun to speak out strongly against these vandalistic practices (Bahn et al. 1995; Tratebas and Chapman 1996; Walderhaug and Walderhaug 1998).

Two different approaches can be distinguished in lichenometry. In the direct approach, growth rates are determined by monitoring individual thalli over several years, typically of yellow-green specimens (subgenus *Rhizocarpon geographicum* agg.) which have provided the best results and are often abundant. The growth curves predict the thallus size through time. In the indirect approach, surfaces of known ages are used to calibrate growth rates empirically. Under ideal conditions, the lichenometric dating curves produced by both methods permit the age estimation of a thallus of unknown antiquity, but there are a number of qualifications. Ecesis (the establishment of a thallus) may not occur for a long time after the surface has become available, or it may occur almost immediately. This was countered by Beschel by focusing on the largest thalli present at a site. While the direct approach is more readily available, because it requires no chronological reference points in the construction of its curve, the indirect approach makes no assumption about ecesis lag and is less susceptible to environmentally determined growth fluctuations. Therefore the latter has been used in the majority of studies, and would also be the more relevant in rock art dating.

Different metrical and statistical devices have been used to collect lichenometric data, including the determination of the longest axis present (Bornfeldt and Österborg 1958; Bickerton and Matthews 1992), the mean of the longest and shortest axes (Hole and Sollid 1979; Erikstad and Sollid 1986), the shortest axis (Locke et al. 1979) and the largest thallus surface area. It has been found useful to measure the several largest thalli present, to avoid reliance on abnormally high values which may be attributable to contact growths or coalescence of multiple centre thalli. Optimal sampling area has been the subject of much research, bearing in mind that relative slope location does affect growth rates: values are 10-15 mm lower on moraine crests than near slope bases. In a full-scale analysis it is preferred to search at least ten sub-plots of no less than 400 m^2, measuring the ten largest thalli in each sub-plot.

Lichenometric dating curves are slightly parabolic, with a decreasing growth rate as the thallus ages. They can be used in one of two different ways:

1. Where an engraved line has been made through an existing thallus, it must postdate it, and the lichen's growth will be impeded. The thallus provides a *terminus post quem* dating (Bednarik 1996b).
2. Where a thallus has formed over a petroglyph, or encroached on a petroglyph surface, it provides a *terminus ante quem* reference, although one involving certain qualifications.

These kind of data can themselves lead to a fairly precise age estimate for a petroglyph, which could be cross-checked by removing dead plant matter from under the thallus, next to the engraved groove (maximum age) or from within the groove (minimum age). If such samples were collected from carefully chosen sites within the thallic topography they would be likely to provide dates very close to the age of the petroglyph. This would be an ideal combination of methods to determine such an age with great precision, particularly of comparatively recent rock art. Therefore the common destruction of lichen at petroglyph panels is regrettable and has done great damage to the scientific potential of rock art (Jaffe 1996).

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