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Front cover:
Dead standing black box Culturally Modified Tree along Kromelak *(Outlet Creek) (Photo: Darren Griffin)*

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Editorial note

The papers included in this ninth issue of *Excavations, Surveys and Heritage Management in Victoria* were presented at the annual Victorian Archaeology Colloquium held at La Trobe University on 1 February 2020. Once again we had over 150 participants whose attendance testifies to the importance of this fixture within the local archaeological calendar. It continues to be an important opportunity for consultants, academics, managers and Aboriginal community groups to share their common interests in the archaeology and heritage of the State of Victoria.

The papers published here deal with a variety of topics that span Victoria's Aboriginal and European past. While some papers report on the results of specific research projects others focus on aspects of method, approach, education and the social context of our work. and approach.

In addition to the more developed papers, we have continued our practice of publishing the abstracts of other papers given at the Colloquium, illustrated by a selection of the slides taken from the PowerPoint presentations prepared by participants. These demonstrate the range of work being carried out in Victoria, and we hope that many of these will also form the basis of more complete studies in the future. All papers were refereed by the editorial team. This year Elizabeth Foley managed this process and the sub-editing of this volume under the guidance of Caroline Spry. Layout was again undertaken by David Frankel.

Previous volumes of *Excavations, Surveys and Heritage Management in Victoria* are freely available through La Trobe University's institutional repository, Research Online < www.arrow.latrobe.edu.au:8080/vital/access/manager/Repository/latrobe:41999 >. We hope that this will encourage the dissemination of ideas and information in the broader community, both in Australia and internationally.

We grateful to the Colloquium's major sponsors ACHM, Ochre Imprints, Ecology and Heritage Partners and Heritage Insight; sponsors Biosis, ArchLink, Christine Williamson Heritage Consultants and Extent; and to la Trobe University for continuing support. We would like to thank them, and all others involved for their generous contributions towards hosting both the event and this publication. Yafit Dahary of 12 Ovens was, as always, responsible for the catering.

Preparation of this volume was, like so much else in 2020, undertaken during the severe restrictions imposed because of the COVID-19 pandemic. We hope that 2021 will be a better year for all and that even if we are unable to hold our Colloquium at the usual time we will be able to do so later in the year.

The editors and authors acknowledge the Traditional Owners of the lands and heritage discussed at the Colloquium and in this volume, and pay their respects to their Elders, past and present.

Update on the Radiocarbon Dating Visualisation Project for Aboriginal places in the State of Victoria, southeastern Australia: insights and issues

David Thomas[1], Caroline Spry[2], Jacqueline Tumney[2] and Rebekah Kurpiel[2]

Abstract

For several years, staff at Aboriginal Victoria, a government agency responsible for administering the Aboriginal Heritage Act 2006 (Vic.)*, have been compiling a dataset of radiocarbon age determinations from Aboriginal places in the State of Victoria, southeastern Australia. The dataset currently contains nearly 1,000 radiocarbon age determinations calculated over the past 65 years, but has not yet been made more readily available due to concerns over its accuracy and completeness. A time-consuming and complex process of verifying the sample information, methods and results for each radiocarbon determination has just been completed, following a partnership between Aboriginal Victoria and researchers in the Department of Archaeology and History at La Trobe University. In this paper, we describe the data-verification process behind the Radiocarbon Dating Visualisation Project, share some of the issues we have encountered, and outline the future directions and proposed outcomes of the project. The data-verification process has highlighted the need to improve standards for building radiocarbon chronologies and publishing radiocarbon age determinations, particularly through the provision of laboratory reports and more careful consideration of the contextual integrity of samples for dating.*

Introduction

Archaeologists have been collecting samples for radiocarbon dating from Aboriginal places in Victoria since Edmund Gill sent a charcoal sample from Koroit Beach midden to the pioneer of radiocarbon dating, Willard Libby (Gill 1953:82). This was, to the best of our knowledge, the first radiocarbon age determination in Australia. Numerous researchers have since periodically attempted to compile lists of radiocarbon age determinations in Victoria, and more broadly across Australia (e.g. Bird and Frankel 1991; Godfrey et al. 1996; Polach et al. 1978; Vines 2015; Williams et al. 2014, inter alia). These lists, however, are necessarily snap-shots of the available information at any particular time, and are often incomplete and contain erroneous information, issues not unique to Australia (Jacobsson 2019).

Indeed, there is no central database of radiocarbon dates at the global level (Wood 2015:69), although attempts are increasingly being made to collate regional databases, such as the Southern African Radiocarbon Database (SARD) (Loftus et al. 2019), and to study local chronologies, such as in Ancient Egypt (Bronk Ramsey et al. 2010; Shortland and Bronk Ramsey 2013). As Wood (2015:61) notes, however: 'the largest and most pressing problem facing the field is appropriate publication of dates'.

In Victoria, the problems of accuracy, consistency and completeness of the data pertaining to radiocarbon age determinations are further compounded by the fact that much of these data are buried in 'grey literature'. Many of these reports are held in the Victorian Aboriginal Heritage Register (VAHR), a restricted-access dataset with limited search capabilities managed by Aboriginal Victoria (AV), the government agency responsible for administering the *Aboriginal Heritage Act 2006 (Vic.)*. Once lists of radiocarbon age determinations are published, any gaps or errors in the lists become replicated as subsequent researchers assume the published lists are relatively complete and accurate. Unfortunately, this assumption has proved not to be the case (Thomas et al. 2018).

The lack of a central, complete list of radiocarbon age determinations that has been through a rigorous process of verifying the sample information, methods and results for each radiocarbon determination is a major limitation to research on the radiocarbon age determinations from Aboriginal places in Victoria. Staff at AV started addressing this problem several years ago, when Thomas and colleagues reported on a research project to collate previous researchers' lists and parse the grey literature. This process resulted in the compilation of a list of 930 radiocarbon age determinations in 2018 (Thomas et al. 2018). By the middle of 2019, the list had grown to 1,130 radiocarbon age determinations and AV committed funding to start a data-verification phase of the project, in partnership with La Trobe University, which also contributed funding. In 2020, the list contained a total of 1,150 radiocarbon age determinations, prior to

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completion of the data verification.

This paper outlines the preliminary data-verification process for the Radiocarbon Dating Visualisation Project and some of the key learnings we have identified, as well as the next stages of the project. Future papers will analyse the dataset and discuss in more detail its implications for our understanding of Aboriginal occupation of Victoria and methodologies for building and interrogating radiocarbon datasets.

Data-verification process

The data-verification process over the past year has been necessarily slow and complex, given the range and varying quality of the available information on the 1,150 radiocarbon age determinations in the original dataset, stretching back nearly 70 years. The initial part of the data-verification process was to review and expand the existing categories of information in the spreadsheet initially compiled by AV. This was a collaborative and iterative process to ensure standardisation between different verifiers, as well as incorporating the flexibility to build in learnings as the data-verification process progressed. A future phase of verification will involve technical assessment by a radiocarbon dating specialist of the dating samples and methods used.

Where possible, our first point of reference was the original radiocarbon laboratory report for each radiocarbon age determination to cross-check the sample information, and the dating methods and results. Unfortunately, we have only been able to access laboratory reports for just over half of radiocarbon age determinations in the verified dataset, although the current State of Emergency has prevented us from attempting to access hard copies of site cards in the VAHR. In some cases, the Radiocarbon Dating Laboratory at the University of Waikato, the Radiocarbon Facility at the Australian National University, and Beta Analytic Testing Laboratory were able to assist by providing relevant information from their databases and digital archives. However, this largely depended upon how recently the sample was submitted and each laboratory's digital archiving policies and procedures (see below). The limited ability to access laboratory reports significantly constrained the amount of information we could verify and/or add to the spreadsheet of radiocarbon age determinations.

In addition to laboratory reports, we checked information concerning the archaeological context, cultural status and/or association, and stratigraphic integrity of the sample material, using the original source where possible. Typically, these sources were a Cultural Heritage Management Plan (CHMP) on the Aboriginal Cultural Heritage Register and Information System (ACHRIS) for Victoria, or academic publications. Other sources included salvage reports, cultural heritage assessments, VAHR site cards and/or files appended to site cards, also available on ACHRIS.

The data-verification process concluded with a subjective assessment of the reliability of each radiocarbon age determination (**Table 1**). Categories ranged from 'Unreliable' to 'Secure'. Any technical or archaeological problems identified for each radiocarbon age determination were noted in a 'Problems' column. We selected the 'Incomplete' category when the lab report or sufficient archaeological information was unavailable.

Overall, the method of assessing reliability for each radiocarbon age determination is broadly similar to the assessment criteria used in other studies, including Jacobsson's (2019:4) evaluation of 547 published radiocarbon samples in the Levant (**Table 2**), and Rodríguez-Rey and colleagues' (2016) assessment of the quality of Middle Pleistocene to Holocene vertebrate fossil ages (**Table 3**).

Criteria	Definition	% pass
Technical	Pre-treatment, calibration	68.0
Strict contextual	Unambiguous connection to a feature; no risk of old wood effects	4.2
Relaxed contextual	Unresolved stratigraphic contradictions relating to the sample	44.2

Table 2. Jacobsson's (2019) criteria for assessing the reliability of radiocarbon age determinations, and the percentage of age determinations which meet these criteria

Category	Definition	Number of age determinations	% of age determinations
Secure	No issues relating to the type, pre-treatment, cultural status/ association, and/or stratigraphic integrity of sample material	175	19.5
Uncertain	Uncertainty over one or more of the above	330	36.8
Unreliable	Specific issues with the date identified in the laboratory report and/ or archaeological report/publication	42	4.7
Inomplete information	No lab report, or not enough information accessible to determine the archaeological context	350	39.0
Total		897	100

Table 1. Categories for assessing the reliability of each radiocarbon age determinations, and preliminary totals for each category

Where possible, we developed data-validation lists in Excel to increase the speed of data entry, consistency and accuracy. Two of the authors (CS, JT) verified roughly equal shares of 87% of the radiocarbon age determinations, reducing the potential problem of inconsistency between multiple verifiers, while regular meetings and a workshop at the end of the verification process to discuss and compare results further improved standardisation across the dataset. A single verifier (CS) checked all the radiocarbon ages at the conclusion for consistency within and between Aboriginal places and verifiers. The ability to filter entries in Excel, and identify and correct inconsistencies rapidly, has also been highly beneficial.

A total of 968 radiocarbon age determinations have been verified during this project, following the removal of 182 determinations from the original list (**Table 4**). A further 71 determinations were excluded from the analysis because they relate to Aboriginal Ancestral Remains and are therefore sensitive information. This results in a total of 897 determinations in the dataset which can be analysed.

Preliminary analysis of the dataset indicates that the largest proportion of verifications are incomplete (**Table 1**). The main reason for this is that the original lab report is not included with the archaeological report/publication or associated VAHR record, or, conversely, a lab report is available but no archaeological report/publication can be located to provide more detailed contextual information. A similar proportion of verifications are uncertain, typically because the association between the cultural material and sample dated is tenuous (e.g. charcoal and stone artefacts), or the material dated is not unequivocally cultural (e.g. shell midden, hearth).

Charcoal is the most dominant type of material dated, followed by smaller quantities of marine and freshwater shell (**Table 5**). The dating of a large proportion of samples coincides with the establishment and operation of the Victoria Archaeological Survey, a government body which had primary responsibility for state archaeological functions, including Aboriginal, historic and maritime archaeology, from 1975 until 1992 when it became the Heritage Services Branch of Aboriginal Affairs Victoria (currently Aboriginal Victoria). Just over half of the radiocarbon age determinations were calculated since 1995, and a third of the radiocarbon age determinations post-date the introduction of the *Aboriginal Heritage Act 2006 (Vic.)* (**Figure 1**).

Quality-rating criteria	Definition
A*	The most reliable ages—direct age estimates (i.e. on the fossil material itself) using the most appropriate, up-to-date dating protocols
A	Reliable indirect ages obtained using the most appropriate or just appropriate dating protocols on material that is not the fossil but has a close or unambiguous association with it. Includes reliable direct ages where the quality of the dating technique is appropriate, but not ideal
B	Direct ages that are unreliable due to sub-optimal dating protocols, or indirect ages dated with appropriate methods but with uncertain association
C	Unreliable—outdated protocols or material unsuited to the dating technique used, or indirect ages with appropriate dating, but with no association

Table 3. Quality-rating criteria by Rodríguez-Rey et al. (2016) for Middle Pleistocene to Holocene vertebrate fossil ages

Reason for removal	Number of age determinations	% of age determinations
Not from Victoria	74	40.6
Duplicate	56	30.8
Does not date cultural material/ horizon	44	24.2
Other	8	4.4
Total	182	100

Table 4. Reasons for removing age determinations

Material dated	Number of age determinations	% of age determinations
Charcoal	553	64.7
Shell – marine	221	25.8
Shell – freshwater	62	7.3
Other	19	2.2
Total	855	100

Table 5. Proportions of different materials dated '(excluding 42 Unreliable determinations)

Major issues and key learnings

The presentation and detailed analysis of the verified dataset are the subject of a report to the VAHR (Kurpiel et al. 2020) and publications in preparation, but in the meantime it is important to discuss some of the major issues and key learnings that we identified during the data-verification process. The issues fall into three major interrelated categories: data presentation, methodology, and changing dating techniques.

Data presentation

As noted above, many of the original sources we reviewed do not include the radiocarbon laboratory report. Our data-verification process also revealed that typographic errors and inconsistencies are common in the presentation of radiocarbon age determinations. These errors often then become replicated and entrenched in secondary sources as authors did not check the original sources, and potentially misrepresented further by subsequent typographic errors and inconsistencies.

Our work to date has highlighted the importance of including a copy of the original lab report for each

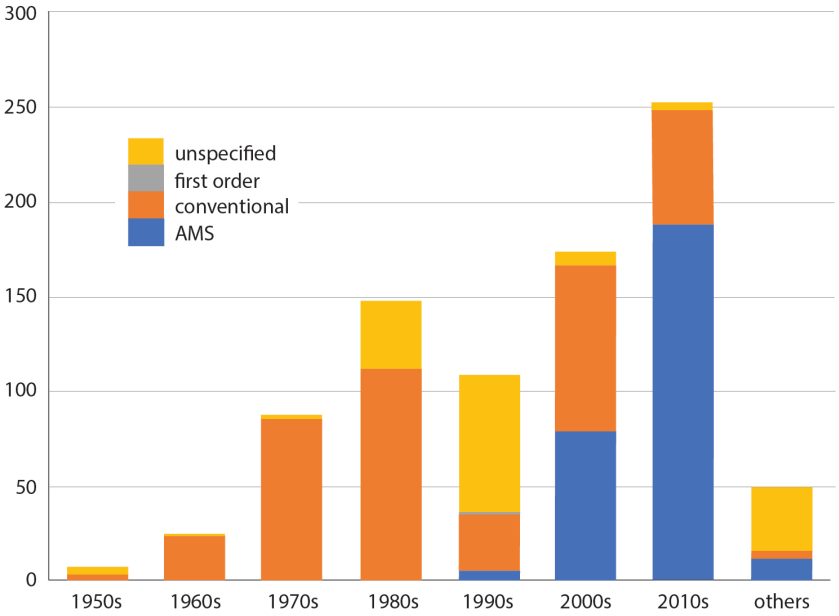

Figure 1. Counts of radiocarbon age determinations generated in Victoria for each decade since the 1950s. This breakdown also shows changes in methods of radiocarbon dating over time

radiocarbon age determination in archaeological reports and publications (e.g. in Supplementary Information) to provide essential information about these ages and reduce errors in their reporting. In most cases, it was not possible to verify ages effectively without this information.

Methodology

Numerous dated samples lack a clear association with cultural remains, while the grounds for determining whether shell, charcoal and 'possible hearths' are cultural or natural are often unclear or not discussed. In other cases, stratigraphic integrity is assumed rather than demonstrated (where contextual details are provided, which was often not the case). Relatively few studies have dated multiple samples from the same stratigraphic unit and/or excavation trench to investigate whether ages appear in stratigraphic sequence; many extrapolate information about chronology based on a single sample from an excavation trench and/or site, where in fact multiple ages are required to build a robust chronology. As well as providing reassurance about stratigraphic integrity, obtaining multiple ages provides opportunities to compare different dating techniques (e.g. radiocarbon vs optically stimulated luminescence) or to compare different materials (e.g. charcoal vs shell, to generate information about the marine reservoir effect).

One, perhaps surprising, learning from the data-verification process and review of CHMPs and other cultural heritage assessments is that archaeologists sometimes find suitable material for dating but do not collect or date it. This, in part, reflects the development-driven nature of most archaeological investigations in Victoria, where profitability is a significant factor in the commodification of Aboriginal cultural heritage and archaeology (Zorzin 2014). However, it represents a missed opportunity to develop more detailed insights into the chronology of Aboriginal places and change over time.

Changing dating techniques

The techniques and technology used to generate radiocarbon age determinations have changed significantly since Libby first pioneered the radiocarbon dating technique (Libby 1952; Van Strydonck 2017). Although most archaeologists have a general understanding of the principles behind radiocarbon dating, the science has become increasingly complex and the gap in mutual understanding between archaeologists and radiocarbon laboratory specialists is problematic (Bronk Ramsey 2008; Wood 2015).

'Older dates' (in the sense of when they were submitted for dating) were often obtained using techniques now deemed unreliable, particularly in relation to the collection and pre-treatment of samples, and the calibration of dates. Additionally, the 'scant details published alongside the majority of dates means assessment of their quality is impossible, either in terms of association with archaeology or accuracy of the number' (Wood 2015:61).

The standard deviations for 'older dates' are often much larger than is achievable and acceptable today, while many laboratories in the mid-1970s did not yet use the $\delta^{13}C$ correction, to take into account variations in $\delta^{13}C$ due to non-climatic factors (Van Strydonck 2017:1242, 1244). 'Older dates' also tend to be more difficult to verify, since numerous radiocarbon laboratories are no longer operational, do not have good or accessible archives, or have lost data. Similarly, different dating laboratories have slightly different methodologies, pre-treatment techniques and standards, which further inhibit the comparison of dates (Waterbolk 1971:19–20).

Chronologically older dates (i.e. early Holocene/late Pleistocene) also suffer greater taphonomic biases, particularly given sea-level rises since the Last Glacial Maximum (Frankel 1991). These dates tend to have larger standard deviations and are also more sensitive to contaminants, a fact most archaeologists are aware of (Wood 2015:68).

The variation in reliability of radiocarbon age determinations submitted over time raises questions over the broader research value of these sorts of datasets. Wood (2015:68) argues that it 'is simply impossible to assess the quality of the vast majority of published radiocarbon dates with any certainty. As a result, it is difficult to include the majority of published radiocarbon dates in statistical analyses to produce high-precision chronologies in the Holocene, or accurate chronologies in the Pleistocene'. This issue, as well as others, has led some researchers to challenge the validity of the 'dates as data' / population proxy studies pioneered by Rick (1987) in the 1980s (Becerra-Valdivia et al. 2020; Contreras and Meadows 2014, inter alia).

Future work

The data-verification process is merely the first, albeit significant, stage of the Radiocarbon Dating Visualisation Project. Although we intend to publish further papers which analyse the dataset in more detail, we are committed to making the dataset accessible to Traditional Owners, Heritage Advisors and researchers within the appropriate access restrictions of the VAHR. We are currently exploring a variety of ways of making the dataset more dynamic, spatially based and visual than a simple spreadsheet to download.

We intend to update the VAHR so that the 'earmark facility', which highlights key features of a report, more accurately identifies reports with dating information to assist in searching the register. Further work is also required to create place registrations for radiocarbon age determinations which are currently not associated with registered places.

Another part of the project is to present the radiocarbon age determinations to a more general audience, via Matthew Coller's Time Machine/Temporal Earth model—the successor to Sahul Time (Coller 2009; < https://temporalearth.org/ >). This has the potential to model radiocarbon age determinations in conjunction with the effects of sea-level and climate/environmental change over time, and create a time-lapse animation of radiocarbon age determinations for Victoria. Dynamic forms of data visualisation have the potential to transform a dataset into a stimulating narrative exploring the time depth and changing nature of Aboriginal settlement in Victoria, whilst acknowledging its limitations.

Lastly, AV intends to publish a Practice Note for radiocarbon dating, drawing on existing advice from radiocarbon laboratories and standard archaeological practice (Millard 2014), while an online database with clear compulsory fields would help to force complete publication (Wood 2015:69). That said, archaeologists are required to submit radiocarbon age determinations to the VAHR but often forget to, and Wood (2015:69) notes that guidelines have been available since 1959, yet significant problems remain.

Conclusions

The verified list of 968 radiocarbon age determinations for Aboriginal places in Victoria has created a useful dataset for future generations while also highlighting several areas of concern. It is crucial that relevant laboratory reports are included in publications and archaeological reports, but other agreed standards in generating and reporting radiocarbon age determinations seem to be required. This will be addressed through the publication of a Practice Note by AV. The Radiocarbon Dating Visualisation Project has laid a foundation for creating an accurate dataset of radiocarbon age determinations for Victoria, and for building on this dataset in a way that improves scientific understanding of the dates of Aboriginal places in Victoria.

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