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Article

The Radiocarbon Dating of Early Malay and Javanese Manuscripts Written on *Dluwang*

Annabel Teh Gallop[1], Karin Scheper[2], and Michael Dee[3] | London, Leiden, and Groningen

Abstract

This article presents an overview of radiocarbon dating with special reference to Indonesian manuscripts. It starts with a survey of the oldest known manuscripts from maritime Southeast Asia written on organic materials, dating from the 14th to the early 17th centuries. It then describes and presents the results of the radiocarbon dating of four manuscripts in Malay, Javanese, Arabic and Persian, held in Leiden University Library, all written on *dluwang*, the Javanese name for a writing support made of beaten bark or tapa. We introduce the manuscripts which underwent radiocarbon dating, with the reasons for their selection; describe and illustrate the process of extracting the necessary samples; and present and analyse the radiocarbon dating results. These four manuscripts in Leiden are then analysed along with the renowned manuscript of a code of laws from Tanjung Tanah in Kerinci, Sumatra, published by Uli Kozok in 2015. This manuscript, which is also written on beaten bark, has been radiocarbon dated to the late 14th or very early 15th century, making it by far the oldest known manuscript in the Malay language.

We then draw some conclusions about the potential value of radiocarbon dating for Indonesian manuscripts. As an invasive technique, the objective of the dating study must be significant, as irreversible damage to ancient artefacts, however tiny, is never a decision to be taken lightly. But researchers are discovering that ^{14}C data can often provide the key piece of evidence in otherwise insoluble debates. It is therefore hoped that the data and information presented in this article will help other scholars considering making use of this technology by highlighting the various factors to be taken into consideration, and by profiling the types of manuscripts most likely to benefit from this procedure.

Keywords

Radiocarbon dating, dluwang, tapa, Javanese treebark paper, Java, Malay, Indonesian manuscripts, Sumatra, ^{14}C data, Southeast Asia

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The oldest surviving Indonesian manuscripts[4]

It is often stated as a truism that manuscripts – books and documents hand-written on organic materials – do not survive long in Southeast Asia due to multiple factors: the tropical climate with high temperatures and humidity, frequent natural disasters such as earthquakes, floods and tsunamis, and calamities such as fires and wars. This general pessimism was proved spectacularly wrong when a manuscript of a code of laws popularly known as the *Undang-Undang Tanjung Tanah*, containing a copy of the *Nītisārasamuccaya* written in Malay in Indic script on beaten bark paper, was radiocarbon dated to the late 14th or very early 15th century, making it by far the oldest known manuscript in the Malay language.[5] This manuscript, held to this day as a village heirloom in the Kerinci highlands in central Sumatra, had evidently survived for over seven hundred years, in the society within which it was created, through being cared for with traditional methods of preservation.

Other Indonesian manuscripts of a commensurate age are all written on varieties of palm leaf and originate from the island of Java. Many of the oldest are written on *gebang* leaf (*Corypha gebanga* or *Corypha utan*) from west Java, including the oldest manuscript in the National Library of Indonesia, a copy of *Arjunawiwāha* dated 1334 (PNRI L 641).[6] The next oldest Indonesian manuscripts are written on *lontar* leaves of the Palmyra palm (*Borassus flabellifer*): a copy of the Old Javanese text, *Sang Hyang Hayu*, from Garut in west Java, is dated 1435, while another *lontar* copy of the same text written in Buda script and dated 1493 is the oldest Indonesian manuscript in the British Library (MSS Jav 53 t).[7] Quite a few manuscripts in Old Sundanese from west Java written on *gebang* leaf date to the 16th century, including a copy of *Sang Hyang Siksa Kandang* dated 1518 in the National Library of Indonesia (L 630), while a manuscript of *Bujangga Manik* in the Bodleian Library, Oxford, may have been copied as early as 1500 according to Noorduyn.[8] It should be noted that apart from the *Bujangga Manik* manuscript – which was given to the Bodleian Library at the University of Oxford in 1627 – all the other manuscripts only entered institutional collections, whether in Jakarta/Batavia or London, in the 19th century, and therefore had already survived for three or four centuries or more in traditional local repositories in Java.

Palm leaf was the earliest widely-used writing support in Southeast Asia, both on the mainland and in the islands, and has continued in use in Bali till today. The coming of Islam however precipitated the need for larger sheets of smoother writing materials suitable for writing the Arabic script in pen and ink, in particular to emulate the codex format of the Qur'an. In Southeast Asia and Polynesia there had long been a tradition of beating and smoothing tree bark to make thin

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4 This section was written by Annabel Gallop.

5 Kozok 2015, 52–53. The manuscript is fully digitised: https://www.qalamos.net/receive/ID20Book_manuscript_00000001 (last accessed 21 July 2025).

6 Gunawan 2015, 255.

7 Kriswanto and Gunawan 2023.

8 Van der Meij 2017, 48.

sheets of tapa, which could be used for clothing, or for other domestic or ceremonial use.[9] In Java and Madura, the beaten bark of the paper mulberry tree (*Broussonetia papyrifera Vent.*) known as *dluwang*[10] is also used as a writing support and accounts for some of the oldest known Indonesian manuscript books. However, while very early Indonesian manuscript books[11] written on European paper may be dated from watermarks,[12] it is not easy to date dluwang manuscripts from the material characteristics of the writing support. The radiocarbon dating result for the *Tanjung Tanah* manuscript thus provided extremely important proof that beaten bark was used as a writing support in Sumatra already by the late 14th century.

The *Tanjung Tanah* code of laws was the first Indonesian manuscript to be radiocarbon dated, although radiocarbon dating had been used for other art forms of Southeast Asia, notably textiles. Between 1994 and 1996, Ruth Barnes organised a pioneering series of tests by the Research Laboratory for Archaeology and the History of Art, Oxford, on Indian cotton textile samples originating in Gujarat which had been found in Egypt and Indonesia. Two of the Indonesian samples dated to the 14th century, with two others from the early 15th century.[13] These results, which were revealed nearly three decades before the testing of the *Tanjung Tanah* manuscript, were the first to provide evidence that organic materials could survive for many centuries in Indonesia, especially when stored carefully as *pusaka* or heirloom items. More recently, a blue-and-white hand-drawn batik textile found in Lampung, which was probably dyed in Java on cotton brought from India, has been radiocarbon dated to 1362–1422.[14] Radiocarbon dating has also been used for a number of wooden artefacts held in Australian institutions, in some cases yielding much earlier dates than would otherwise have been thought. A carved door from a Sarawak longhouse was dated to 1453–1624; a densely carved Toraja coffin has been dated to 1469–1509;[15] and two decorated doors from Bali have both been dated from the mid-15th to the 16th centuries.[16] However, a pair of wooden doors with not dissimilar decoration from Lampung were radiocarbon dated to the early to mid-18th century,[17] reflecting the value of radiocarbon dating over art-historical analysis in the presence of deeply embedded and long-lasting iconographic practices. Radiocarbon

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9 Teijgeler 2016, vi.

10 The dictionary definition of paper is a sheet made from an aqueous mixture which is lifted and dried. By this definition, *dluwang* (also written as *daluang* or *dluang*) is technically not paper, as it is not made from an aqueous mix: the tree bark is just pounded and polished until thin sheets of tapa are formed, which can be used for writing or even for clothing. However, in popular usage dluwang is generally termed 'Javanese paper'. On the process of making dluwang in Java and Madura see Teijgeler 2016, 10–15, and for an illustrated account see Ekadjati and McGlynn 1996.

11 Documents such as letters, notes and contracts from maritime Southeast Asia do survive in small numbers from the 16th century onwards. Those extant today which attest to contact with Europeans are generally written on European paper, and are often dateable from the historical context. Books created in local contexts are more difficult to date.

12 See, for example, Cod. Or. 247, a volume containing parts of the Qur'an and Malay charms, written on French laid paper with a watermark of a flower with hand below pot similar to Briquet 11284, identified in use in 1572 (Wieringa 1998, 15).

13 Guy 1998, 186.

14 Sardjono 2023, 29, 446.

15 Bennett 2023, 168, 452.

16 Carpenter 2023, 266, 269.

17 Bennett 2011, 26–27.

dating has also been of crucial value in evaluating a very rare wood sculpture depicting a *kalpataru* or wishing-tree located in Tuban on the north coast of east Java, carved in the round from part of a branched tree trunk which was felled between 1445–1525 or 1555–1630 and evidently carved soon after.[18]

The new insights obtained on many aspects of Indonesian material culture from radiocarbon dating led to the present project, whereby between 2020 and 2023 four dluwang manuscripts from Leiden University Library were, with the collaboration and permission of the library staff, radiocarbon dated at Groningen University by Michael Dee, Associate Professor of Isotope Chronology, Centre for Isotope Research.

In this article we give an overview of radiocarbon dating; introduce the manuscripts which underwent radiocarbon dating, with the reasons for their selection; describe and illustrate the process of extracting the necessary samples; present and analyse the radiocarbon dating results; and then draw some conclusions about the potential value of radiocarbon dating for Indonesian manuscripts. As an invasive technique, the objective of the dating study must be significant, as irreversible damage to ancient artefacts, however tiny, is never a decision to be taken lightly. But researchers are discovering that ^{14}C data can often provide the key piece of evidence in otherwise insoluble debates.[19] It is therefore hoped that the data and information presented in this article will help other scholars considering making use of this technology by highlighting the various factors to be taken into consideration, and by profiling the types of manuscripts most likely to benefit from this procedure.

An overview of radiocarbon dating[20]

Radiocarbon dating is a chronometric technique that is based on the determination of the ratio of carbon isotopes in different materials. Put succinctly, radiocarbon (^{14}C) is an extremely rare isotope of carbon that is present in similar concentrations in all living organic tissue. Once an organism dies, however, the ratio of ^{14}C to the most abundant isotope of carbon (^{12}C) declines because ^{14}C undergoes radioactive decay. By measuring the ratio $^{14}C/^{12}C$ it is possible to determine how much time has lapsed since that sample was part of a living organism.

To measure the $^{14}C/^{12}C$ ratio it is necessary to extract pure carbon from the material being dated. Thus, the chemical processes that are required are ultimately destructive. However, nowadays, increasingly smaller amounts of sample material are needed for dating.

The radiocarbon dating facility at Groningen recommends that 50 mg of plant-based material is submitted for dating. However, it also explains that in many cases a successful result can be obtained on as little as 5 mg of material. Obviously, much depends on the purity, and density of carbon, in the specific sample. As a guideline, a typical submission of paper might amount to 25 mg,

18 Njoto 2014, 170–171.

19 e.g. Marom et al. 2012; Kuitems et al. 2020.

20 This section was written by Michael Dee.

or approximately 1 cm^2. Other organic substances may require larger amounts. For example, it is generally necessary to submit >250 mg of bone, parchment or hair for a reliable result.

It is also always worth bearing in mind that ^{14}C dating can never prove that an item is authentic. In some cases, it can prove that an object is not genuine by showing that the measured ^{14}C/^{12}C ratio could never relate to the time period in question. However, even if a ^{14}C result matches the date expected by historians or archaeologists, that does not mean the method can *verify* the object's authenticity. ^{14}C dating returns the natural age of the material being analysed. It cannot discount the possibility, for example, that a forgery has been produced on material from the same time period.

Because of the pattern of ^{14}C in the environment at the time, it is of little value to attempt to date any sample from approximately 1650–1950 CE. This impediment actually largely stems from the burning of carbon-rich fuels (such as coal and oil) linked to the industrial revolution from the mid 18th century onwards, a process that has disrupted the natural levels of ^{14}C in the atmosphere in such a way that it is essentially impossible to say when, within this 300-year range, a sample comes from. This problem alone inhibits the application of the ^{14}C dating to many historical questions.

The outputs of ^{14}C analyses are not easily summarised. The measured ^{14}C/^{12}C ratio is first mathematically converted into a '^{14}C determination', which is sometimes just referred to as a '^{14}C date'. However, it is important to understand that this is not a date in any colloquial sense of the term. Even more confusingly, this number carries the units 'yr BP' which stands for 'years Before Present' (when 0 BP=1950 CE) but now are best not referred to in this way. These faux-amis are largely vestiges of the first attempts at ^{14}C dating, which have long since been superseded. We now know these yr BP values have to be *calibrated* to have any real meaning. The process of calibration involves comparing the ^{14}C determination with series of reference determinations obtained in exactly the same way but on samples whose exact calendar age was already known. By way of this process, probabilities are obtained that the sample came from different calendar years. The calendar years that are included in the highest 95% of all the probabilities are then bracketed within the '95% date range'.

^{14}C dates are often summarised by graphs, which will be presented and explained further below along with the results of the radiocarbon dating of the four manuscripts from Leiden University Library.

Radiocarbon dating of early dluwang manuscripts: selection and description[21]

In 2020, Majid Daneshgar, then of Freiburg University, published the first full study of the contents of Or. 7056,[22] a dluwang manuscript of 13 folios in Leiden University Library, which had come into the hands of Snouck Hurgronje (1857–1936) as war booty from Lam Pisang in Aceh in 1896.[23] The manuscript contained an anthology of Persian and Arabic poetic couplets, accompanied by

[21] This section was written by Annabel Gallop, with grateful thanks to Majid Daneshgar for input and comments.

[22] The manuscript is fully digitised: http://hdl.handle.net/1887.1/item:2684700 (last accessed 21 July 2025).

[23] Daneshgar 2020.

interlinear Malay translations. Daneshgar was particularly struck by the fact that of the 13 different poets quoted, none lived after 1431, while certain archaic orthographical and linguistic elements also suggested that the manuscript was of considerable antiquity.[24]

Daneshgar thus approached Karin Scheper, Conservation Specialist at Leiden University Libraries (Universitaire bibliotheken Leiden, UBL), to enquire whether it would be possible to radiocarbon date Or. 7056. Despite the fact that this type of analysis is destructive, for it requires a small part of the manuscript substrate to be cut for analysis, UBL agreed to the request in view of the research value of the project. As Scheper clarified, the arguments in favour were the interesting approach of Daneshgar's study and the absence of other means to determine the origin and age of dluwang. Another consideration was the good condition of the manuscript, and that the pages included wide margins from which the substrate could be taken, without encroaching upon the text. The sample was taken and then sent to the Centre for Isotope Research at the University of Groningen to be analysed by Michael Dee. The radiocarbon dating of Or. 7056 (presented in detail in Fig. 4 below) confirmed with a 95% certainty the dating to before 1623, with a 70% probability that the bark was collected between 1450 and 1521.

Impressed by these results, in early 2022, Annabel Teh Gallop, Lead Curator for Southeast Asia at the British Library, discussed with Daneshgar and Scheper the idea of building on this study, and proposed that three further manuscripts in UBL written on dluwang could be submitted for radiocarbon dating. Her main focus was on Acad. 19, a small volume suspected on palaeographical and art-historical grounds to be of considerable age, but of which little was known about its early provenance.[25] The two other manuscripts selected were already widely acknowledged as being amongst the oldest Javanese manuscripts in UBL: Cod. Or. 1666, which is dated 1582, and Cod. Or. 1928, which entered the Leiden library in 1614. Brief details of these three manuscripts are given below.

UBL Acad. 19

Contains a selection of Qur'anic surahs, with prayers, and a fragment on *dhikir* in Javanese, with illuminated frames and sketches. Dluwang; [32] folios, with 62 written pages (unfoliated); 22.5 × 16.5 × 1 cm.[26] Not yet digitised.

The earliest known owner was D.A. Walraven (1779–1804), professor of Oriental languages at Amsterdam,[27] and thus the only firm information on dating was that the manuscript pre-dated 1804. It was hoped that the radiocarbon method would help to date the decorative elements in this manuscript, and thereby contribute to the understanding to the artistic aspects of early Indonesian book culture.

[24] Daneshgar 2022, 165.

[25] On this manuscript see further Gallop (forthcoming).

[26] Voorhoeve 1980, 278; Witkam 2006.

[27] Witkam 2006, 11.

UBL Or. 1666

Entitled *Qulāṣa 'ilm al-ṣarf*, this has now been identified as a short Persian rendition of *Marāḥ al-Arwāḥ*, a treatise on Arabic grammar by Aḥmad b. ʻAlī b. Mas'ūd from ca. 14th century CE,[28] with a Malay interlinear translation in Jawi script. Dluwang; 35 folios; 20.5 × 15 cm.[29] Not yet digitised.

The colophon on fol. 33v states that the writing of the Persian text was completed in Ramadan 990 (?) (September–October 1582) by Abdul Jamal, the copyist and owner of the manuscript. The manuscript once belonged to D. van der Vorm (1664–1731) in Batavia, and then entered the library of J. Van Voorst (1757–1833), from which it was bought in Amsterdam in 1859 by UBL. As this manuscript has a dated colophon, it was believed that it would serve as a helpful 'yardstick' to see what radiocarbon dating could say about the lapse of time between the harvesting of the tree bark and the writing process.[30]

UBL Or. 1928

Kitab Pangeran Bonang, a treatise on Islamic theology and mysticism, in prose in the form of a question-and-answer dialogue between Seh Bari and his disciple; Sunan Bonang is one of the saints credited with bringing Islam to Java. In Javanese, written in Javanese script. Dluwang; 44 folios, with 83 numbered pages of written text, from fol. 2r to 43r; 25 × 20 cm; European binding of marbled paper front and back cover boards.[31] Fully digitised.[32]

Part of the library of Bonaventura Vulcanius (1538–1614), who probably acquired it from one of the first Dutch navigators at an east Javanese port (Sedayu or Tuban) at the end of the 16th century; entered UBL in 1614. There has long been scholarly interest in this important manuscript, and it was hoped that radiocarbon dating would cast more light on its date of creation.

The procedure in Leiden University Library for taking samples for radiocarbon dating [33]

As mentioned above, radiocarbon dating is an invasive and destructive procedure which involves removing a sample of substrate from an item, and therefore any sampling application requires very careful consideration. In response to the request from Gallop and Daneshgar in 2022, UBL agreed to collaborate for a number of scholarly reasons. Although non-invasive analysis would always be

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28 Daneshgar 2022, 162.

29 Wieringa 1998, 28; Witkam 2007, 2.212–213.

30 For example, Russell Jones reached the conclusion that 90% of Malay manuscripts on (European) paper were written on paper that was eight years old or less (Jones 2021, 299).

31 References: Schrieke 1916; Pigeaud 1968, 2.31, 3.70–71; Drewes 1969; Witkam 2007, 2.286–287; Sugahara 2023.

32 http://hdl.handle.net/1887.1/item:1576531 (last accessed 21 July 2025).

33 This section was written by Karin Scheper based on her report entitled 'Carbon dating of three manuscripts on dluwang', 26 July 2022, following the sample-taking from Or. 1666, Or. 1928, and Acad. 19.

preferable, the removal of some particles or a tiny piece of material can be acceptable in certain situations and under certain conditions. In this case, because so few early dluwang manuscripts have dateable colophons, and as dluwang has no other (known) characteristics that can help establish its age and as a material is understudied, it was believed that the dating of these volumes could provide an anchor for future material-technical studies.[34] Further considerations were that the manuscripts are part of a research collection in UBL, and this kind of material research is as valid as studies of their content. From the outset certain strict parameters were established: the material sample could only be taken from a margin, without interfering with or risking the loss of any textual information, and without distorting the visual perception of the item; these criteria were easily met for all the selected UBL manuscripts. Also conditional for the UBL was that a proper record of the sample-taking would be made.

To meet the required amount of material for radiocarbon dating we aimed to take 25 mg of the substrate. It is not possible to give an exact size of the sample, since this depends on the thickness of the substrate. For material with the density of paper, it usually suffices to take around 7 × 7 mm. However, since dluwang might be lighter than paper, and since taking too little would make the sample entirely worthless, it was decided to err on the side of caution. Since the conservation studio in the UBL does not have the refined equipment to weigh matter less than a grammage, the exact weight of the samples taken cannot be stated. For each of the three manuscripts, the different considerations which influenced the selection of the sample area for each manuscript will first be described, and then the procedure for taking the samples will be illustrated.

The samples were all taken in the conservation workshop in the UBL by Godelieva van der Randen and K. Scheper on July 22, 2022. After extraction, all the samples were wrapped individually in aluminium foil, sealed in small Secol sleeves, labelled and then packed and sent to the Centre for Isotope Research, University of Groningen, on July 26, 2022.

UBL Or. 1666

This manuscript has evenly trimmed edges, and therefore cutting a small strip of one of these edges did not seem appropriate. The textblock has insect damage throughout, mostly in the margins though the text areas are affected as well. The worm holes are fairly small, and the damage is not severe and does not compromise the text or usability of the manuscript. However, it did provide the option of taking some material from the substrate where worm holes had already 'loosened' bits of the dluwang. Since the bottom margin contained the fewest annotations, an area with such damage was chosen, at a safe distance from the catchwords as well. Two adjacent folios were selected for taking the sample material. The two irregular pieces of dluwang together measured a little more than a square cm (Figs 1a–e).

[34] As noted above, the rationale for analysing the one dated manuscript (Or. 1666, dated 1582) was that the dating of the substrate might shed light on dluwang production and scribal practices; at least for this case it might provide information about the possible time span between the harvesting of the bark and the copying of the manuscript.

Fig. 1a: Or. 1666, fols 28v–29r, with a white marker indicating area for sample extraction.

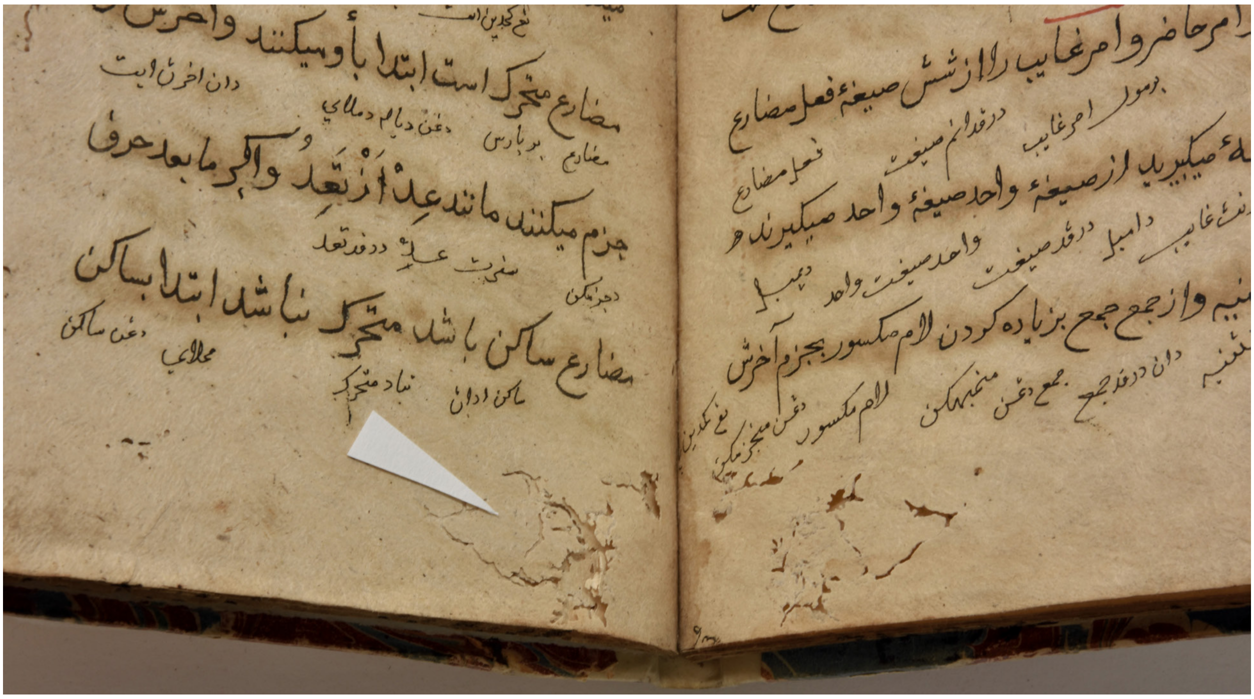

Fig. 1b: Or. 1666. The white marker indicates the area on fol. 29 where the dluwang will be cut from the bottom margin near the gutter, in between the insect-damaged parts of the dluwang that do not contain any textual information; a similar area on the facing folio, fol. 28, will also be extracted.

Fig. 1c: Or. 1666, extracting the sample from fol. 29.

Fig. 1d: The extracted samples of dluwang from Or. 1666, together measuring in total about 15 × 15 mm, placed on aluminium foil.

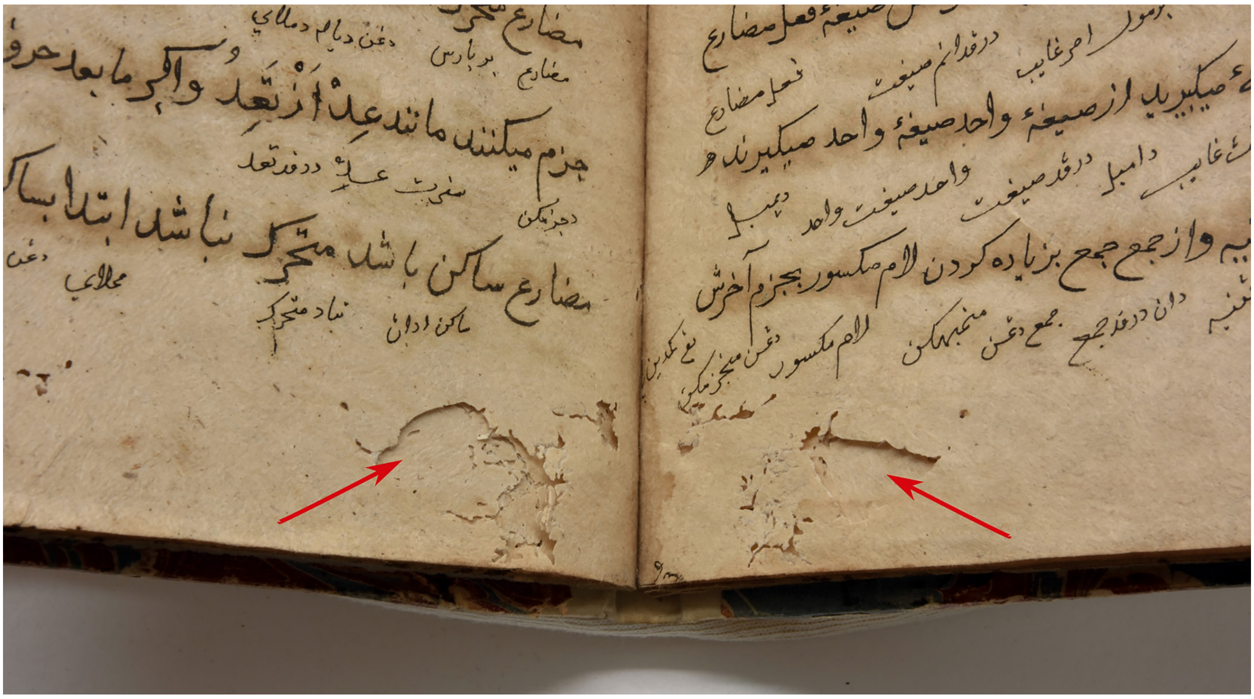

Fig. 1e: Or. 1666, red arrows showing the gaps in the dluwang where samples have been extracted from fol. 28 and fol. 29.

UBL Or. 1928

This manuscript did not have insect infection that could have led to the loosening of parts of the substrate (such as has happened in Or. 1666). Most of the folios of this manuscript have fairly rough edges, which have not been trimmed to a smooth edge, despite the wide margins (not even in the rebinding process). The irregular edges of the folios bear witness to the dluwang-making process, and as such are an important material feature, since a thorough understanding of the development of this technique is still lacking. We did not want to sample from these uneven edges of the textblock, and therefore one of the smaller folios with a straight fore-edge was selected (p. 54). With a height of 25 cm, the 1 mm strip would provide more than enough sample material (Fig. 2 and Figs 2a–c).

It is noteworthy that both Or. 1666 and Or. 1928 have been rebound in a western-style binding, sewn on parchment strip supports, with western paper endpapers, covered in half parchment with marbled paper covering the boards. In Or. 1666, a tiny blue thread remnant of the former endband tiedown is visible, and the original sewing stations. In Or. 1928, a few remnants of the original sewing thread stay secured in the current structure. The similarities between both bindings are striking, most notably the bookbinder's use of small pieces of the marbled paper, clearly to economically use up off-cuts and leftover bits in such a way that the appearance of the resulting binding does not give away its low-budget making immediately. It strongly suggests that both manuscripts were rebound by the same craftsman. The loss of the original bindings is, of course, irreparable.

UBL Acad. 19

This manuscript is in a relatively poor condition. In all likelihood it was never bound in covers to protect the textblock, although the gatherings are sewn. The gatherings are each made of three bifolios (trinions), and were originally sewn with blue thread, with unsupported link-stitch sewing on three stations. There are no traces of endbands. There is evidence of repair sewing with neutral coloured thread in the first and last gathering. There are eight gatherings in total. Assuming that trinions were consistently used, and judging by damage and gaps in text continuity, the fifth and seventh gatherings are currently very incomplete.

As in the case of Or. 1928, this manuscript also yields information about the process of making dluwang. Several folios have actually split or have 'delaminated' into two layers (or have begun to split across half the thickness of the folio), showing that during the process of manufacture, the two sides were beaten into one sheet. Some of the folios show that these two sides were not necessarily equally large, nor are the edges necessarily straight. The drawing (Fig. 3a) represents the structure of the eight gatherings, indicating which folios are partly or completely delaminated, or are damaged with one side of the dluwang missing.

Because of the encrusted dirt and tattered edges, it seemed best not to take any samples from the first and last few folios, nor from any folios with illumination. It was decided to cut a strip from one of these split folios, with uneven sides: fol. 24a (note: the folios are not foliated; we counted and

Fig. 2: The similar western style bindings of Or. 1928 (left) and Or. 1666 (right), with marbled paper covering the front and back boards.

Fig. 2a: Or. 1928, the white markers indicate the straight fore-edge margin of p. 54, from which the 1 mm wide sample will be cut.

Fig. 2b: Or. 1928, extracting the sample of dluwang from the fore-edge of p. 54.

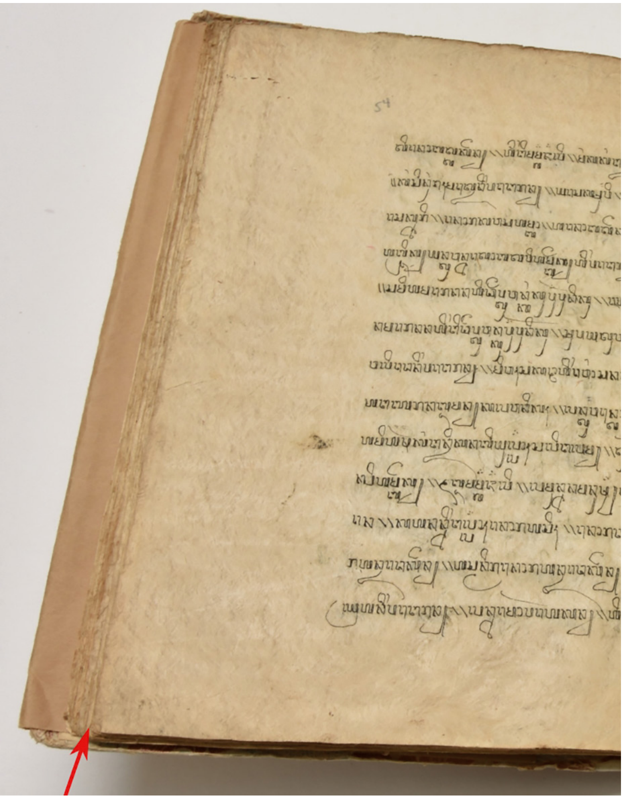

Fig. 2c: Or 1928, the red arrow indicating the area of the foredge of p. 54 from which the sample has been extracted.

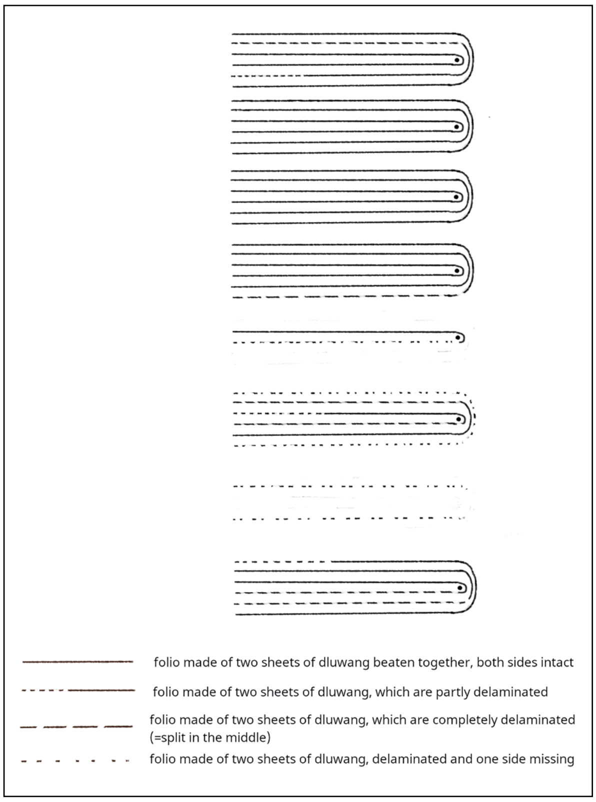

Fig. 3a: The main diagram shows the likely sewing structure of Acad. 19, with eight gatherings; the key above explains the state of each folio.

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Fig. 3b: Acad.19, the white markers indicating the top edge of fol. 24 from which the sample will be extracted.

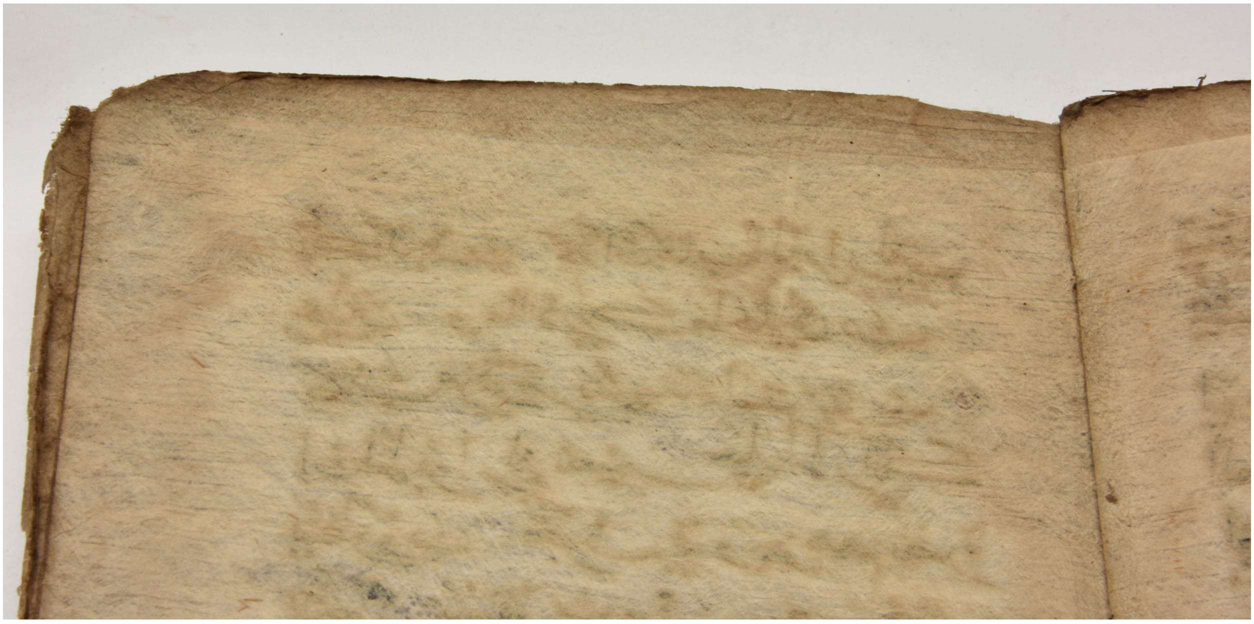

Fig. 3c: Acad. 19, fol. 24, which has become delaminated (the folio has split into two sheet), and fol. 24a is shorter than fol. 24b: the shorter top margin left a strip of 1.2 mm exposed, and this part of the dluwang on the right side of fol. 24b has become greyish because of dust and dirt. After cutting a strip of material from the top edge of fol. 24a, its length will no longer correspond to the demarcation line between the clean and the dusty surface that has formed on the right side of fol. 24b.

Fig. 3d: Sample-taking from Acad. 19, fol. 24.

Fig. 3e: Acad. 19, the sample of dluwang removed, approximately 2 × 160 mm, placed on aluminium foil.

Fig. 3f: Acad. 19, showing the upper margin of fol. 24 after a strip of dluwang has been removed.

selected the 24th leaf). The sample was taken along the top edge that was a good centimetre shorter than its verso or b-side. Because of the difference in sheet length, the formerly inner side of fol. 24b had been exposed to dust and dirt, and had become greyish in colour. Cutting of a strip of material from the top edge of fol. 24a will therefore be visible mostly because the line of dust-dirt that has formed on fol. 24b will no longer correspond to the top-edge of the reverse of fol. 24a. This primary evidence of our interference may help prevent confusion should this volume be included in a future study of dluwang production and manuscript making. Also, because of the grey deposit on the dluwang surface and unevenness of the edge, it was decided to remove a slightly broader strip than required to equal 25 mg. The strip measured 16 cm in length and ranged from 1–2.5 mm in width (Figs 3b–f). Should the dirtiest part of the material be unsuitable for the analysis, then this could be removed.

The results of the radiocarbon dating of five dluwang manuscripts, with some comments[35]

The outcomes of radiocarbon dating are generally presented in the form of graphs. The way to read such graphs will be explained below with reference to the graph in Fig. 4 relating to UBL Or. 7056, and the same principles can be applied to the graphs in Figs 5 to 8. The results relating to five dluwang manuscripts – four from Leiden and one from Kerinci – are summarised in Table 1 below.

UBL Or. 7056 (GrM–24345) – tested 2020[36]

At the top of the graph, the alpha-numeric code GrM–24345 is just the laboratory reference number for this result. This is followed by two numbers in brackets separated by a comma, in this case (382, 19), which can also be read as 382 ± 19 yr BP. This is the radiocarbon determination, prior to calibration, and it is graphically illustrated by the red distribution on the vertical axis. The grey shaded areas relate to the horizontal axis, which represents absolute (BCE/CE) time. Beneath these two areas are square brackets which demarcate the periods encompassed by the most likely calendar years at 68% (upper brackets), and at 95% probability (lower brackets). These ranges are written out in full on the top right of the graph.

By examining Fig. 4, it can be seen that the date range resulting from the ^{14}C analysis of this sample is divided into two periods. There is a 70.5% probability that this bark was collected for processing between 1450–1521 CE. But there is also a 24.9% chance it was collected 1586–1623 CE.

UBL Or. 1666 (GrM–30748) – tested 2022

There is a 53% probability that this sample comes from 1457–1524; and a 42% chance it comes from 1571–1631; there is actually also a 0.5% probability it comes from 1560–1562. So an assumed date of 1582 would indeed concur with the 1571–1631 region of probability very well.

[35] This section was written by Michael Dee.

[36] Results published in Daneshgar 2022, 164.

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Or. 1928 (GrM–30750) – tested 2022

There is a 58% probability that this sample comes from 1456–1523; and there is a 37% probability it comes from 1574–1626. So if it was placed in the library in 1614, either one of these regions of probability would still be possible.

Acad. 19 (GrM–30752) – tested 2022

There is a 42% probability that this one comes from 1468–1528; and there is a 53% probability it comes from 1553–1634.

For the three UBL dluwang manuscripts tested in 2022 – Or. 1666, Or. 1928 and Acad. 19 – all of the probabilities are essentially split into two periods: either the samples come from within a few decades of the year 1500 CE or within a few decades of 1600 CE. Thus, the ^{14}C dates in this case are really only able to confirm that these documents all do come from before 1634 CE (at 95% probability). This in some way at least verifies their age to the early 17th century at the latest. Whether or not they come from the earlier period of probability around 1500 CE or from the later period around 1600 CE is unfortunately not possible to know using this method.

Tanjung Tanah manuscript (NZA–18645) – tested 2003 (Rafter Radiocarbon Laboratory, Wellington) [37]

There is a 45% probability that this sample comes from 1306–1365; and there is a 50% probability it comes from 1384–1438.

Table 1: A summary of the analytical results obtained on the five artefacts. The ABA protocol is a standard procedure for cleaning plant samples prior to carbon extraction. The percentage of carbon released on combustion provides additional information on the density of carbon in the artefact. The δ13C results are obtained from stable isotope ratio mass spectrometry. These values can help with determining the taxonomy of the plant material being analysed. The Laboratory Reference (Lab. Ref.) and the ^{14}C determination, with its accompanying uncertainty, are the main outputs of the dating process. It is these estimates that are compared with international reference data to obtain the final calendar date ranges, at specified levels of probability.

Sample	Material	Pretreatment Protocol	% Carbon on Combustion	$\delta^{13}C$ (‰, VPDB)	Lab. Ref.	^{14}C Determination yr BP	±
UBL Or. 7056	Bark	Acid–Base–Acid (ABA)	41.8	–24.42	GrM–24345	382	19
UBL Or. 1666	Bark	Acid–Base–Acid (ABA)	43.3	–25.50	GrM–30748	364	19
UBL Or. 1928	Bark	Acid–Base–Acid (ABA)	42.5	–24.78	GrM–30750	369	18
UBL Acad. 19	Bark	Acid–Base–Acid (ABA)	42.7	–25.20	GrM–30752	353	19
Kerinci 01	Bark	–	–	–24.50	NZA–18645	553	40

37 Results published in Kozok 2015, 52–54.

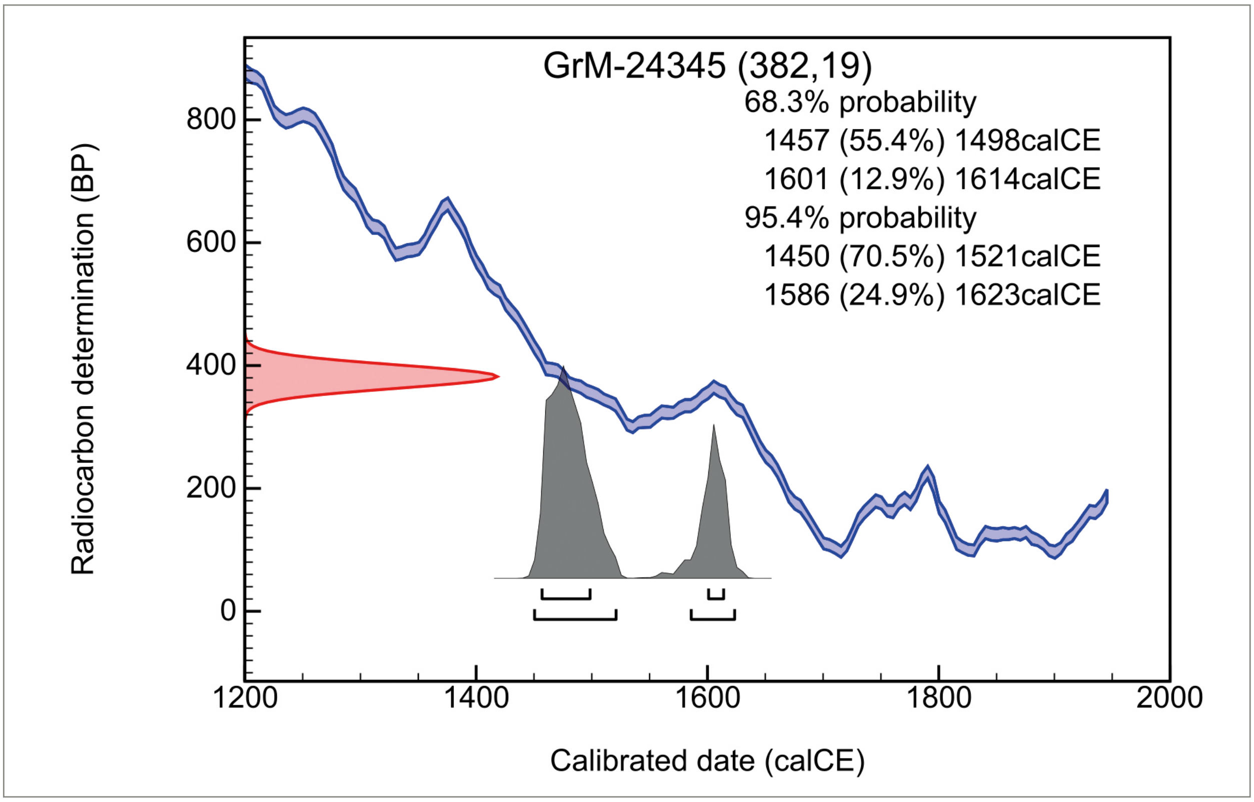

Fig. 4: The results of the ^{14}C analysis on sample UBL Or. 7056.

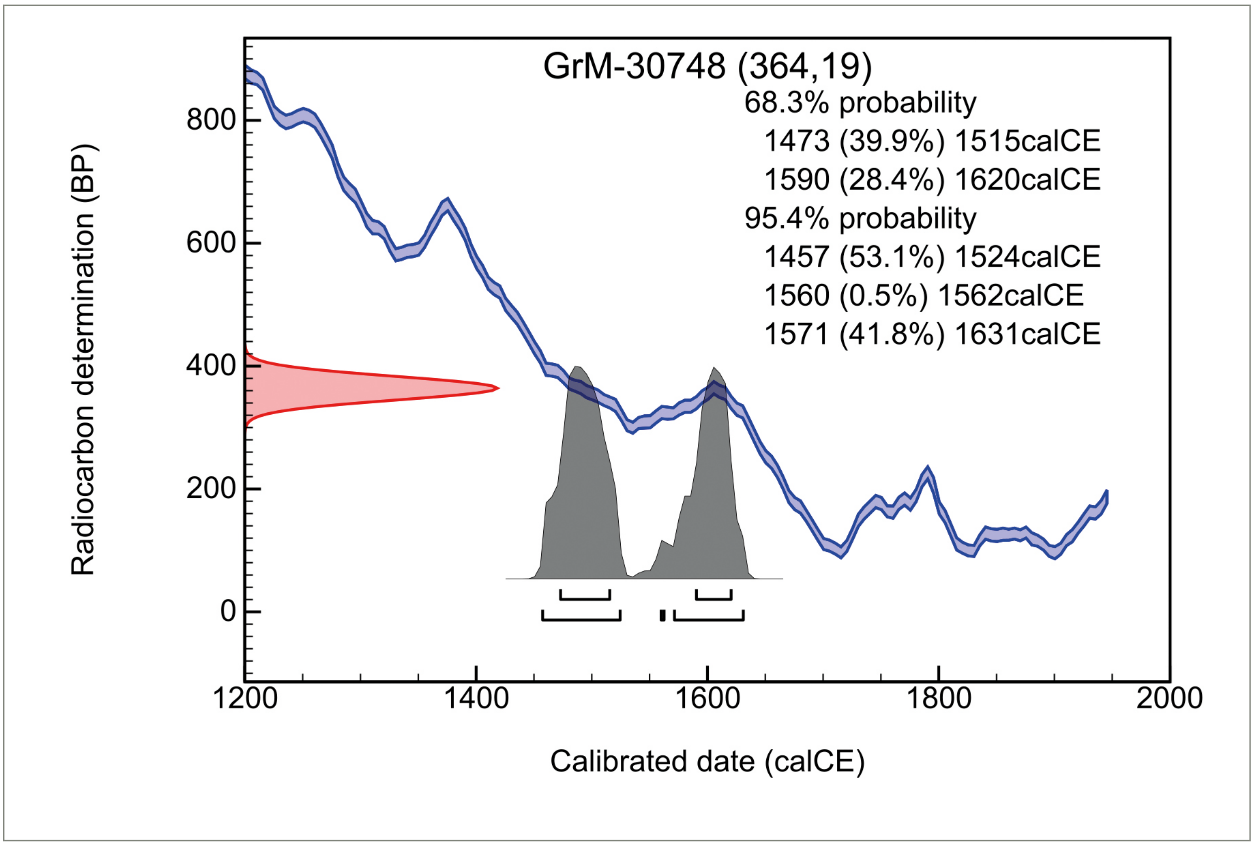

Fig. 5: The results of the ^{14}C analysis on sample UBL Or. 1666.

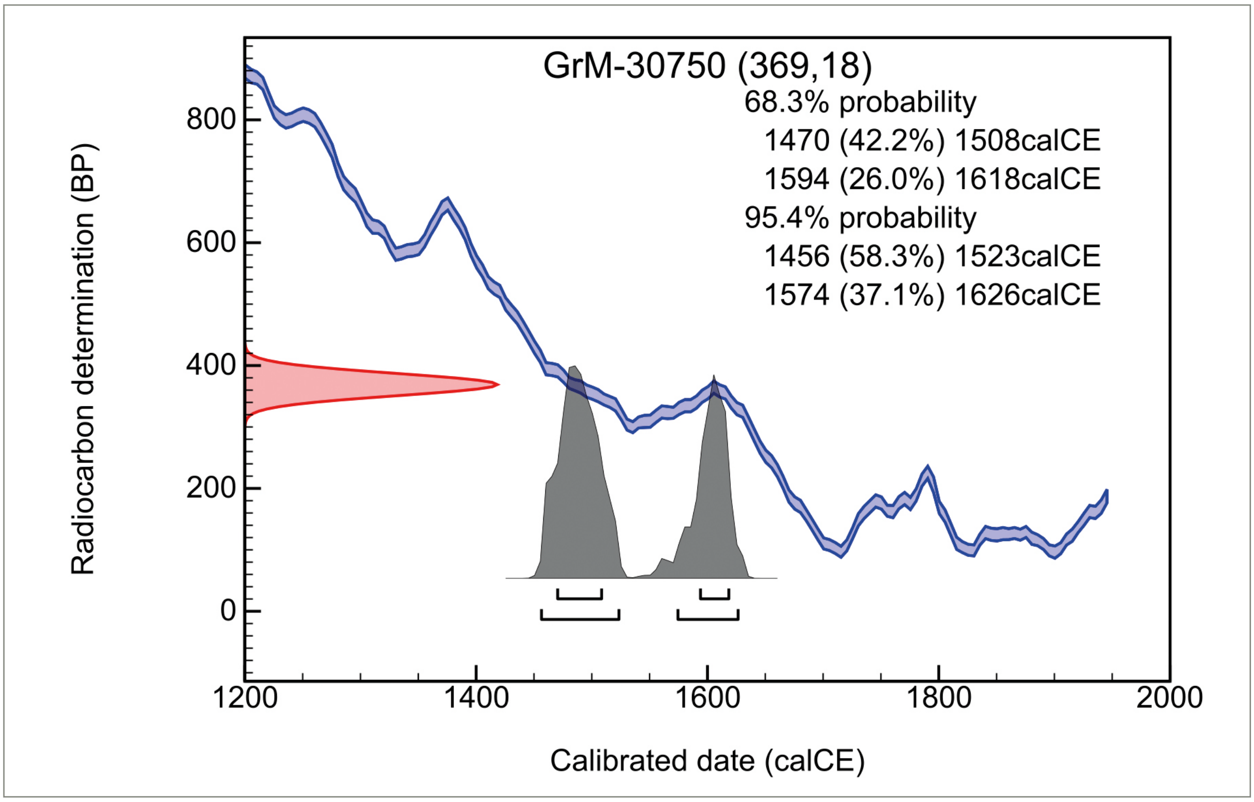

Fig. 6: The results of the ^{14}C analysis on sample UBL Or. 1928.

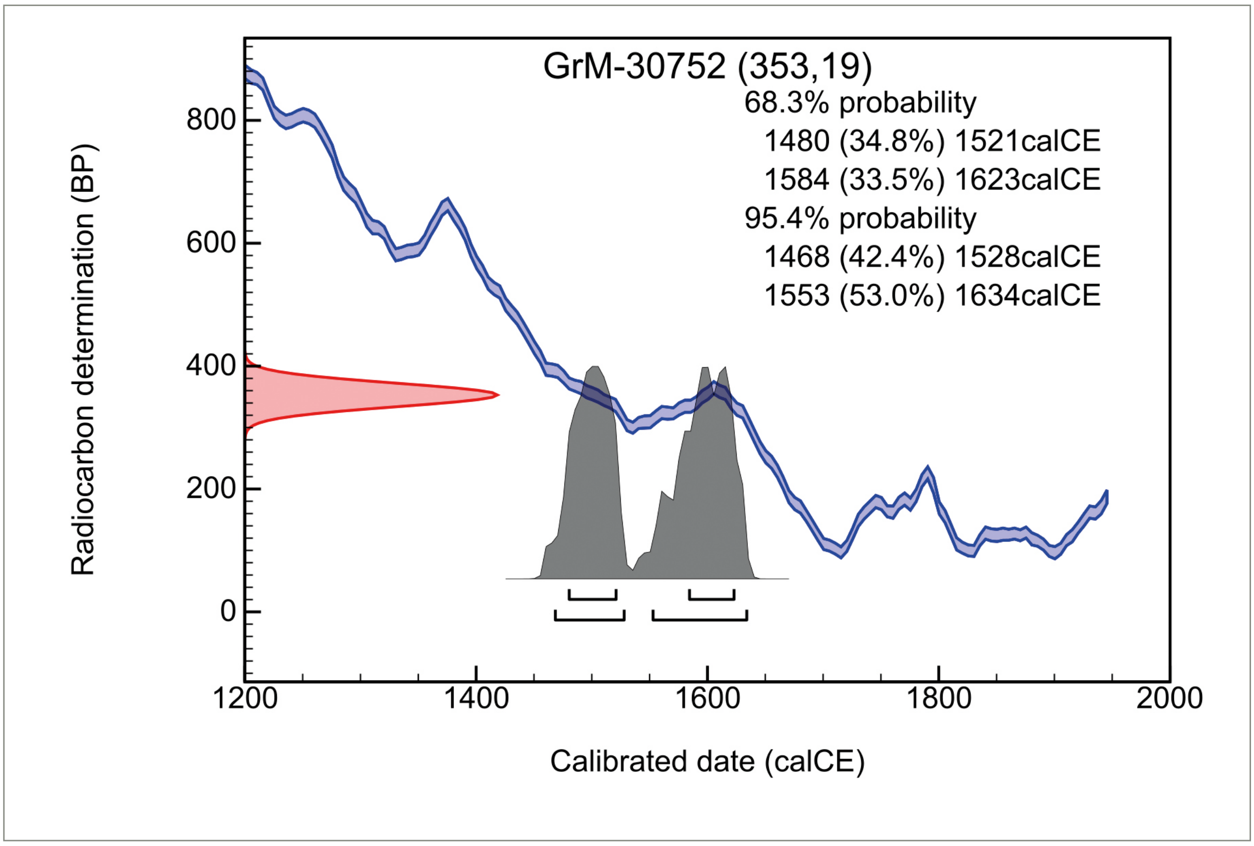

Fig. 7: The results of the ^{14}C analysis on sample UBL Acad. 19.

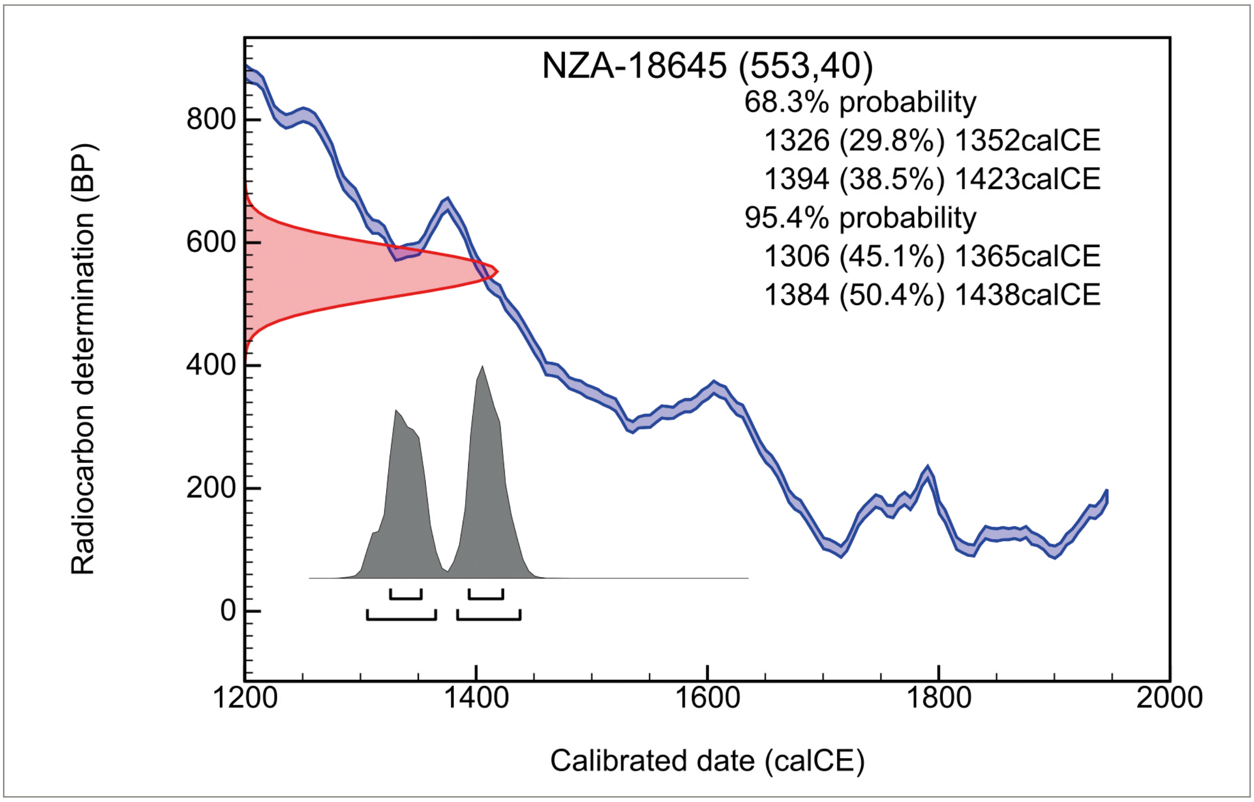

Fig. 8: The results of the ^{14}C analysis on sample from *Tanjung Tanah* MS.

Some comments on radiocarbon dating for Indonesian manuscripts

As can be judged from the major catalogues of manuscripts in Malay and Indonesian languages, the great majority of documented manuscripts from maritime Southeast Asia date from the 19th century, with a small number from the 18th century, but very few from the 17th century and earlier.[38] As noted at the start of this article, there are some exceptional survivors testifying to the much longer history of writing traditions in maritime Southeast Asia, but the actual number of extant manuscripts created before the 17th century is probably very small. It could perhaps be estimated that Indonesian manuscripts from before 1650 perhaps number only a few hundred, of which most are probably written on palm leaf.[39]

For the four manuscripts from Leiden University Library submitted for radiocarbon dating, the most significant results were obtained from Or. 7056, the first manuscript from UBL to be tested, in 2020. Although textual analysis had already hinted at a very early date of writing, the manuscript was only acquired in Aceh in 1896, and therefore the radiocarbon dating result of 95% probability that the manuscript dated before 1623 was highly significant. Even more striking was the balance of probabilities for the two periods for the gathering of the bark, with a nearly 70% probability that the bark was harvested between 1450 and 1521, and 25% probability for a later period, between

[38] cf. Jones 2021, 163.

[39] cf. Wiryamartana and Molen 2001, 51.

1586 and 1623. Thus, there was a statistically significant likelihood that the manuscript could date from as early as the late 15th or very early 16th century. This would make it one of the earliest known dluwang manuscripts, and also correlates well with Daneshgar's observation that no poet who lived after 1431 was cited in the anthology.[40] The fact that Or. 7056 may be one of the oldest dluwang manuscripts in UBL may also prove to be of great value to the Library for any further comparative studies of the nature of dluwang and its manufacturing process.

Turning to the three manuscripts from UBL which were radiocarbon dated in 2022 – Or. 1666, Or. 1928 and Acad. 19 – the results were strikingly similar for each of the three manuscripts. As was the case for Or. 7056, the results confirmed with 95% probability that all the manuscripts pre-dated 1635. However, for all three manuscripts the balance of probabilities for the harvesting of the bark was more or less equally divided between two possible time periods: either in the late 15th–early 16th centuries, or in the late 16th–early 17th centuries. Thus, in contrast to Or. 7056, for these three manuscripts there is not enough evidence to favour the earlier dating, even though it remains a possibility.

Or. 1666 is the one dated manuscript, with a colophon dated 1582. Radiocarbon dating shows that there is a 53% probability the tree bark comes from 1457–1524; a 42% probability that it comes from 1571–1631; and there is actually also a 0.5% probability it comes from 1560–1562. Thus, while the radiocarbon dating is fully compatible with the date of 1582 in the colophon, it does not revise our knowledge in a statistically significant way. The presence of the colophon, in confirming that the manuscript was copied in 1582, is actually the most precise source of information available to us, and remains the most valuable means of dating the text and even its writing support.

Or. 1928 is suspected to be very old and was believed by Drewes to have been collected no later than 1598,[41] the date of the second Dutch voyage to Java; it definitely pre-dates 1614, when it entered Leiden University Library. The radiocarbon dating yielded a 58% probability the tree bark was harvested from 1456–1523, with a 37% probability it comes from 1574–1626. Thus, while in this case there is a stronger emphasis on the earlier period, it is still not conclusive enough to add substantively to our firm knowledge of the manuscript's history, namely that the manuscript pre-dates 1614. Indeed, for this text – variously called 'The Admonitions of Seh Bari' or 'The Book of Pangeran Bonang' – a better candidate for radiocarbon dating might be the second copy found in UBL, Or. 11.092, a dluwang manuscript acquired by Drewes in Java in about 1930.[42] The manuscript is of the rare folding book or concertina (*lepihan*) format probably attesting to an early period in Javanese book culture.[43]

For Acad. 19, radiocarbon dating suggested a 42% probability that the bark was harvested between 1468–1528, with a 53% probability it comes from 1553–1634. Since for this manuscript

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[40] Daneshgar 2022, 165.

[41] Drewes 1969, 2.

[42] Drewes 1969, 33; Witkam 2007, 12.44–45.

[43] Jákl 2016. Teijgeler 2016, 5 draws attention to UBL Or. 8657, comprising paper printouts from microfilms of two other dluwang folding books from west Java; Witkam 2007, 9.242.

the only firm information on dating previously was that the manuscript pre-dated 1804, when its first known owner Walraven died, it has been very valuable to have the radiocarbon dating result which confirms a dating with 95% probability of before 1634.

The final manuscript to be considered, for comparative purposes, is the *Tanjung Tanah* manuscript, which was radiocarbon dated at the Rafter Radiocarbon Laboratory in Wellington, New Zealand, in 2003.[44] Radiocarbon dating gave a 95% probability that the manuscript dated before 1436, with probabilities for bark collection of 44% between 1304 and 1370, and a 53% probability of collection between 1380 and 1436. In this case, as mentioned earlier, the result was nothing short of astounding, because of the general belief that manuscripts could not survive for more than a century or two in the midst of the tropical environment, let alone nearly seven hundred years. Of course there were many other philological and codicological factors that already indicated the great age of the manuscript, including the use of Kawi script for the Malay language, and its rare physical form as a concertina-format dluwang book. Nonetheless, it was the extraordinarily early radiocarbon dating result which allowed many firmer analyses about Malay society and writing culture in Sumatra to be put forward based on this manuscript, which to date is still the only known example of the Malay language written in Kawi script on an organic writing support.

After considering all the results above, the following tentative conclusions can be presented, as a guideline for the selection of possible candidates for radiocarbon dating. In the absence of philological data such as a colophon or similar textual clues, or contextual historical information such as biographical data of owners or date of acquisition by an institution, radiocarbon dating may be an exceptionally valuable tool for dating manuscripts from Indonesia which are believed to be of considerable age. The main criterion for selection for radiocarbon dating is that there should be good grounds for believing that a manuscript may pre-date 1650. The proposed early dating may be based on contextual historical reasons such as information on the acquisition process or the biography of previous owners, or philological or codicological factors, such as palaeographical features. This scenario applies both to manuscripts still held in Indonesia, such as the *Tanjung Tanah* manuscript, as well as manuscripts which entered an institution at a relatively late date, such as Or. 7056, now held in Leiden University Library but known to have been collected at Lam Pisang in Aceh in 1896. The fact that radiocarbon dating for these two examples has shown that it is possible for manuscripts to survive for many centuries stored in local repositories in the Malay world should alert scholars to the possibility of other very old manuscripts still being held in Indonesian repositories today.

However, where other methods of dating are available – for example through a colophon in the text, or the use of European paper of which the watermark can be dated with reference to published guides, or known early dates of acquisition or ownership – these will probably provide a better and more precise way of dating a manuscript. For such manuscripts, radiocarbon dating – which is always expressed in terms of probabilities, and over a relatively wide time range – may not promise enough significantly extra benefits to justify the invasive procedure.

[44] Kozok 2015, 52–54.

To date, all five examples of radiocarbon dating presented and discussed in this article involved manuscripts written on dluwang. It is not yet known how manuscripts from Southeast Asia written on other writing supports, such as palm leaf, would perform under radiocarbon dating.

Finally, and as stressed by Dee, radiocarbon dating only concerns the substrate upon which the text is written by a scribe. Although there are good grounds for believing that both in the case of locally-made dluwang as well as of imported European paper, paper was nearly always used reasonably soon after it was made (and in the case of European paper, normally within eight years of manufacture),[45] nonetheless it is not impossible that a text could be copied on a much older writing support. More common, though, is the practice of adding notes, annotations and even sketches and decoration to older manuscripts. Thus, while the date of the writing support may be a good guide to the date of the main text in a manuscript, it might not necessarily apply to all paratextual elements.

[45] cf. Jones 2021, 162.

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