KEYWORDS: ***Beeswax - Australia - Dating - Taphonomy - Logic - Metamorphology***

THE TAPHONOMY OF BEESWAX FIGURES

Robert G. Bednarik

Abstract. Beeswax rock art has been produced in the Northern Territory of Australia for many millennia. A significant number of reliable radiocarbon dates from this art corpus is subjected to an application of taphonomic logic. It is shown that orthodox interpretation of these data is likely to be inadequate and an alternative explanatory construct is presented.

Introduction

A recent study by Nelson et al. (2000) has resulted in the presentation of accelerator mass spectrometry radiocarbon dates from 137 figures of beeswax rock art in the Northern Territory, Australia. Selected from a total of about 600 such figures from sixteen sites, the dated samples represent easily the most comprehensive age-related data we have from any form of rock art. These data amount to the first statistically meaningful quantitative information we have gained since the introduction of 'direct dating' methodology for rock art, about twenty years earlier. By comparison, all other dating information we have secured in these years has been opportunistic and non-systematic, and much of it (including some of what I myself have contributed) does not survive rigorous scrutiny (see Bednarik 1996, 1998, 2001 for critiques and self-critiques).

The Nelson et al. (2000) data from beeswax figures in several regions of the Northern Territory are a random sample large enough for meaningful statistical treatment. Of particular importance is that this form of rock art dating result is the most robust we have at this stage, for three reasons. First, it refers to an ample supply of datable material, because of the relatively substantial bulk of the wax figures in comparison to the very thin surface residues of rock paintings. Second, that material is very likely to refer to the event of art production, which is not the case with most other materials analysed in rock art dating. The beeswax used can be assumed to have been applied in a fairly fresh state in most cases, because as it ages it loses its plasticity. Therefore its radiocarbon age is likely to differ only marginally from the age of the rock art. By contrast, carbon results from charcoal pigment never date rock art, they even fail to date the charcoal involved. (Radiocarbon analysis does not determine the age of charcoal, contrary to archaeolore.) Finally, because of the bulk and relative purity of beeswax samples, contamination is unlikely to have a significant effect on results. Very few such comparatively reliable methods are available in rock art age estimation, one of them being the carbon isotope analysis of soot (Clottes et al. 1995). The radiocarbon analysis of organic matter in mineral accretions or of carbonates and oxalates is much less reliable, for a variety of procedural or logical reasons (Bednarik 1996, 2001).

Within the greater picture of rock art age determination, however, the dating of beeswax figures is only of limited application, because this is an 'art' form limited to a small section of northern Australia. Essentially it seems to be geographically restricted to an area ranging from the Tabletop Range south of Darwin to the Mann River region on Arnhem Land. While there are thus no wider applications of this otherwise highly promising and convincing method, its results so far can, because of their probable representativeness, be employed in a theoretical exercise that remains perhaps inaccessible to any other rock art dating method at this stage. In particular they can be subjected to an application of taphonomic logic, a form of analysis that could not reliably be applied to the current collective results of any other rock art dating technique. Here, such an analysis will be attempted.

Taphonomic logic

What is taphonomy?

The word taphonomy referred initially to the study of the processes by which organic remains become preserved. Hence its original use was in palaeontology, but even here the concept has been seriously considered only since the 1960s. Efremov (1940) introduced the term in an effort to seek laws explaining the processes relating to the burial of bones within a single framework. This fundamentally scientific approach to the study of fossil remains was gradually taken up by palaeontologists over the following decades (e.g. Behrensmeyer 1975; 1978; Gifford 1981; Hill 1976, 1979). During the 1980s, archaeologists seemed to have realised that the underlying principles also applied to their discipline, and after initially restricting their application still mostly to faunal

remains, they eventually perceived that the concept has a much broader application. For instance, Hiscock (1985, 1989) observed that the underlying principles were also applicable to stone implements.

Today the word taphonomy is really a misnomer: tapho- is from the Greek ('grave'), and -nomy indicates systematisation of knowledge. Archaeologically, taphonomy is now taken to refer to the study of the transformation of materials into the 'archaeological record' (Bahn 1992: 489). In the study of rock art, 'taphonomy' is the study of the processes affecting rock art after it has been executed, determining most of its present variables, such as appearance, distribution and statistical properties. This is the reason why simple statistics of rock art are irrelevant to aspects of interpretation.

In palaeontology, taphonomy covers all events during the transition of animal and plant remains from the biosphere to the lithosphere, including mode of death, scavenging, ingestion and digestive processes, transport (by animals, gravity, wind, water or sediment movement), surface weathering and geological erosion, trampling, differential dissolution of tissues and mineralisation or other replacement processes, and even modification of osteal remains as tools by hominids. The organic remains one recovers bear evidence of their preservational history, including degree of completeness, damage patterns, orientation in respect to other debris, surface wear and alteration results. Without a good understanding of how these many processes may have affected statistical indices of the material it would be fairly futile to attempt reconstruction of biological models of the species or ecosystem in question.

Taphonomy does not, however, inherently deal with osteal remains. It could be seen as pure coincidence that the underlying principle first appeared in palaeontology. In essence, taphonomy deals with the logic underpinning the idea that the quantified characteristics of a record of past events or systems are not an accurate reflection of what would have been a record of the living system or observed event. This science therefore aims to elucidate how empirical information has been altered from the original living systems to a 'fossil record', by biological, physical and chemical degradation or alteration processes. When this idea is applied to rock art, it refers to the multitude of factors that affect survival and alteration of rock art, how they impact on the evidence and how they, and not cultural factors, largely determine the composition of the surviving record (Bednarik 1994).

What is taphonomic logic?

Close examination of many taphonomic factors has revealed logical principles that fundamentally challenge orthodox archaeological theory. If we imagine a phenomenon category whose total population increases as a function of time, and which experiences a loss of *x*% per time unit due to taphonomy, it must inevitably reach a point in time when all of the evidence above a certain age should have been exhausted. In practice this is not entirely possible, because the probability of survival can never be nil. Nevertheless, there is a point in time, called the 'taphonomic threshold', which marks the point at which the distribution curve of the surviving population approaches the zero line — but without actually touching it (Figure 1). Beyond that point in time, all the way back to the time when the phenomenon category was first introduced, the curve must hover just immediately above the abscissa, and this time period is called the 'taphonomic lag time' (Bednarik 1994).

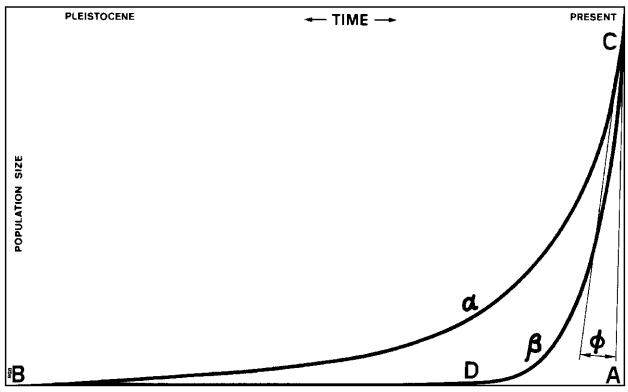

Figure 1. *Principles of the relationship of total production of an archaeological phenomenon s_α to its surviving instances s_β as a function of angle φ (see text). These principles are the basis of taphonomic logic.*

In taphonomic logic the crucial point to understand is that, whatever the loss of an artefact population might be per time unit, it must increase as a function of age. Hence the taphonomic threshold can never be at the same point in time as the first historical instance of the phenomenon in question. Indeed, for most phenomenon categories the lag time is thought to exceed 90%. So if we rely uncritically on the unrefined 'archaeological record', we will inevitably favour the generation of false interpretations, based as they are on the occurrence, distribution, frequency and form of observed data. The relevance of these quantified data declines with increasing age, back to the taphonomic threshold of the phenomenon in question, at which time all quantitative data about it become meaningless for interpreting the behaviour the phenomenon category is thought to be related to. For instance to then state that there is an absence or near-absence of any kind of evidence is for all practical purposes meaningless.

Every phenomenon category or material class in archaeology is subject to taphonomy and obeys the laws of taphonomic logic, irrespective of whether the object is a snowman made by Neanderthals or a golden vessel— although in these two cases the relevant taphonomic curves would present quite extreme forms. The taphonomic lag, which is crucial in understanding the historical duration of a phenomenon category irrespective of the archaeological record, can in practice range from less then one per cent to more than ninety-nine per cent of the historical duration of the particular phenomenon.

Bearing in mind that archaeology has a tendency of ignoring or discounting the rare finds reaching us from a find category's lag time, or explaining them away as a 'running ahead of time' (Vishnyatsky 1994), it becomes apparent that archaeology's interpretations of cultural, technological and cognitive systems, particularly of the Pleistocene, must be expected to be false in nearly all cases. This one theoretical mistake, of not appreciating the significant effects of taphonomic logic, is the greatest single theoretical error archaeology has made in its history. It shows that for all practical purposes, and except in the case of materials of an extremely short taphonomic lag time (most especially sedimentary silicas), the interpretations traditional archaeology has offered about Pleistocene human history must in most details be mistaken.

In looking specifically at rock art, taphonomic logic is a form of logic viewing such evidence as the surviving remnant of cumulative motif populations that have been subjected to continuous degradation which selects in favour of specific properties facilitating longevity. It does not represent a random sample of a tradition, style or culture. Without an understanding of how lithology, site morphology, micro- and macro-climate, site biology and a host of other taphonomic factors have contributed to selective survival and to alterations of both the appearance and statistical characteristics of the surviving corpora, any archaeological interpretation using variables such as distribution, location, style or technique is doomed to failure.

What is metamorphology?

A third useful concept is the term metamorphology. This word refers to the science of how forms of archaeological evidence change with time and how they are perceived or understood by the individual archaeologist today (Bednarik 1995). Taphonomic logic forms the backbone of this science, but in addition to matters of selective preservation it also considers all other distortions reflected in the perception of the observer, including the subjectivity of many aspects of archaeology, the distorting methods of recovery of evidence, conventions of understanding and interpretation, of selective reporting and dissemination; the biases of statistical treatment of data under the pretence that they are representative; the individual researcher's personal bias and limitations, including the limitations of knowledge or language, academic conditioning and so forth; the systematic preoccupations of specific research traditions, institutions or individual influential scholars. These and other thoroughly subjective dynamics of knowledge acquisition, interpretation and dissemination all affect how the individual practitioner experiences and processes so-called empirical evidence which has already been massively and systematically distorted by taphonomic factors.

Metamorphology thus addresses the way selectively gathered data are translated into constructs of the human past, analysing the processes of traditional theory formulation in this discipline, thereby providing a scientific alternative to orthodox archaeology. It formulates testable, refutable constructs, it is a science. Orthodox archaeology is not.

The quantified application of taphonomic logic

In considering the quantification of taphonomic logic we can imagine plotting the chronological distributions of two aspects of an archaeological phenomenon category: total production versus surviving production. The example depicted in Figure 1 assumes a uniformly gradual increase in production with time, which is perhaps the most typical scenario in long-range archaeology (because human populations themselves increased gradually, and in some phenomena the production per person increased as well). However, even in the scenario of a perfectly stable production, in which curve α would be a straight line connecting *B* and *C*, curve β would still be a double-parabola, for every conceivable phenomenon category of archaeology. The critical element in understanding taphonomic logic is to appreciate the behaviour of β relative to α, which is perhaps best characterised as follows: two forces constrain β, one compelling it away from α (the preservation bias), the other preventing it from reaching the abscissa (the 'equilibrium bias'). The second becomes increasingly effective as the curve approaches the abscissa. It is presumed that while the preservation bias is essentially linear, the effect of the equilibrium bias probably increases exponentially as the abscissa is approached. The parabolically exponential regression in the ratio *R* between total production s_α and surviving production s_β on the ordinates determines the location of the taphonomic threshold, the precise point of which is when the equilibrium bias prevails over the preservation bias. Taphonomic logic decrees that the ratio *R* must increase as a function of time, irrespective of changes in population size per time bracket. It is determined by the angle φ, formed by the parabolic tangents tan_α and tan_β, and is expressed by this integral function:

$$R = \frac{\lim_{x_\forall} \int_B^A f(x_\forall)\,dx_\forall}{\lim_{x_\beta} \int_B^A f(x_\beta)\,dx_\beta} \qquad (1)$$

It follows that taphonomic logic is accessible to quantification and that by applying these principles judiciously it would be possible to broadly estimate the time of a phenomenon category's taphonomic threshold, and therefore its taphonomic lag could be determined if angle φ were known from replicative archaeology. However, the data acquisition dynamics of traditional archaeology cannot be expected to deal with such issues effectively, because they are geared towards simplistic interpretation, having been derived largely or exclusively from procedures of non-random sampling. Therefore a scienti-

fic archaeology is available to us only theoretically at this stage: the data of non-scientific archaeology are biased against it. The massive academic biases are another issue still: a discipline basing its pronouncements on its non-falsifiability cannot be expected to abandon its false constructs over night. The ensuing crisis of confidence would not be acceptable.

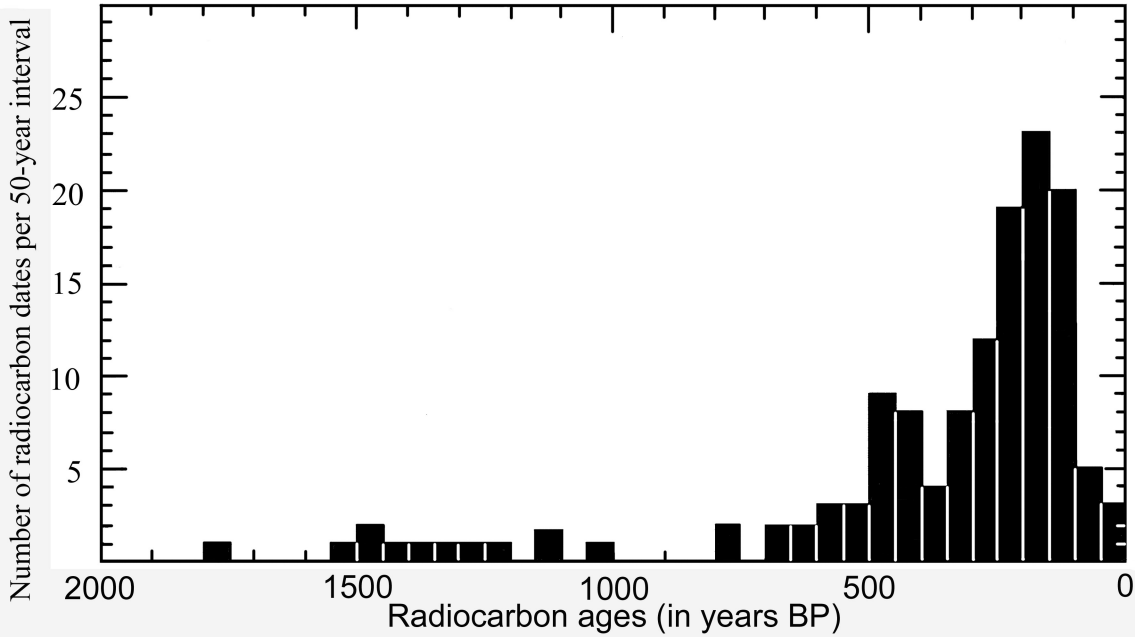

Figure 2. *Radiocarbon ages for 135 of the 137 samples obtained from beeswax figures in northern Australia, after Nelson et al. (2000).*

Application of taphonomic logic to beeswax figures

Nevertheless, the data by Nelson et al. (2000) are so comprehensive that they offer as good a random sample as we can probably expect to secure from the rather minor phenomenon category of beeswax figures. They therefore offer an opportunity to apply the theoretical construct to a fairly representative sample. The process is surprisingly simple. Nelson and colleagues have already prepared a histogram for 135 of their 137 radiocarbon determinations, omitting the two much older specimens (of about 3820 and 4040 carbon years). It is reproduced here (Figure 2). Bearing in mind that all samples were collected, prepared and processed under presumably similar conditions and by the same analysts, and that tolerances are a variable always to be aware of but which for this exercise must be ignored, this is as good a basis as we can hope for.

The traditional archaeological interpretation of this histogram would be that beeswax art was produced for at least 4000 years, infrequently initially, becoming more popular around 700 years ago, and experiencing a peak in production in recent centuries, followed by a collapse of the tradition since European colonisation in the second half of the nineteenth century.

Taphonomic logic would share elements of the interpretation of the most recent section of the phenomenon category's history, but would need to progressively disagree with any interpretation of earlier data so older it is, until a point in time is reached where it would need to pronounce all archaeological interpretations of the evidence as historically irrelevant. In the present example, the pronouncement concerning the last 100 or 150 years would be accepted with one caveat: that the abruptness in discontinuation of the tradition was much more pronounced then literal reading of the histogram would imply (i.e. what may appear to be a reduction to about 25%, taphonomic logic would regard as indicating a real reduction to 10% or less). Next, a trend though time that resembles a typical parabolic curve β would need to be identified, and this is readily seen in the steep decline from 150 BP to 800 BP. There appears to be a minor peak between 400 and 500 BP, which can either be a sampling characteristic, especially if combined with the possibility of some ages lying outside the 1 sigma tolerance; alternatively the practice of making beeswax figures may indeed have been more popular during that century.

However, the dates between 1000 and 1500 BP appear to be beyond the taphonomic threshold, and these several determinations need to be explained accordingly. They appear to be more numerous than a uniform production rate would be expected to yield from a lag period. Therefore the preferred explanation is that there was a considerably greater production of beeswax art from about 1500 BP on, which declined to a level roughly similar to recent centuries after 1000 BP. The lack of any dates between 1780 and 3820 BP is of no practical consequence, nor is the fact that the oldest date is 4040 BP (Nelson et al. 2000: Table 1). It certainly does not indicate the advent of this practice, nor can any valid deductions concerning frequency or distribution of the practice be derived from the empirical evidence. There

can be no doubt that these three oldest results are from the phenomenon's taphonomic lag time, so all they can tell us is that beeswax art was produced. Moreover, the lack of such dates from any earlier times is of no consequence to the advent of the phenomenon, which could only be vaguely estimated by developing an α-curve for it, for which it would be essential to first determine the phenomenon category's angle φ. This is certainly not possible with our current level of knowledge, particularly as the acquisition of that knowledge base has not been geared towards such an approach. It can only be provided through experimental work.

Summary

On the whole, the histogram of Nelson et al. is a good example to facilitate a practical demonstration of taphonomic logic. The interpretation of the primary data differs significantly from what orthodox archaeology is likely to perceive in them. In particular, while orthodox archaeologists might be aware that there must have been a loss in beeswax art over time, they might see that reflected in the much smaller number of dates from 1000 to 1500 BP. According to taphonomic logic, however, if the threshold is at 800 BP—as is almost certainly the case—the amount of beeswax art produced between 1000 and 1500 BP must have been significantly greater than at any subsequent time to still offer so many surviving specimens from that period, which then lies in the phenomenon category's lag time.

Similarly, at the most recent end of the time scale, the taphonomic curve must increasingly steepen as it approaches present time, provided that there is a constant production of the phenomenon. Therefore the decline in phenomenon frequency must have been very considerably greater than the histogram implies. In Australian rock art research this is a particularly interesting observation, because it is surprisingly difficult to obtain a quantitative construct of the effects of Europeanisation on rock art production. In the perspective of taphonomic logic, Nelson's carbon dates from beeswax figures demonstrate that the decline, at least in this form of rock art, occurred rapidly and was massive, reducing production to less then ten per cent within a century. Naturally such a trend cannot automatically be extended to other rock art forms, but it is certainly relevant in such considerations.

Robert G. Bednarik
P.O. Box 216
Caulfield South, Vic. 3162
Australia
E-mail: *robertbednarik@hotmail.com*

Résumé. *L'art rupestre sur cire d'abeilles est pratiqué dans le Northern Territory en Australie depuis de nombreux millénaires. Des datations au radiocarbone concernant ce corpus artistique, fiables et en nombre significatif, doivent être emaninées dans une perspective taphonomique. On montre ici que l'interprétation classique de ces datations est probablement inadéquate, et l'on présente un schéma explicatif différent.*

Zusammenfassung. *Bienenwachs-Felskunst ist für viele Jahrtausende im Northern Territory von Australien produziert worden. Eine bedeutungsvolle Anzahl zuverlässiger Radiokarbondaten von diesem Kunstkorpus wird einer Anwendung von taphonomischer Logik unterzogen. Es wird gezeigt, daß orthodoxe Auslegung dieser Daten wahrscheinlich unzulänglich ist, und ein alternatives erklärendes Modell wird präsentiert.*

Resumen. *Arte rupestre con cera de abejas ha sido producido en el Northern Territory de Australia durante muchos milenios. Un número significante de dataciones fiables de radiocarbono de este conjunto de arte es sujeto a una aplicación de lógica tafonómica. Se demuestra que es probable que la interpretación ortodoxa de esta información sea inadecuada y un sistema explicativo alternativo es presentado.*

REFERENCES

BAHN, P. 1992. *Collins dictionary of archaeology*. Harper Collins Publishers, Glasgow.

BEDNARIK, R. G. 1994. A taphonomy of palaeoart. *Antiquity* 68: 68-74.

BEDNARIK, R. G. 1995. Metamorphology: in lieu of uniformitarianism. *Oxford Journal of Archaeology* 14: 117-22.

BEDNARIK, R. G. 1996. Only time will tell: a review of the methodology of direct rock art dating. *Archaeometry* 38: 1-13.

BEDNARIK, R. G. 1998. Direct dating results from Australian cave petroglyphs. *Geoarchaeology* 13: 411-18.

BEDNARIK, R. G. 2001. The dating of rock art: a critique. *Journal of Archaeological Science* (in press).

BEHRENSMEYER, A. K. 1975. The taphonomy and paleoecology of Plio-Pleistocene vertebrate assemblages east of Lake Rudolf, Kenya. *Harvard University Museum and Comparative Zoology Bulletin* 146: 473-578.

BEHRENSMEYER, A. K. 1978. Taphonomic and ecological information from bone weathering. *Paleobiology* 4: 150-62.

CLOTTES, J., J.-M. CHAUVET, E. BRUNEL-DESCHAMPS, C. HILLAIRE, J.-P. DAUGAS, M. ARNOLD, H. CACHIER, J. EVIN, P. FORTIN, C. OBERLIN, N. TISNERAT and H. VALLADAS 1995. Les peintures paléolithiques de la Grotte Chauvet-Pont d'Arc, à Vallon-Pont-d'Arc (Ardèche, France): datations directes et indirectes par la méthode du radiocarbone. *Comptes Rendus de l'Académie des Sciences Paris* 320: 1133-40.

EFREMOV, J. A. 1940. Taphonomy: a new branch of paleontology. *Pan American Geologist* 74(2): 81-93.

GIFFORD, D. P. 1981. Taphonomy and paleoecology: a critical review of archaeology's sister disciplines. In M. A. Schiffer (ed.), *Advances in archaeological method and theory* 4: 365-438. Academic Press, New York.

HILL, A. 1976. On carnivore and weathering damage to bone. *Current Anthropology* 17: 335-6.

HILL, A. 1979. Butchery and natural disarticulation: an investigatory technique. *American Antiquity* 44: 739-44.

HISCOCK, P. 1985. The need for a taphonomic perspective in stone artefact analysis. *Queensland Archaeological Research* 2: 82-97.

HISCOCK, P. 1989. A study in scarlet: taphonomy and inorganic artefacts. In S. Solomon, I. Davidson and D. Watson (eds), *Problem solving in taphonomy: archaeological and palaeontological studies from Europe, Africa and Oceania*, pp. 34-49. Tempus Archaeology and Material Culture Studies in Anthropology 2, University of Queensland, St. Lucia.

NELSON, D. E., J. R. SOUTHON and C. TAKAHASHI 2000. Radiocarbon dating the wax art. In D. E. Nelson (ed.), *The beeswax art of northern Australia*, pp. 44-59. CD-ROM, Archaeology Department, Simon Fraser University, Burnaby.

VISHNYATSKY, L. B. 1994. 'Running ahead of time' in the development of Palaeolithic industries. *Antiquity* 68: 134-40.

RAR 18-579