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Reply to Letter to the Editor

## Lichenometric dating: Science or pseudo-science?—Response to comments by Michael A. O'Neal, pp. 244–245




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### Keywords:

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Prof. O'Neal has made constructive comments about a way forward for lichenometric dating. We will respond to his comments both by citing recent work that further exposes deficiencies in lichenometric dating practices and by reporting on research efforts that offer hope for improvements in the compilation, reporting, validation and sharing of lichenometric data sets. Like O'Neal we appreciate that the technique may continue to be used by default in some settings, but we hope that readers, reviewers and editors will better appreciate the need to question the accuracy and scientific value of lichenometric ages.

Clearly, as O'Neal notes, the standardization of sampling, measurement, digital documentation and data dissemination are pressing concerns. So too is the recognition that “biometry” and the analysis of population dynamics need to be better integrated into lichenometric dating. Indeed, the real issue may be that there is a need to adopt an interdisciplinary research focus that unites geoscientists, lichenologists and statisticians. If we work together perhaps we can build a dating technique that is scientifically robust. Not many geoscientists read and understand lichenological and statistical literature, and so miss, for example, the significance of conclusions of [Roca-Valiente et al. \(2016\)](#). That paper reports on a careful examination of *Rhizocarpon geographicum* type specimens using molecular analysis, chemical testing, and morphological inspections. The authors found inconsistencies in the lichen type specimens. This finding calls into question the validity of traits used in all *Rhizocarpon* identification keys and questions all identifications of *R. geographicum* to the species level. This has enormous implications for lichenometric dating: now, no one knows what *Rhizocarpon* they measured. So ... does *R. geographicum* grow at different speeds in different environments? We don't know. Are “growth curve” and growth rate comparisons valid if we don't know for certain what is being measured? Probably not. Geoscientists cannot navigate this taxonomic mess without the help of lichenologists, and taxonomic revisions will not soon be available. So where does that leave us?

We're pleased to see that O'Neal appreciates the value of digital photogrammetry. Indeed, prodigious changes are occurring in

photogrammetric methods. Only a few years ago, [McCarthy and Henry \(2012\)](#) used painted crosshairs as fixed points and superimposed digital images of lichens on those points. Now, structure from motion (SfM) techniques (e.g., [Nouwakpo et al., 2014](#)) are being applied to lichenometry. Voxels has entered our vocabulary.

Early field testing of the SfM approach by D.P. McCarthy has produced 3D models of lichen covered rocks that are geometrically anchored by a few million triangulated fixed points (voxels). Experimentation with low-cost approaches to SfM show it can produce incredibly accurate and precise models that yield exceptionally accurate planar and volumetric measurements of lichens. This is an extremely powerful tool that represents a quantum leap from the days of plastic rulers and painted cross hairs. It offers the sort of information we need if we are going to recast lichenometric dating into a robust method.

We also see reason for optimism in the growing popularity of digital repositories. For example, a digital repository of lichen images is now under development by D.P. McCarthy and librarians at Brock University in Ontario, Canada. This repository will eventually house thousands of repeated macro-photographs that have been collected semiannually for the last 20 years at the Illecillewaet Glacier ([McCarthy, 2003](#)). Like many repositories it will be indexed by internet search engines and will have a variety of download/display options. At one level, thumbnails of images will be available for general viewing and annotated GIFs will be shared for teaching purposes. Metadata, research grade images, orthoimages, 3D models, time lapse GIFs and all raw images used to compile models and quantify change in lichen communities will be accessible for download with permission. Perhaps in the not so distant future, publication of lichenometric work will routinely be accompanied by raw data and image files available in repositories.

We are cautiously optimistic about the future of lichenometric dating. But at this point in time we continue to invoke Bob Dylan:

*I've been shooting in the dark too long,*

*When something's not right it's wrong ...*

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