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# THE CHRONOMETRIC HOLOCENE ARCHAEOLOGICAL RECORD OF THE SOUTHERN THAI-MALAY PENINSULA

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## ABSTRACT

*A survey of the archaeological literature on the southern Thai-Malay Peninsula identifies 39 sites associated with chronometric dates suitable for quantitative analysis covering the Holocene, since 10,000 years ago. The essential criterion for accepting a date is an expected error of less than five percent in assessing the probability that the date refers to any of the 20 intervals of 500 years covered by the Holocene. The resulting documentation would suggest little changed occupancy levels for cave sites throughout the Holocene apart from a mid-Holocene dip. Higher levels of site occupancy are documented for the late Holocene than earlier times, due to the addition of a wide variety of open-air sites to the record. However, literal reliance on the quantitative results should be tempered with recognition that archaeological sites and their contents are prone to destruction with time or, in the case of open-air sites, preservation in contexts at inaccessible depths beneath the surface. Mid-Holocene and earlier open-air sites have been recovered only in exceptional circumstances, and so any review of the Peninsula's Holocene prehistory should be careful not to interpret absence of evidence as evidence of absence for early open-air sites. In the case of cave sites, some allowance can be made for the destruction of suitable dating materials over time. This allowance would point to the Pleistocene-Holocene transition at around 10,000 years ago, and an interval of elevated sea-levels at around 6,500 years ago, as the peak periods for occupancy rates of cave sites. These findings are discussed in the context of the probable commencement of the Neolithic in the Peninsula at around 6,500 years ago, and current issues in relating the archaeological record to the Austroasiatic (Aslian) and Austronesian (Malay) languages spoken by the indigenous inhabitants of the southern Peninsula.*

**Keywords**: Thai-Malay Peninsula archaeology, Holocene Southeast Asian archaeology, summed date probability distributions, Neolithic transition, Aslian prehistory

## INTRODUCTION

This contribution quantifies the chronometric information currently available on the Holocene archaeology of the southern Thai-Malay Peninsula. The Isthmus of Kra, the narrowest point along the Peninsula, is used as the northern border of this contribution's study area (Figure 1). Defined this way, the study area includes the southernmost provinces of Thailand with their large Malay populations, including the traditional Malay kingdom of Patani (Bougas 1994), and the Ten'en and Tea-de, two Aslian-speaking groups who live north of the major concentration of Aslian speakers in Peninsular Malaysia (Burenhalt et al. 2011). Although previous archaeological research on the Peninsula has, generally speaking, divided it into Thailand and Malaysian silos, there is a growing awareness in recent years of the irrelevance of the Thailand-Malaysia border to the region's archaeology. For instance, Adi (2000) included Thailand caves with charcoal drawings, and Thailand sites with Buddhist clay tablets, in documenting the distribution of these archaeological phenomena from south of the Isthmus of Kra to northern Peninsular Malaysia. And the major synthesis by Jacq-Hergoualc'h (2002) on the region's ancient history covers the same study area as defined here. Where Jacq-Hergoualc'h (2002) may be open to criticism is in naming this area as the Malay Peninsula, since the Peninsula actually extends well to the north of the Isthmus of Kra, where it comprises territory that belongs to Thailand (and Myanmar) but not Malaysia. The correct label for the land from the Isthmus of Kra southwards is the southern Thai-Malay Peninsula, which is a mouthful and so will be abbreviated here to STMP.

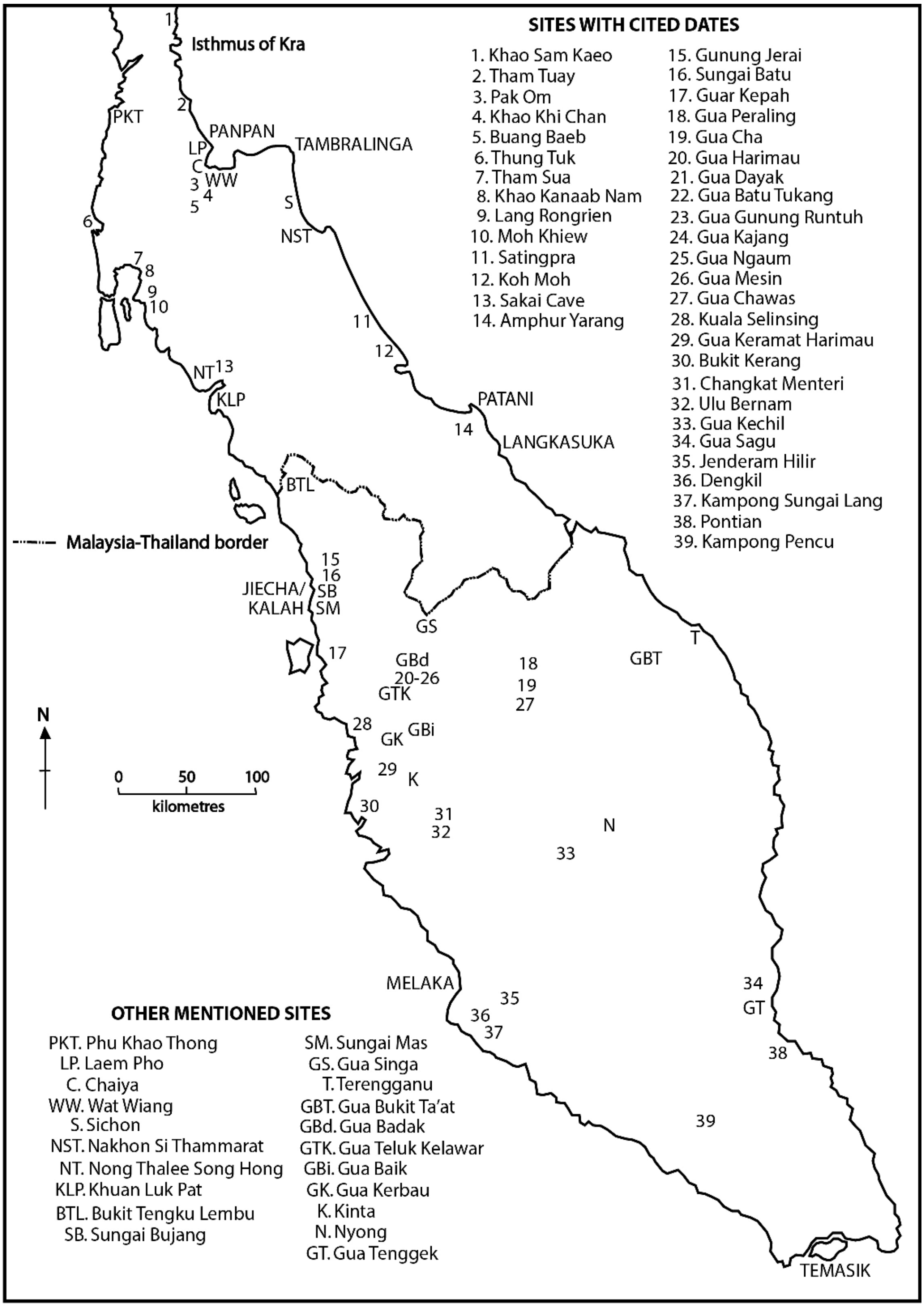


Figure 1: Southern Thai-Malay Peninsula; polities and sites mentioned in the text.

The previous paragraph hints at some of the topics for which the archaeological record is important for understanding the STMP's past over the "*longue durée*." One such topic is the diversity of the indigenous inhabitants, who not only include speakers of Malay—both Melayu Malay, the official language of Malaysia, and various Malay dialects—but also speakers of Aslian languages, which belong to the Austroasiatic language family (Benjamin 2002). Within Austroasiatic, the Aslian languages are most closely related to the Mon and Nyakur languages of Thailand and, at a more distant remove, Nicobarese, spoken on the Nicobar Islands to Sumatra's north (Sidwell and Blench 2011). There is a general agreement that the immigration of early Austroasiatic speakers to STMP was related to the local establishment of a Neolithic material culture, defined by the presence of polished stone artefacts and pottery and the absence of metal. However, it is equally clear that the pre-existing "Hoabinhian" material culture, based on river cobbles that were knapped and/or utilised, continued long after the incorporation of Neolithic material elements, before giving way to metal tools (Adi 2000; Bulbeck 2003).

The period when metals started being available to STMP communities is also considered by many scholars to tie in with the early presence of Austronesian speakers. The dialects they spoke probably did not include "Old Malay," the language of the early Sumatra states which evolved into Melayu Malay (Benjamin 1987; Bulbeck 2004). The early Melayu Malay kingdoms in STMP included some where Buddhism was initially the state religion, reflecting the influence of Buddhism over STMP polities during the preceding thousand years, and some that appear to have been Islamic sultanates from their inception (Hooker 2003). However, neither Buddhism nor Islam seems to have made much impression on the belief systems of Aslian speakers, or gained many converts from their ranks (until recent times). Aslian speakers have also followed lifeways that distinguish them from their Melayu Malay and Thai neighbours, including nomadic foraging in the rainforest and swidden horticulture in the highlands. Also, many have distinctive physical looks, with some groups characterised by wavy hair and other groups by dark skin and woolly hair (Benjamin 2002). Thus, while there would be no justification in viewing any of the Aslian speakers (or speakers of distinctive Malay dialects) as changeless relics from the past (Bulbeck 2011), their retention of "tribal" in preference to peasant lifeways, despite the contemporary establishment of peasantry as the majority lifeway in STMP, is an important consideration for the archaeological record to accommodate.

Some umbrella chronological terms will be introduced at this stage to facilitate our review of the archaeological record. "Pre-Neolithic" will cover the period prior to the availability of Neolithic material culture anywhere in STMP. "Neolithic" and "Early Metal Phase" will cover the succeeding periods defined respectively by the absence and presence of metals in STMP, with the transition dated to the last half-millennium BCE, based on the evidence for bronze and iron metallurgy at Khao Sam Kaeo on the Isthmus of Kra (Bellina-Pryce and Silapanth 2006; Murillo-Barraso et al. 2010). In addition, the term "protohistoric" will be used to cover the first millennium CE, for which there are sparse external references to STMP as well as a small corpus of local inscriptions (Jacq-Hergoualc'h 2002), whereas the better documented period after 1,000 CE will be glossed as "historical." The use of these terms does not imply that they were accompanied by uniform change across the study area; on the contrary, pronounced diversity in material culture and economic systems can be expected from the Neolithic onwards.

Quantification of the STMP chronometric dates involves distributing the probability area represented by the dates to 500-year intervals or "bins" up to 1,950 bp (before the present), back to 10,000–9,500 bp. The justification for choosing bin lengths of 500 years is presented towards the end of the Materials and Methods section. As detailed in that section, my literature survey came across 39 STMP sites (one unprovenanced) with dates that are acceptable for quantification. Performance of this exercise does not imply blind acceptance of the results. Instead, the dates will be analysed for the reliability of the profile they represent, both in terms of potential shortcomings with the dates themselves, and broader considerations that temper a literal interpretation of the results.

## MATERIALS AND METHODS

The materials used in the present analysis are radiocarbon (RC) and Accelerator Mass Spectrometry (AMS) dates that can be calibrated, and luminescence (optical luminescence [OSL] and thermoluminescence [TL]) dates. Calibration of RC and AMS dates (together referred to as C14 dates) is a necessary step to account for changes over time in the atmospheric concentration of radioactive Carbon-14. The standard convention is for the determinations themselves to be cited as BP (radiocarbon years before the present) but as bp (calendar years before the present) after calibration. Luminescence dates do not need calibration and so are all expressed here as bp.

Only dates from archaeological sites or objects are included, and only those for which there are not good reasons to exclude them. Radiocarbon dates on freshwater shellfish from limestone regions are excluded, as the shellfish would have ingested "dead" carbon that renders the date too old by an unknown amount of 1,000 years or more (Spriggs 1989; Bulbeck 2003). "Modern" radiocarbon dates are also excluded as they cannot be calibrated. Other excluded dates and their reason for rejection (see text below) are presented in Table 1.[**] The accepted dates, along with their aspect, site use, and class of dating material (explained below) are presented in Tables 2 to 19.

The implicit assumption with a chronometric date is that it refers to a specific "age" or point in time. Most dates are published in the form of a normal distribution of what this specific age is. The date is given as the median estimate of the true age, and the range above and below the median estimate (that is, the standard error) that would cover 68.4 percent of the probability of including the true age.

In the case of luminescence dates, which do not require calibration, their presentation as a normal distribution is literally correct. Therefore, the range represented by two standard errors above and below the median estimate covers 95.4 percent of the probability of including the true age, and the range represented by three standard errors above and below the median covers 99.7 percent of this probability. For instance, with UW2083 from Sungai Batu (1900 ± 100 bp, Table 11), there is a 68.4 percent probability that its true age lies between 2,000 and 1,800 bp, while (effectively) the remaining 31.6 percent of the area of the probability distribution is evenly split between a 15.8 percent probability that the true age falls between 2,200 and 2,000 bp and a 15.8 percent probability that it falls between 1,800 and 1,600 bp. In terms of 500-year intervals, then, the probability that UW2083 refers to a time between 2,500 and 2,000 bp is 0.158, while the probability that it refers to a time between 2,000 and 1,500 bp is 0.842.

Radiocarbon dates do not conform to the same easily calculable "normal distribution" after calibration. However, as explained below, the Oxcal program (Bronk Ramsey 2013) for Intcal 09—the latest released calibration standard at the time the research for this paper was complete—allows these dates to be expressed in terms of how probable the true age lies within one or the other 500-year period. Unfortunately, this is not the case with radiocarbon dates published in terms of their 95.4 percent confidence interval (for instance, the dates from the Bernam cist graves in Table 17), which require special treatment, as also explained below.

To be calibrated, radiocarbon dates on marine shell (Tables 10 and 18) need to take account of the ocean reservoir effect, which varies across the ocean's surface. The recommended practice is to use the delta R correction factor at the closest location for which this factor has been calculated, which for STMP is Singapore (–15 ± 38). Using the Oxcal program, it is possible to calibrate marine shell dates in terms of their 68.2 percent range, 95.4 percent range and 99.7 percent range. From these results it is possible to estimate the approximate proportion of the calibrated date to be assigned to 500-year bp intervals.

With the other C14 dates, when cited as years BP, their 100 percent probability area can be accurately assigned to 500-year bp intervals. The Oxcal program for Intcal 09 includes presentation of the calibrated date in terms of its probability by 5-year intervals, which can accordingly be summed into 500-year probabilities. While the resulting probability distribution of the date should be accurate, how the date may relate to the object or event of archaeological interest is another issue. Some tropical trees can live for hundreds of years, and their inner trunk can contain an "inbuilt age" that would exaggerate the age of the wooden object made from the tree or the charcoal obtained from burning the tree's timber. When there are multiple dates from the same object, as in the case of the Kampong Sungai Lang canoe containing two Dongson bronze drums (Tables 1 and 19), this problem of potential age exaggeration can be mitigated to some degree by electing to use the least old date. However, even here it would have to be understood that any determination on timber or wood charcoal stands as a maximum estimate of the age of archaeological interest.

RC dates on bone processed before 1993 are often considered unreliable on the grounds of inadequate pre-treatment procedures to date bone samples (Spriggs 2003). However, this would not seem to be a serious concern for Khao Khi Chan, which is the STMP site most dependent on bone dates for its chronology. The available dates on charcoal from layer 5 (near the top of the site) and layer 2 (near the bottom of the site) effectively envelope the large number of accepted bone dates from the site, which themselves are consistent with each other (Table 7) While the three rejected bone dates from Khao Khi Chan (Table 1) include two that appear to be younger than the other bone dates from the site, the specific grounds for their rejection is that they have a larger standard error than any of the accepted dates from the site. After these three dates are excluded, the N-TP-1 dates consistently increase in age with depth, as would be expected of a habitation deposit, while the TP-1 dates show only a weak tendency to increase in age with depth, as would be expected of a deposit disturbed through repeated interments of the deceased (Table 7). It is also worth noting that the single available bone date on a Gua Cha Neolithic burial (BM-946) is entirely consistent with the charcoal date obtained from the base of the Neolithic habitation deposit (ANU-2217), and in fact is arguably more reliable for dating the Gua Cha Neolithic based on its much smaller standard error (Table 13).

While a relatively large standard error always impairs the usefulness of a date, some dates with a standard error greater than 200 years are accepted for this study (Tables 3, 6, 8, 13 and 15), for otherwise the sites involved could not be included in the present survey. The relevant criterion used by Spriggs (2003) is to reject dates with a standard error in excess of 400 years, which is suitable for this study's purposes too.

A final issue regarding general criteria to accept or reject dates relates to dates published only in terms of their 95.4 percent confidence interval, after calibration. Let us entertain the simplifying assumption that these calibrated dates conform to a normal distribution, to allow their median and standard error to be back-calculated from their 95.4 percent confidence interval. The validity of this assumption can be tested with reference to all the accepted C14 dates (excluding those on marine shell) that are expressed in terms of their median and standard error (BP). Since these can be expressed in terms of the distribution of their 100 percent probability to 500-year intervals, and also in terms of their 95.4 percent confidence interval (bp), we can also determine the accuracy of assigning their 100 percent probability to 500-year intervals from back-calculation of their calibrated median and standard error from their 95.4 percent confidence interval (This test was undertaken using only the results from Intcal 09 calibration, whereas earlier released calibration standards were used for the calibration of the dates that would be useful for this study but are published only in terms of their 95.4 percent confidence interval. However, the difference between Intcal 09 and these earlier standards in terms of the resulting 95.4 percent confidence interval is generally slight).

The point is that if the back-calculated median sits well away from any 500-year boundary, and the back-calculated standard error is small, then the entire date will be assigned to the same 500-year interval whichever of the two calculation methods is used. Further, if it would take two or more back-calculated standard errors to reach the 500-year bp boundary closest to the back-calculated median, then the difference between the probability distribution (by 500-year intervals) resulting from back calculation from the 95.4 percent confidence interval, and the actual probability distribution obtained with Intcal 09, is no more than a couple of percent (Figure 2). However, when the back-calculated median gets closer to a 500-year bp boundary in terms of the number of back-calculated standard errors, the difference between the "simulated normal" and "actual" probability distributions can become quite large. It can reach 20 percent or more (per 500-year interval) if there is less than one back-calculated standard error between the back-calculated median and the closest 500-year bp boundary. When there are between one and two standard errors to the closest 500-year bp boundary, use of dates expressed only by their 95.4 percent confidence interval shifts from unreliable to reliable. Let us use an expected difference of 5 percent (the conventional confidence level for statistical significance) between the "simulated normal" and "actual" probability distributions as the point at which to reject dates expressed only in terms of their 95.4 percent confidence interval.

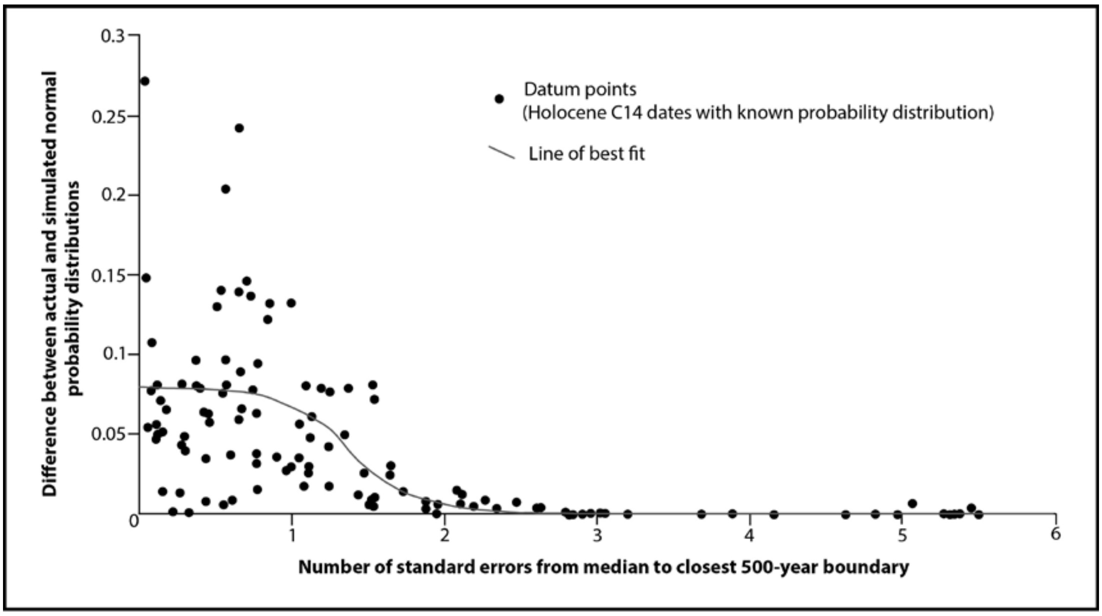


Figure 2: Differences between actual and simulated normal distribution by 500-year intervals for STMP calibrated Holocene C14/AMS dates (excluding marine shell dates).

XLSTAT was used to investigate the best fitting non-linear regression model between the two variables of interest. The model that is both simple and also reasonably predictive (*r* = 61.6 percent) is shown in Figure 2. Based on this model, and applying the ceiling of a 5 percent expected difference, we would only accept dates whose back-calculated median was at least 1.4 back-calculated standard errors from the closest 500-year bp boundary. Accordingly, with the STMP C14 dates published only in terms of their 95.4 percent confidence interval, seven are accepted for having their back-calculated median at least 1.4 back-calculated standard errors from the closest 500-year bp boundary (Tables 3, 8 and 17), while two are rejected for failing to meet this criterion (Table 1).

Independent of the question of which STMP dates to accept is the question of how to quantify the dates that are accepted. By way of example, consider the 15 Khao Sam Kaeo dates that cluster tightly between 2,500 and 2,000 bp (Table 2). While they make it virtually 100 percent certain that the site was occupied at some stage during this interval, summed together they would amount to nearly 1,500 percent. Treated this way, we would obtain a picture of high levels of site occupancy at 2,500–2,000 bp just on the basis of intensive research at one site. A more balanced approach would be to estimate the number of sites occupied per 500-year interval, which, in the case being discussed here, would involve capping Khao Sam Kaeo's probability at 100 percent for 2,500–2,000 bp. This can be done by calculating the complement of the probability that there are no dates from the site referring to a particular interval.

A useful example of how this works is provided by the Sungai Batu dates in terms of whether it was occupied at any point between 2,500 and 2,000 bp. There are two dates (one discussed previously) that have a 0.158 probability of falling in this period, while the probabilities that the radiocarbon date and the other OSL date fall within this period are both 0.000 (to three places). Therefore, the four dates' probabilities of not falling in this period are 0.842, 0.842, 1.000 and 1.000, and the probability that none of them fall in this period is the product of these four probabilities, or 0.708. Therefore, the probability that at least one of the available dates refers to 2,500–2,000 bp is the complement of 0.708, that is, 0.292 (Following the same approach for the 2,000–1,500 bp interval, the probability that at least one of the four Sungai Batu dates refers to this period is 1 – (0.158 * 0.158 * 0.000 * 0.000), or 1.000 to three places).

Restricting the discussion to Khao Sam Kaeo and Sungai Batu, we can add their respective 1.000 and 0.291 probabilities of occupancy at some point between 2,500 and 2,000 bp, to arrive at 1.291 as our best estimate of the number of these sites occupied during this period. Extending our consideration to other sites with any probability (on the available dates) of occupancy for 2,500–2,000 bp, we can continue to sum probabilities to arrive at our best estimate of the number of Malaya sites occupied during this period. This procedure resembles the "summed probability" approach frequently used in quantifying chronometric dates (for example, Williams 2011), except that the site rather than the date probabilities are summed.

Site occupancy probabilities can also be used as the term to be summed for investigating chronological changes in site use. Returning to the 2,500–2,000 bp AMS dates from Khao Sam Kaeo (Table 2), we can see that the majority relate to the industrial activities undertaken at the site (production of ornaments of glass and semi-precious stone as well as metalworking), but there is also one date relating to a mortuary interment, and several dates that relate to miscellaneous habitation activities (including construction of the site's earthen walls). Accordingly, Khao Sam Kaeo contributes a probability of 1.000 (or value close to this) to the sum of sites with evidence for industrial activity, for mortuary activity, or for "habitation" during the 2,500–2,000 bp interval. This does not amount to triple counting of Khao Sam Kaeo, instead it reasonably reflects the wide variety of activities undertaken at this major site. In the study presented here, the six site use or activity categories are "Mortuary" (associated with the ritual disposal of the remains of the deceased), "Ceremonial" (associated with rituals other than the disposal of the deceased's remains), "Industrial" (associated with specialist craft working), "Transport" (in STMP's case, boat remains and the Sungai Batu jetty), "Gardening" (including forest clearance in preparation for planting), and "Habitation" (any evidence of site occupancy not assignable to one of the preceding categories). This order also expresses the order of precedence for dates that cover more than one category; for instance, the Kampong Sungai Lang canoe date (noted above) is not counted as a Transport date because the Ceremonial category takes precedence in its case.

For the purposes of analysis, dates are also assigned to the class of material that provided the date. In order of precedence, the categories are "Ceramic," "Boat," "Human bone," "Marine shell," "Charcoal," "Animal matter" and "Plant matter." The Ceramic category includes any dates directly associated with ceramic material, including dates on charcoal extracted from ceramic objects as well as luminescence dates on pottery and bricks. The Boat category includes any dates from boat-shaped objects or their parts. The Human bone and Marine shell categories cover cases of dated materials identified to these classes whether burnt or not. The charcoal category covers carbonised samples that either include both plant and animal matter (as with the 1,065 ± 50 bp date from an elephant cremation at Satingpra, Table 3) or which are described in no further detail than "charcoal." The Animal matter and Plant matter categories cover uncarbonised to lightly carbonised samples with the identifications detailed in Tables 3 to 19.

In addition, dates are categorised according to the "aspect" of the site at the time referred to by the date. The "Closed" category covers all dates from caves and rockshelters, including deposits described as marine or freshwater shell midden. Categories that may apply to open-air sites, in order of precedence, include "Monumental" (notably, fortifications and megalithic structures), "Maritime" (in STMP's case, estuarine sites including the dates from the Kuala Selinsing offshore islands), "Marine midden" (open-air middens built up from marine shell) and "Freshwater midden" (open-air middens built up from freshwater shell, none dated in STMP's case). When none of these categories apply, the site's aspect is categorised as miscellaneous "Open." Note that a site's aspect can change over time. For instance, the concentration of 2,500–2,000 bp dates from Khao Sam Kaeo strongly indicate that its remnant fortifications date to this period, whereas at other times the site was merely Open rather than Monumental. Site aspect is critical to understanding chronological changes in STMP's chronometric documentation. Accordingly, the histograms that present the estimated numbers of sites per 500-year interval (see Results) will present the bars in terms of their site-aspect composition.

An interval size of 500 years is chosen as a unit of time that is sufficiently fine-grained to register dynamic changes in STMP's occupation history but that also caters for the frequent imprecision and incomplete accuracy of the available dates. By way of illustration, if all STMP sites were as well documented as Khao Sam Kaeo, in terms of a large number of dates with small standard errors, then the analysis undertaken here could be performed in terms of more discrete intervals of a century or so. If on the other hand all sites were as loosely documented as Gua Cha, covered by just five dates including three with standard errors in excess of 200 years (Table 13), then there would be no basis for analysis at any finer level than the millennial scale. The chosen interval of 500 years stands as a compromise between these extreme examples. It also allows some "slack" for minor inaccuracies that may be associated with calibrating marine shell dates with reference to Singapore's delta R correction factor, or assuming that a date derived from tree timber refers to the exact age of the event or artefact of archaeological interest.

Finally, the current analysis is presented as a reasonable summary of current knowledge on the chronometric dating of STMP's Holocene archaeology. There are certainly further dates not covered by this survey, for instance, dates published in local literature that I could not access or dates still being prepared for public release. And of course, investigations into STMP's archaeology will continue into the future. However, any attempted synthesis of an area's archaeology is constrained by the current documentation available to the scholar, whether that synthesis takes an explicitly quantitative approach (as here) or mixes qualitative and quantitative concerns. The advantage of an explicitly quantitative approach is that it generates clear hypotheses that future research may either falsify or confirm.

## RESULTS

For an overview of the analytical results we start with the estimated number of occupied sites per 500-year interval (Figure 3). The results suggest an early period of site occupancy, with approximately two to six documented sites between 10,000 and 4000 bp, and a late period of site occupancy, peaking at over ten documented sites at 1,500–1,000 bp. The decline in chronometric documentation after 1,000 bp is readily explicable in terms of the copious chronological information available for most sites under occupation during later times. This information includes detailed historical documentation (e.g., Chinese, Malay and European/colonial texts, and local oral history) as well as tightly dated, mass-produced artefact types such as imported Chinese, Mainland Southeast Asian and European ceramics (e.g., Guy 1986; Harrisson 1995).

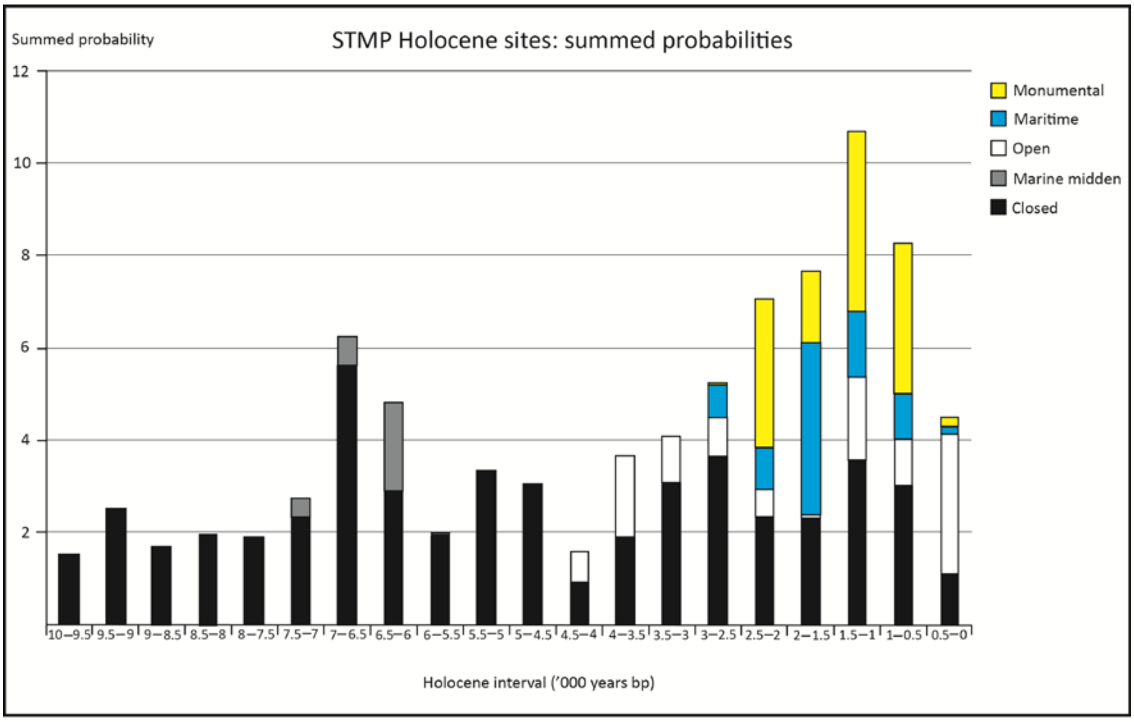


Figure 3: Estimated number of STMP sites occupied by 500-year Holocene interval.

Occupation of closed sites is documented as a pan-Holocene phenomenon, fluctuating between approximately one and four sites per 500-year interval. Although closed sites are attractive to prehistorians because of their relative permanency in the landscape, evidence for their occupation is susceptible to "taphonomic" loss over time (e.g., Williams 2011). This is due to a greater time period for the deposit to have been scoured away or the incorporated materials to be degraded beyond the point where they would be useful for dating. This taphonomic effect however could not explain the low points in documented occupancy of closed sites at 500–0 bp or (with respect to earlier times) at 4,500–4,000 bp. The 500–0 bp dip can be explained in a number of other ways, including the recovery of mass-produced artefacts that obviate the need for chronometric dating (Bulbeck 2003), prehistorians' disinterest in rockshelter deposits that are obviously of historical antiquity, and the availability of local, ethnohistorical documentation to account for finds that date to the last several hundred years (e.g., Hamid 2007; Hongo and Auetrakulvit 2011). None of this would apply to the 4,500–4,000 bp dip, and so we may provisionally hypothesise that the occupancy of closed sites decreased at this time with respect to the 10,000 to 4,500 bp period.

Open-air sites are even more susceptible to taphonomic loss than closed sites, and many that are preserved have survived through deep burial in alluvial sediment. In fact, the oldest open-air sites are three marine shell middens, dating to around the seventh millennium bp that originally accumulated when littoral dwellers piled their food refuse into hillocks at a time of high sea-level stands. The shell contents cemented these hillocks into durable sites even after the coastline had retreated through the combination of a fallback in sea-level and the build-up of deposit along the coastal plain. This build-up of coastal deposits accounts for the preservation of the majority of the oldest of the other open-air sites, discovered fortuitously during tin mining exploration (Jenderam Hilir, Table 16) or geomorphologic investigations (Table 19). The other, oldest open-air site was recovered on elevated land within the precincts of Khao Sam Kaeo (Table 2), whose earthen walls created a local depositional environment upon their decay. On current documentation, 4,500 bp is the floor for open-air Holocene sites in STMP, apart from the special case of its marine shell hillocks. We can be certain that the inhabitants were widely distributed across the landscape before 4,500 bp. However, almost all traces of their open-air occupation have either been eroded away or buried to inaccessible depths, combined with degradation of these traces and/or their poorly diagnostic nature (for instance, flaked stone that could date to almost any time since *Homo* first arrived in the Peninsula).

In summary, STMP's Holocene chronometric dates provide a record of continuous occupation of closed sites, and two periods of open-air sites. The first of these periods is represented by early-middle Holocene marine shell middens and the second by a variety of open-air sites postdating 4,500 bp. While the 4,500–4,000 bp interval is most sparsely represented, this can be attributed to a decrease in closed-site occupancy at this time, combined with the difficulties in retrieving early, open-air archaeological sites.

Figure 4 focuses on habitation evidence from STMP Holocene sites. The major difference from Figure 3 is the decrease in site numbers postdating 4,000 bp, affecting both closed and open-air sites. There is also a minor decrease in the numbers of closed sites for the 6,500–4,500 bp period. As will now be reviewed, the 6,500–4,500 bp and post-4,000 bp periods correspond to peak times for other forms of site use in addition to habitation.

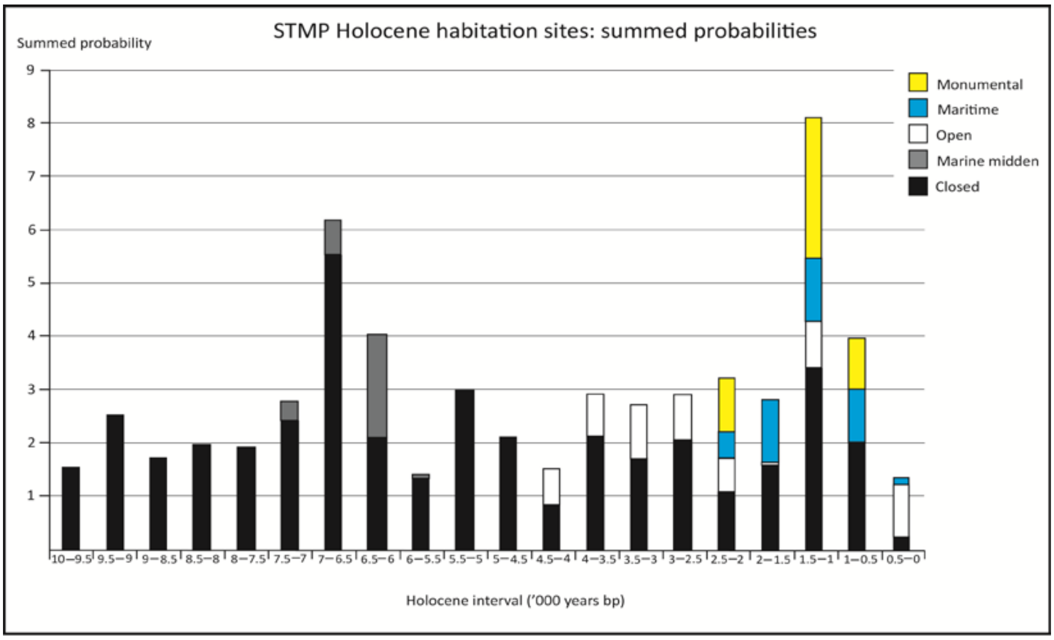


Figure 4: Estimated number of STMP sites with habitation site use, by 500-year Holocene interval.

One such site use involves mortuary interments. Directly dated mortuary interments in closed sites are largely restricted to two periods: 6,500–4,500 bp and 4,000–1,500 bp (Figure 5). However, site numbers are small, and future research may well document a wider chronological use of closed sites for Holocene human burials. Closed sites are complemented by open-air sites for evidence of late Holocene mortuary interments, including pre-fortified Khao Sam Kaeo in the fourth millennium bp, a number of monumental sites spanning 2,500–1,000 bp, and the maritime Kuala Selinsing site in the second millennium bp. The last millennium bp is barely represented in terms of chronometric documentation of mortuary remains, for a variety of reasons (for instance, the sacrilege of excavating Islamic burial grounds), despite the large number of STMP burials known to date to historical times.

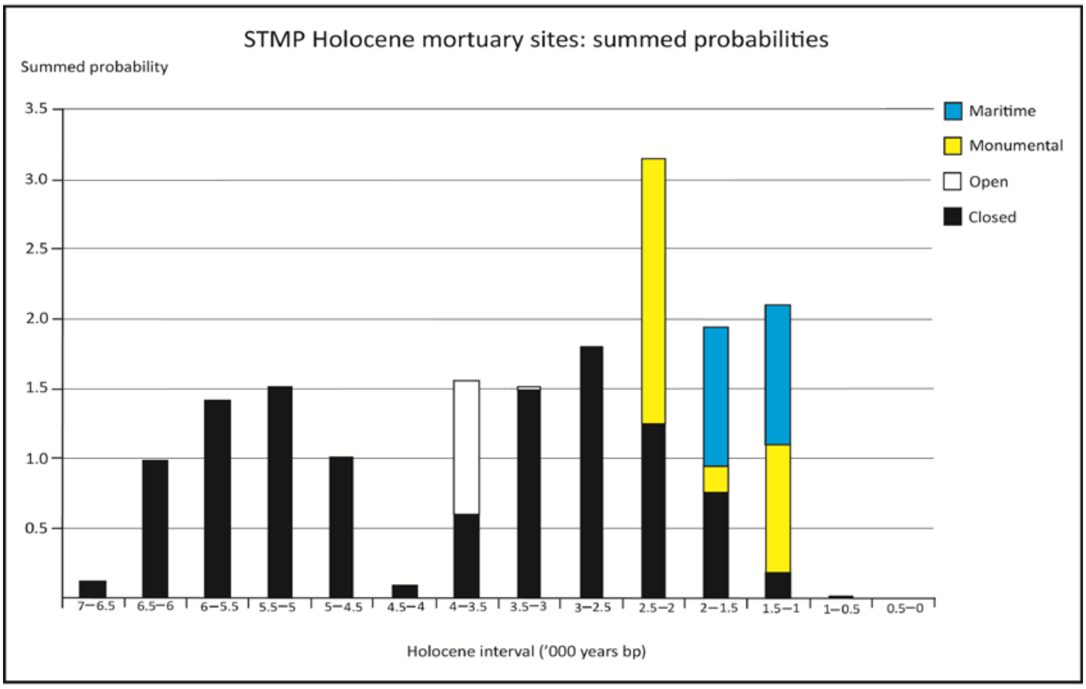


Figure 5: Estimated number of STMP sites with mortuary site use, by 500-year Holocene interval.

Turning to site uses for transport, ceremonies, industry and gardening, we find that their chronometric documentation in all cases is restricted to the last 3,000 years bp. The number of transport sites peaks at 2,000–1,500 bp (Figure 6). However, the NZ4489 date on one of the Dengkil boats (Table 19) refers to the third millennium bp, and historical sources make it clear that maritime transport remained very important in STMP after 1,500 bp. The presence of ceremonial sites (and objects) is well-documented only after 2,000 bp (Figure 7), but this perspective may well change if the lengthy sequence of cave art at Gua Tambun (Tan and Chia 2012) could be chronometrically documented. Sites with a chronometrically dated industrial use are restricted to three (Khao Sam Kaeo, Sungai Batu and Koh Moh), and these together provide 100 percent confidence in the existence of industrial sites at 2,500–2,000, 2,000–1,500 and 1,000–500 bp (Figure 8). Finally, gardening sites are documented only as of 1,500 bp (Figure 9), which is consistent with the 930 BP determination for the study area's only directly dated rice remains (Table 13).

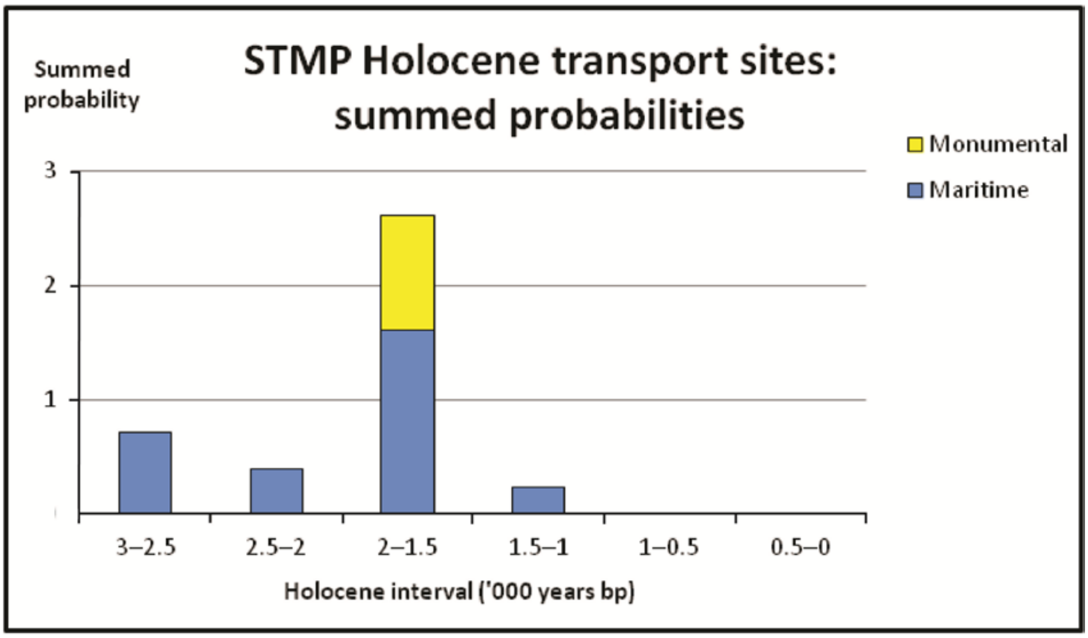


Figure 6: Estimated number of STMP sites with transport site us, by 500-year Holocene interval.

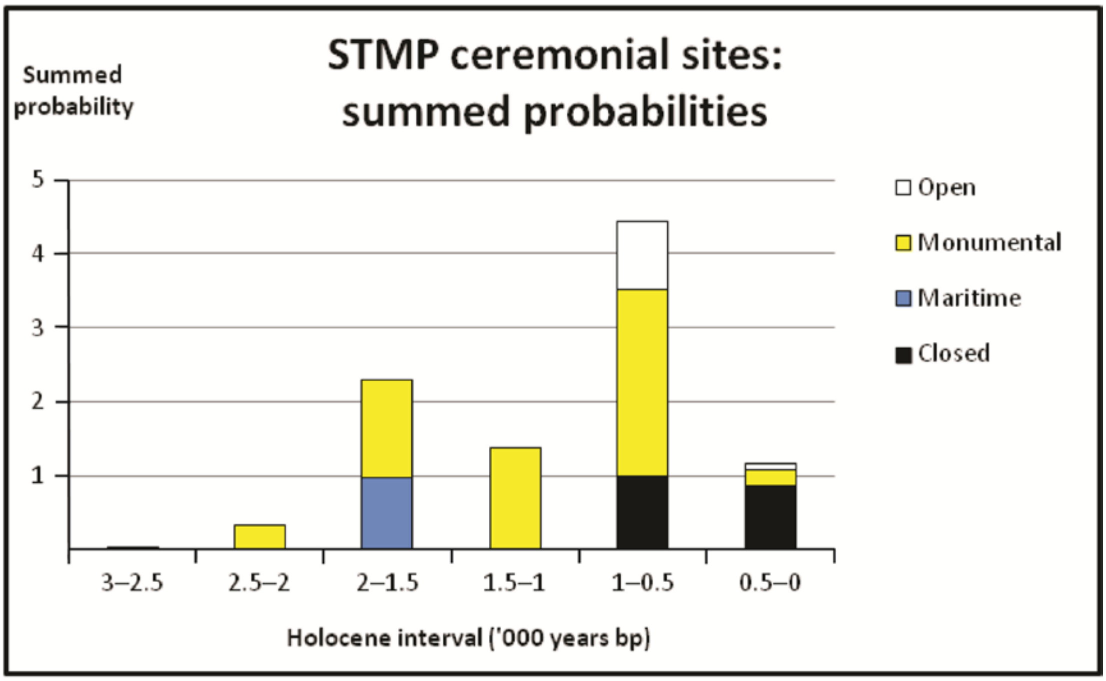


Figure 7: Estimated number of STMP sites with ceremonial site use, by 500-year Holocene interval.

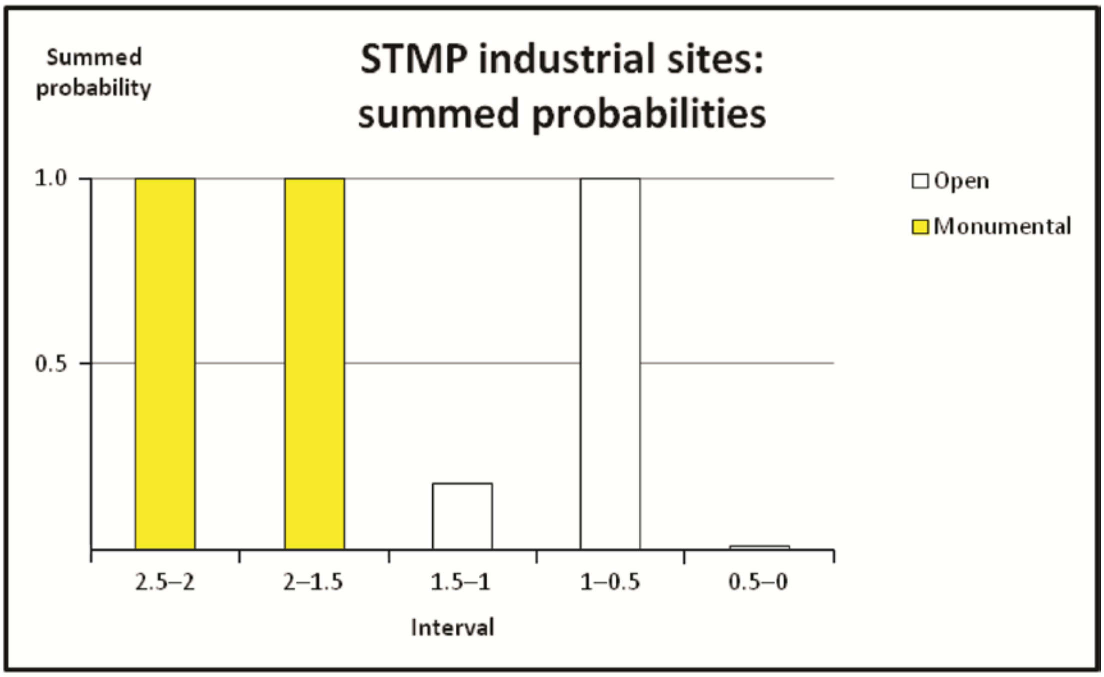


Figure 8: Estimated number of STMP sites with industrial site use, by 500-year Holocene interval.

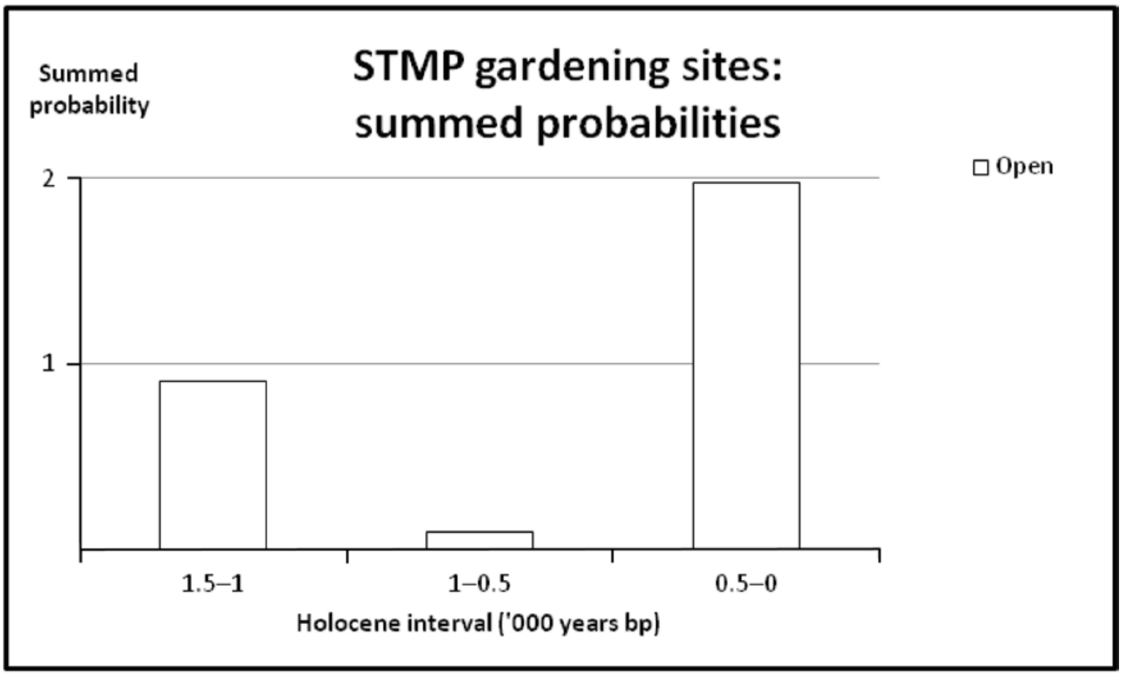


Figure 9: Estimated number of STMP sites with gardening site use, by 500-year Holocene interval.

With respect to classes of material used for dating purposes, charcoal is the single most important material for dating STMP sites, including sites dated to every 500-year Holocene interval (Figure 10). The available coverage is not constant over time. There are two peaks, at 7,000–6,500 bp and 1,500–1,000 bp, which correspond to the peaks observed for occupied sites overall (Figure 3). There are also three 500-year dips, at 8,000–7500, 6,000–5,500 and 4,500–4,000 bp.

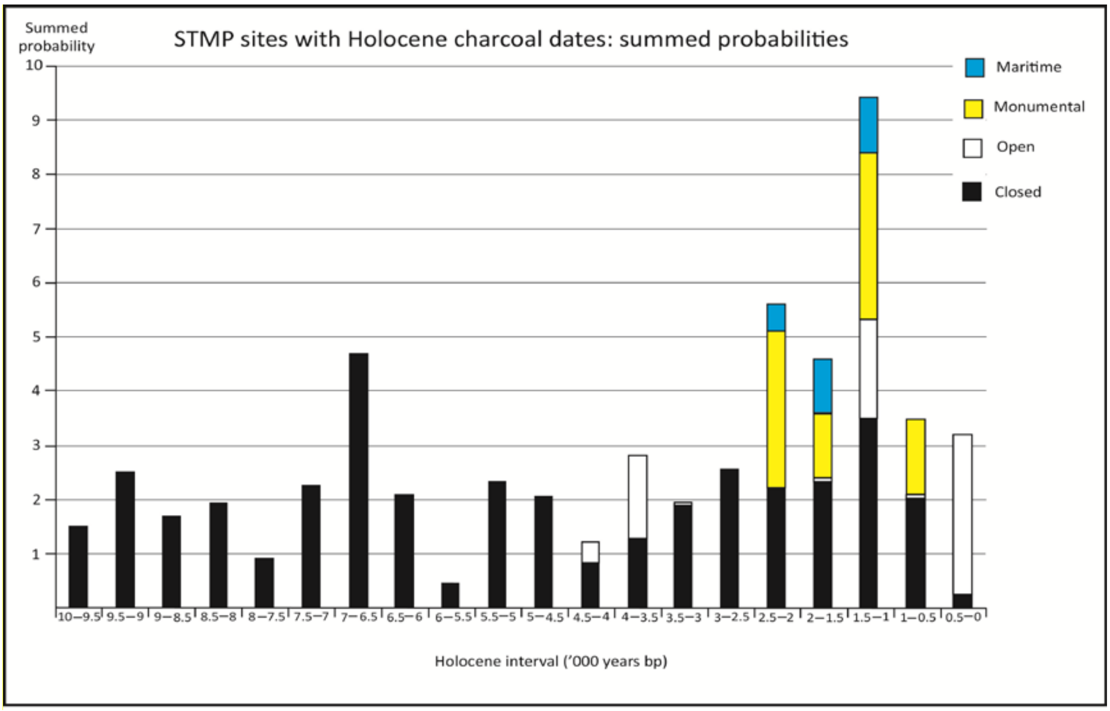


Figure 10: Estimated number of STMP sites with charcoal dates, by 500-year Holocene interval.

Figure 11 presents the numbers of sites dated by plant matter, mainly wood (excluding dates on boat timber, which are treated separately) but also including the Gua Cha date on rice remains. Figure 12 presents the number of sites dated by marine shell, which include the early-mid Holocene marine shell hillocks and three dates of around 1,000 years bp from Kuala Selinsing. Both graphs are similar in referring to the chronometric documentation of sites both before and after, but not during, the middle Holocene. Curios of marine shell have been recovered from transitional Pleistocene-Holocene contexts at Moh Khiew and Sakai Cave and upper Holocene contexts at Gua Kerbau, Gua Sagu and Gua Tenggek, while marine shell jewellery is associated with Neolithic burials at Sakai Cave, Lang Rongrien, Gua Cha and Gua Harimau (Pookajorn 1996; Bulbeck 2003, 2011). Direct dating of these finds could serve as a critical test for the disuse of closed sites at 4,500–4,000 bp hypothesised on the basis of the currently available dates.

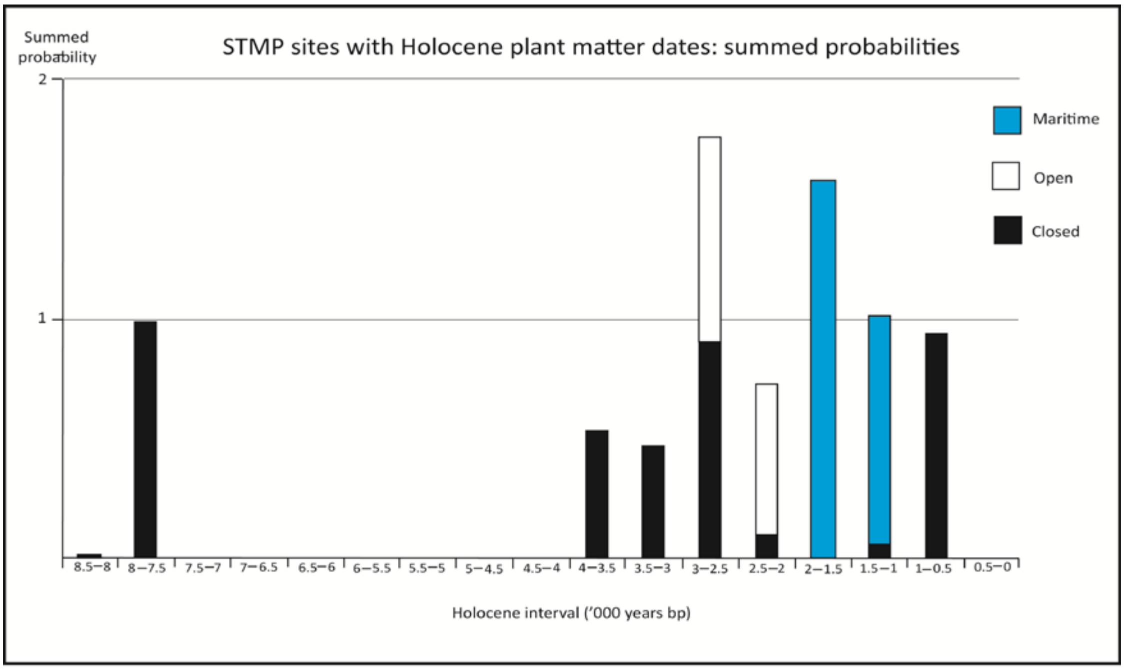


Figure 11: Estimated number of STMP sites with plant matter dates, by 500-year Holocene interval.

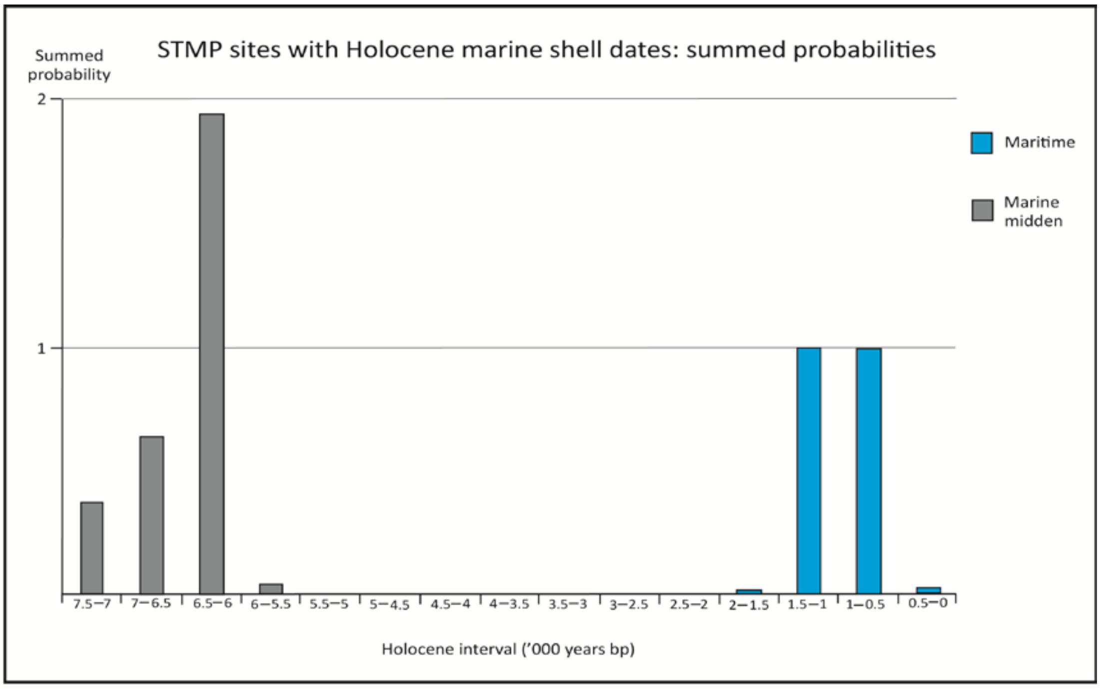


Figure 12: Estimated number of STMP sites with marine shell dates, by 500-year Holocene interval.

The chronometric documentation of STMP sites with accepted human bone dates produces a coherent, early peak focused around the sixth millennium bp, complemented by late Holocene dates from Gua Cha and Khao Sam Kaeo (Figure 13). The early peak summarises the chronology of the Khao Khi Chan and Buang Baeb burials, the main STMP burial sites with published dates from human bone. A project currently underway to extend the direct dating of the Gua Cha burials (Charles Higham, pers. comm. 3 September 2012) may substantially change any future counterpart to Figure 13. The available, accepted dates from animal bone refer to the same period and the same sites as the Khao Khi Chan and Buang Baeb human bone dates, but there are also landsnail dates from Gua Ngaum and Pak Om (Figure 14).

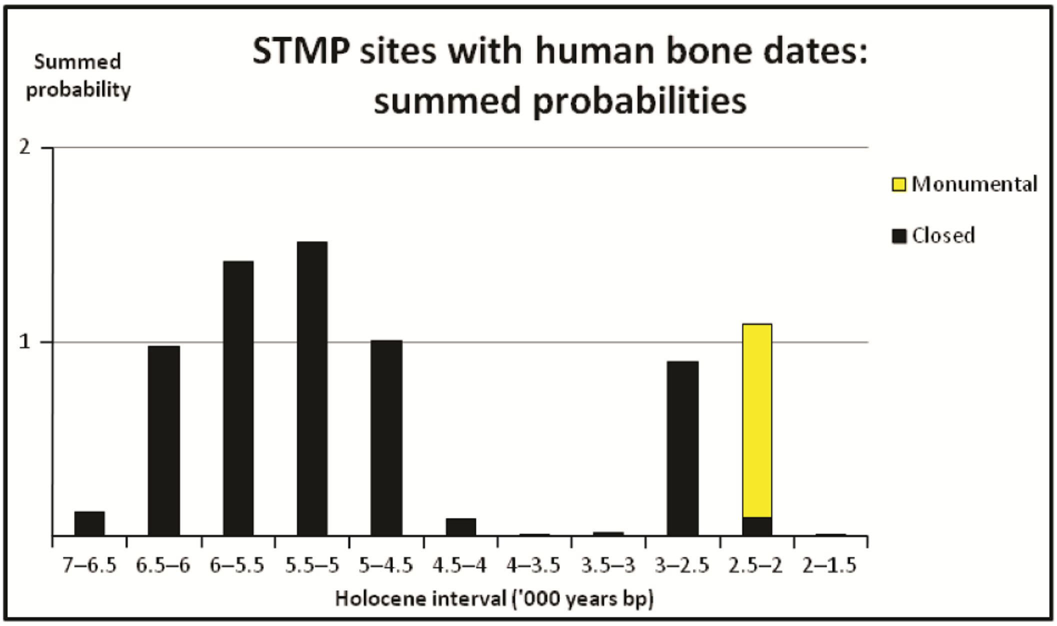


Figure 13: Estimated number of STMP sites with human bone dates, by 500-year Holocene interval.

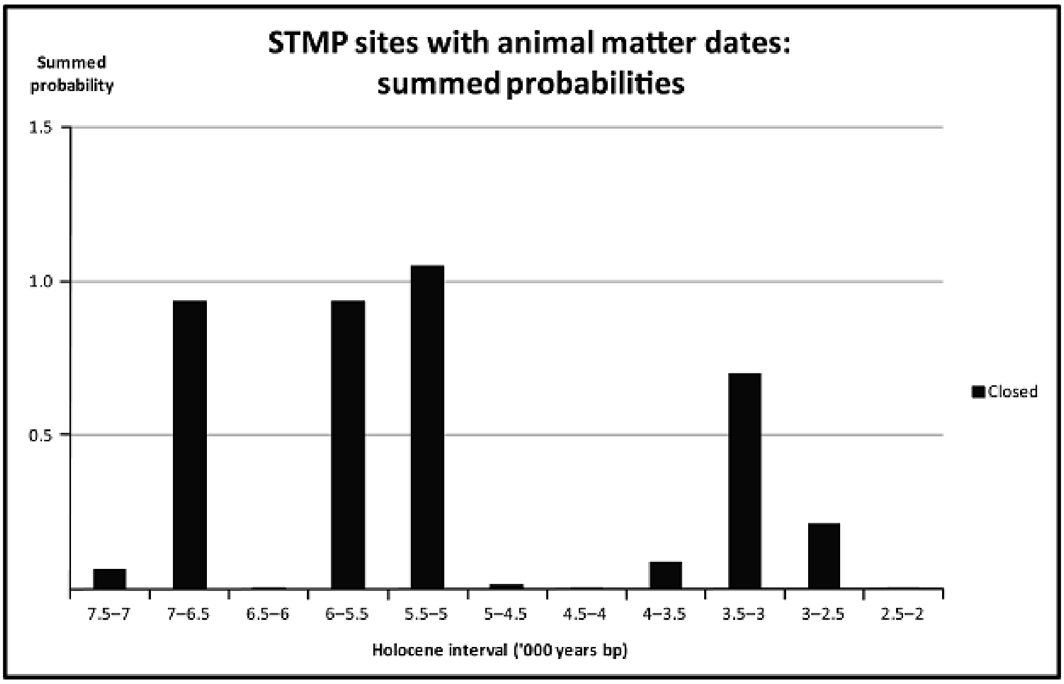


Figure 14: Estimated number of STMP sites with animal matter dates, by 500-year Holocene interval.

Figures 15 and 16 are of archaeological interest in their representation of direct dates from material technology known to have been important during the late Holocene. Dates from ceramic objects demonstrate the presence of ceramics in STMP by the early fourth millennium bp, but also hint at a particular importance of ceramic material culture circa 2,000–500 bp (Figure 15). On current evidence, the presence of ceramics in STMP at other times would need to be determined on grounds other than the direct dates from ceramic items. As for the production of watercraft in Malaya, the NZ4489 date from Dengkil indicates origins by the third millennium bp, although the boat dates peak strongly at 2,000–1,500 bp (Figure 16).

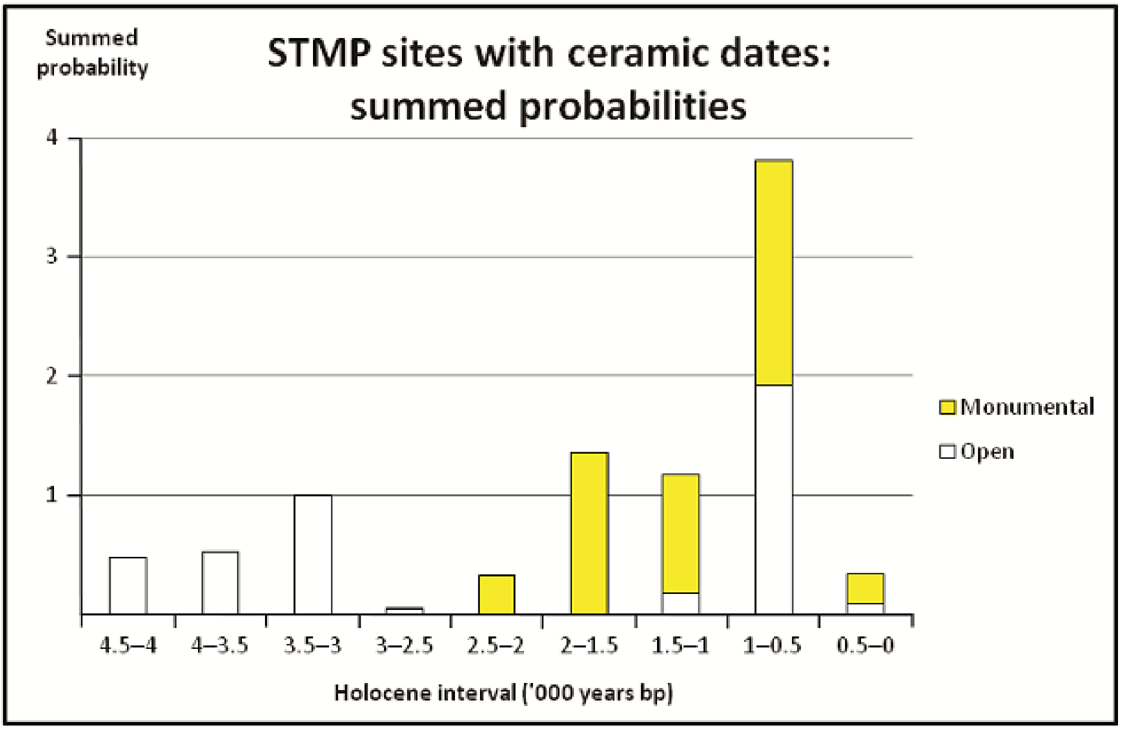


Figure 15: Estimated number of STMP sites with ceramic dates, by 500-year Holocene interval.

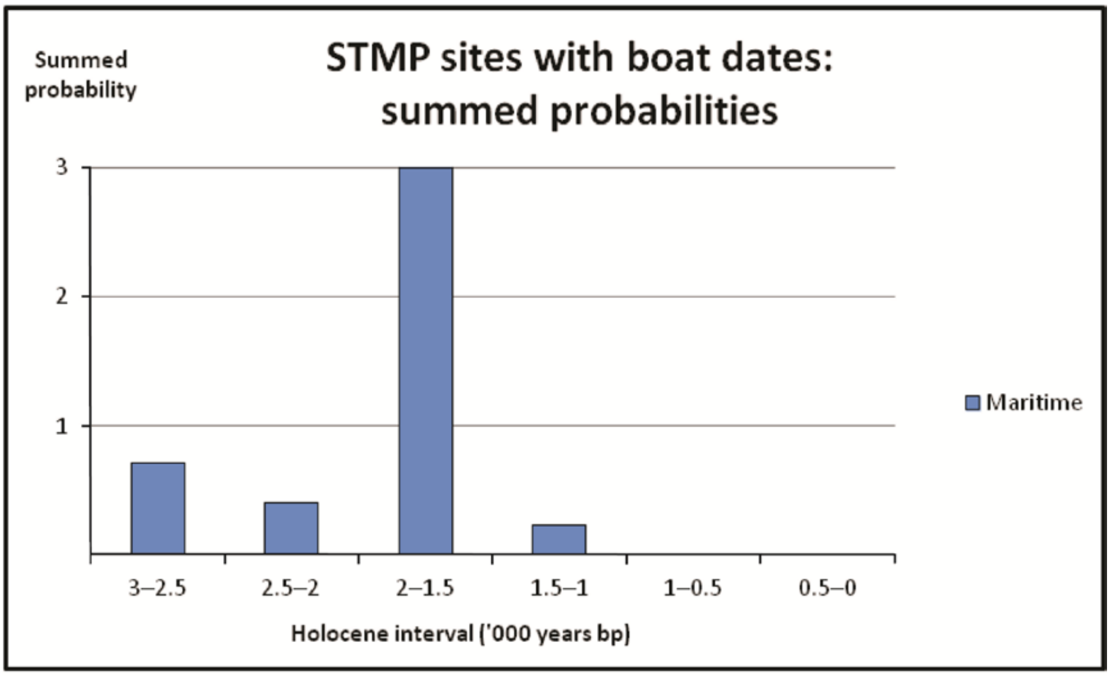


Figure 16: Estimated number of STMP sites with boat dates, by 500-year Holocene interval.

## DISCUSSION

Figure 3 understates archaeologists' understanding of the level of occupancy of closed sites in STMP during the Holocene. This is because of the tendency of archaeologists working on limestone rockshelters in Peninsular Malaysia during the 1980s and 1990s to obtain some or all of their RC dates from samples of freshwater shellfish. The median estimates obtained for these dates stand as a reasonable estimate of their median calendrical age, at least for early Holocene and earlier dates. This is because calibration of RC (and AMS) dates tends to make them older than their conventional expression (based on a half-life of 5,568 years for radioactive Carbon-14). This discrepancy increases with the dated sample's age, offsetting the overestimation of the dates obtained on freshwater shellfish in limestone regions (noted above). Therefore, let us attempt a broader perspective on the occupancy of STMP closed sites by factoring in median dates on freshwater shell, and (for reasons to become clear) additionally incorporate evidence for the terminal Pleistocene occupation of STMP closed sites (Table 20). In this exercise, the middle Holocene period will be presented as half-millennia to closely monitor what appears to have been a time of significant change in the occupation of closed sites.

As noted previously (Bulbeck 2003), there is virtually nil evidence for the occupation of closed sites in STMP dating to the Late Glacial Maximum at around 18,000 bp, arguably because the coastline lay far from any present-day land-based sites. Thereafter, evidence for the occupation of these sites steadily increases during the closing millennia of the Pleistocene and the early Holocene, corresponding to when the coastline rose towards its present position. However, a refinement to this perspective is now available, in that the peak periods of closed-site occupation apparently include the Pleistocene-Holocene transition and the 7,000–6,500 bp interval, both characterised by documented evidence for eight to ten closed sites (Table 20, last column). After 6,500 bp, documented occupation of closed sites decreases to a documented level of six sites or less at any time, including a virtual abandonment at 4,500–4,000 bp.

In addition to the evidence for chronological changes to the occupation levels of closed sites, the nature of the occupation appears to have changed over time. Although care should be exercised in accepting any date for a rockshelter burial apart from direct dates on the burial itself, isolated interments in rockshelters apparently occurred throughout the period considered here (Bulbeck 2003, 2011). These include the transitional Pleistocene-Holocene burial at Gua Gunung Runtuh, the early Holocene burial at Gua Teluk Kelawar, middle Holocene burials at Gua Peraling and Moh Khiew, and late Holocene burials at Gua Peraling and Gua Baik. However, the concerted use of rockshelters for burials, with a part of the site reserved to function as a cemetery, is currently well documented for just two periods, 6,500–4,500 bp and 3,500–2,000 bp (Figure 5). The earlier period is best represented by Khao Khi Chan but may also be the peak period for the numerous Hoabinhian burials at Gua Cha (Bulbeck 2011). The later period is represented by the Neolithic burials at Lang Rongrien and Gua Cha as well as the Neolithic/Early Metal Phase burials at Gua Harimau.

Of importance in this context is the archaeological evidence for an early Neolithic phase in STMP starting at around 6,500 bp. The evidence includes: (i) earthenware pottery in the Tham Sua shell midden at all levels above its basal, 7,500–6,500 bp date (Anderson 2005); (ii) earthenware pottery at all levels in the Guar Kepah shell midden (now dated to 6,500–6,000 bp), and its waisted ground adzes (Matthews 1961); (iii) ground stone tools from Khao Khi Chan (Srisuchat 1993) whose central period of use is dated to 6,500–5,500 bp; (iv) pottery and polished stone adzes from archaeological unit 4 at Moh Khiew associated with RC dates (uncalibrated) between 5,590 and 7,060 BP (Pookajorn 1996); (v) polished stone adzes and tripod pots associated with fifth millennium RC dates (after calibration) and freshwater shell dates between 5,000 and 7,000 BP at Buang Baeb (Srisuchat 1993); (vi) a polished stone adze and bases to complete pots from cultural phase 4 at Gua Peraling, dated to the sixth millennium bp (Adi 2000); and (vii) numerous potsherds associated with

RC dates on freshwater shell older than 6,000 BP at Gua Batu Tukang (Hassan 1998).

To be sure, an even earlier Neolithic presence in STMP is suggested by a potsherd and two polished stone flakes from Lang Rongrien's early Holocene levels (Anderson 1990) but this evidence currently stands in isolation. Further, pottery does not appear to have been present at Gua Cha before the fourth millennium bp (Bellwood 1993). Although a parallel may be drawn here with the scarcity of late Holocene pottery at Gua Peraling (Adi 2000), it may stretch credibility to contemplate too long a period during which the Gua Cha occupants went untouched by the Neolithic. Also, a 6,500 bp dating for the onset of STMP's early Neolithic is coherent in correlating with the period when phytolith evidence from the Nong Thalee Song Hong swamp points to the onset of arboriculture (Kealhofer 2003). Still, direct dating of the pottery reportedly from contexts older than 5,000 bp should be regarded as a priority to test the antiquity of the STMP Neolithic as indicated by certain sites on stratigraphic grounds.

The onset of the Neolithic may be expected to have been accompanied by a transformation in settlement patterns. Unfortunately, the recovery of supporting evidence is hampered by the shallow time depth of open-air sites in STMP. As noted above, taphonomic factors appear to have made open sites older than 4,000 bp very difficult to access apart from marine shell hillocks left from a circa 6,500 bp period of elevated sea-levels. While two of these hillocks fortunately capture the early Neolithic in STMP, and even foster speculation that its onset may have been associated with sea-level rises, they are not particularly informative on settlement patterns in general. Such evidence as we have is the shift towards the use of rockshelters as burial rather than habitation sites after 6,500 bp, and their hypothesised disuse for any purpose at 4,500–4,000 bp. This may reflect relocation of the majority of the population to hamlets scattered across the landscape.

An important consideration is the estimated time depth of the Aslian languages. Burenhalt et al. (2011) date their reconstructed ancestor, proto-Aslian, to around 4,000–5,000 bp. This loosely coincides with the time depth in STMP estimated by Hill et al. (2006) for the F1a1a mitochondrial DNA lineage, which features strongly amongst the Aslian-speaking, horticultural "Senoi." However, recent recalibration of the mutation rates that allow the F1a1a lineage to be dated suggest that its southward dispersal through Indochina occurred during the early Holocene and that it has an antiquity in STMP of 5,500 years (Oppenheimer 2011). This chronology would corroborate an association with the onset of the STMP Neolithic at around 6,500 bp, particularly as proto-Aslian is unlikely to mark the initial presence of Austroasiatic speakers in the Peninsula. The Aslian languages evidently expanded northwards from a centre towards the south of their extant range (Bulbeck 2011). This suggests that sister languages of Aslian, now extinct, existed in Peninsular Thailand (where the archaeological evidence for an early Neolithic is particularly strong) before the diversification of the Aslian languages.

To be sure, an onset of the STMP Neolithic by 6,500 bp would be incompatible with Bellwood's (1993, 1997) argument that the so-called Ban Kao culture was the vehicle for the movement of the Neolithic (and Austroasiatic) from mainland Thailand to Peninsular Malaysia. This is because the Ban Kao burials postdate 4,000 bp. However, as pointed out by Bulbeck (2011, incidentally correcting Bulbeck 2003, 2004), the superficial similarities between the mortuary goods buried at Ban Kao and at rockshelter cemeteries like Gua Cha should not beguile archaeologists into imputing the existence of a Ban Kao culture in STMP. For instance, with tripod pots, one of the supposed markers of this culture, their oldest dates and most concentrated archaeological recovery occur in the region between the Isthmus of Kra and the Thailand-Malaysia border. Accordingly, their presence both at Ban Kao and at sites south of the border would appear to represent secondary dispersal both north and south following their mid-Holocene appearance in northern STMP.

Should we retain the notion of a "package" involving the introduction of the F1a1a lineage, Austroasiatic and the Neolithic to STMP, but recalibrate the introduction date to circa 6,500 bp? One issue for this proposal is historical linguists' reconstruction of rice in proto-Aslian (Diffloth 2011), which accordingly should have been introduced to STMP by 6,500 bp. Rice was reportedly recovered from Sakai Cave, at a level dated to the ninth millennium bp (OAEP-1364 and OAEP-1366 in Table 6); although the rice remains have not been directly dated, the excavator suggests a mid-Holocene antiquity (Pookajorn 1996). Kealhofer (2003) recovered rice phytoliths, possibly domesticated and certainly different from the local wild rice, in low numbers from the mid-Holocene section of her Nong Thalee Song Hong core. In line with a 6,500 bp dating, there is actually better evidence for domesticated rice in middle Holocene than late Holocene STMP, at least, prior to the rice remains from Kuala Selinsing (Nik Hassan et al. 1994), a site intensively occupied during the first millennium CE (Table 18).

Dated documentation of STMP's open-air sites may commence at around 4,000 bp but stays sparse until around 2,500 bp, being essentially restricted to Neolithic items and forest plant remains from Jenderam Hilir, and the mortuary pottery and stone axes from Khao Sam Kaeo. This period is associated with some evidence for agricultural intensification, albeit involving crops other than rice, based on the pollen evidence from Nong Thalee Song Hong (Kealhofer 2003). The Neolithic levels at the open site of Nyong may reflect the establishment of village life but unfortunately the only indication of their antiquity is Adi's (1989) guesstimate of 4,000–3,000 bp. Evidence for an increase in material prosperity is provided by the grave goods from the Neolithic burials at Lang Rongrien, Gua Harimau and Gua Cha, which include fine pottery, some with pedestals; spoons, bracelets and other jewellery of shell; nephrite and marble bracelets; and polished stone adzes and barkcloth beaters (Bulbeck 2011). Further, the three identifiable children from Gua Cha are no different from the male adults in the richness of their burial goods (Table 21), implying a hierarchical society where status was ascribed at birth rather than achieved (Carr 1995).

This evidence for a late Neolithic consumer market for sumptuary goods, associated with stratified societies, is an important context for appreciating the semi-precious stone bead industry at Khao Sam Kaeo, dated to 2,500–2,000 bp. Bellina (2007) infers the establishment of a colony of South Asian lapidarists who mass-produced stone beads highly valued by local elites as a vehicle for cementing their elevated social status. Bellina is unclear on whether the form of social organisation from which these elites emerged consisted of "trans-egalitarian" societies, in which elite individuals would have continually acquired status and re-crafted their social alliances to maintain their fragile, apical position in society. The alternative is chiefdoms with separate strata accustomed to different expectations of privilege by birth. The evidence from Gua Cha suggests the latter, confirmed by the recovery of grave goods (stone axes) with the cremated infant and child interred in a funerary urn at Khao Sam Kaeo (Bellina-Pryce and Silapanth 2006). A chiefdom form of social organisation would also have enhanced the level of social cohesion and orderly command required for the construction of the earthworks at Khao Sam Kaeo, the most complex and extensive known in Southeast Asia at this early date, as well as the dense settlement of its large population.

The pottery from Khao Sam Kaeo includes a variety of fine wares from India (Bouvet 2011) including types also found to the south at Phu Khao Thong (Chaisuwan 2011) and Bukit Tengku Lembu (Bellwood 1997). Settlement of Indian potters at Khao Sam Kaeo is suspected on the basis of the application of Indian pottery techniques to wares produced in the local tradition (Bouvet 2011). A South Asian contribution may also have been involved in the technological skills employed in Khao Sam Kaeo's earthworks, glass-bead production and iron metallurgy, although the case is not as strong as for its stone-bead industry (Bellina-Pryce and Silapanth 2006; Murillo-Barroso et al. 2010). Further, its high-tin bronzes show stronger influence from Mainland East Asian production centres to the north than South Asia, and may have been produced from copper or bronze imported from the north, blended with Peninsula tin, for exportation to South Asia and elsewhere (Murillo-Barroso et al. 2010).

The picture is developing that Khao Sam Kaeo's location at one terminus of a trans-peninsular trade route attracted sea-borne cultural influences and sumptuary goods from as far afield as South Asia and China, and fostered incipient trade between South and Southeast Asia. While there are no other pre-2,000 bp sites in STMP that rank with Khao Sam Kaeo in these regards, related developments to the south are suggested by the older of the Dengkil boats (Table 19), the 2,500–2,000 bp dating for two of the Bernam Valley cist graves (Table 17), and the inception of glass bead production at Kuala Selinsing by 2,000 bp or soon after (Bellina 2007). In addition, the shafted iron tools from Khao Sam Kaeo and the contemporary site of Ban Don Ta Phet, in mainland Thailand (Glover and Bellina 2011), resemble the shafted iron tools found with the Bernam Valley cist graves and as "hoards" in the vicinity of these graves (Bellwood 1997; Bulbeck 2004).

The following interval, 2,000–1,500 bp, which essentially corresponds to the first half-millennium of the Common Era, is widely viewed as the onset of "Indianisation" in the Peninsula (Jacq-Hergoualc'h 2002). The oldest inscriptions and Hindu-Buddhist iconography, dated respectively by palaeographical and art-historical comparisons, relate to this period. Khao Sam Kaeo provides a critical context for understanding this period because it demonstrates that contacts with South Asia and local settlement by South Asians, at a settlement reasonably described as urban, preceded Indianisation in the Peninsula (Bellina-Pryce and Silapanth 2006). This implies that, if Indianisation was associated with the adoption of a South Asian-style *mandala* form of polity formation (Jacq-Hergoualc'h 2002), it may have either been established at Khao Sam Kaeo before the Common Era, or operated as an ideological superstructure for emerging polities already equipped with local experience in managing maritime trading centres.

The inscriptions are concentrated in north-western Peninsular Malaysia, supplemented by inscribed sherds from Phu Khao Thong (Chaisuwan 2011), inscribed seals from Khuan Luk Pat (Jacq-Hergoualc'h 2002) and inscribed seals and stone sphere from Khao Sam Kaeo (Bellina-Pryce and Silapanth 2006). The Khao Sam Kaeo inscriptions are short and uninformative, and evidently postdate the site's main period of occupation, but are relevant in demonstrating the use of only South Asian scripts and languages. This is also true of the Phu Khao Thong sherds, dated to the second to fourth centuries CE, and the Khuan Luk Pat seals, dated to between the first or third and sixth/seventh centuries CE. It is also true of the Peninsular Malaysia inscriptions (Table 22) except the SB14 inscriptions, which use a Javanese script, and also differ from the other six in being engraved on metal discs and dating to a later time. Considering just the six positively or potentially dated to the fourth/fifth centuries CE, we can appreciate their focus on presenting Buddhist homilies, suggesting local conversion to Buddhism (at least by the elite) by this time. Jacq-Hergoualc'h (2002) noted the problem that these inscriptions were dated centuries before the antiquity accepted by archaeologists for the known brick structures from Sungai Mas and Sungai Bujang. Fortunately, this problem is now resolved with the 0–500 CE dating for the brick jetty and religious structures documented for Sungai Batu in the Bujang Valley (Table 11). (Fired bricks are an ancient technology dating back to the middle Holocene both in the Indus Valley and Chinese civilisations – Wikipedia 2013.)

Religious iconography dated to the first half-millennium CE has been recovered from several locations in southernmost Thailand. These include the Chaiya stone sculpture of Vishnu dated to circa 400 CE; three similar sculptures from Nakhon Si Thammarat and Sichon; a stone linga from Nakhon Si Thammarat suspected to predate the sixth century; small stone images of the Buddha dated to circa 500 CE from Wat Wiang, Sichon and an unknown provenance in Malaya; and a clay votive tablet in the same style from Khao Khanaab Nam. A bronze Buddha from Kinta in Peninsular Malaysia may also date to the fifth century or earlier (Jacq-Hergoualc'h 2002). The Peninsula's oldest chronometrically dated, complete examples of bronze regalia also date to the first half-millennium CE, including the two Dongson drums found with the Kampong Sungai Lang canoe, and possibly the Kampong Pencu bell (Table 1).

External sources also provide inklings of the establishment of coastal polities in Malaya during to the first half-millennium CE. General references by Ptolemy to the "Golden Khersonese," with its trading centre at Takola, known to early Indian writers as Suvarnadvipa (Golden Island or Peninsula) with a trading centre at Takkola, appear to refer to the Peninsula as a source for alluvial gold (Jacq-Hergoualc'h 2002). The Puranas, Indian devotional texts compiled by the Gupta period (320–550 CE), refer to Katahadvipa or modern Kedah (Wheatley 1983); this can now be readily indentified with the Bujang Valley based on the dating for Sungai Batu and the early inscriptions nearby. However, for detail we need to turn to early Chinese accounts, starting with the third century CE mission to Funan, a city-state based on the Mekong delta. The recorded polities include Langkasuka, which can be identified with the archaeological site of Yarang; Panpan, tentatively identified with Chaiya, also on the east coast of Peninsular Thailand; and Dunsun, currently unlocated but described as a centre for long-distance trade where numerous families from South Asia lived, including more than a thousand Brahmins (Jacq-Hergoualc'h 2002).

Archaeologically, the 2,000–1,500 bp interval was associated with a peak in STMP dates on boats and a rise in its maritime sites, including a tranche of dates from the offshore site of Kuala Selinsing. This stands as the archaeological signature for a trading system in which valuable produce, evidently including gold and presumably tin, was collected at coastal centres for onward transport to entrepôts (Leong 1990; Jacq-Hergoualc'h 2002). This system remained prominent in succeeding times although the supporting documentation increasingly involves textual accounts and archaeological sites dated by non-chronometric means.

During the sixth to tenth centuries CE, Tambralinga emerged as the successor of Langkasuka, and Chinese and Arab references crop up for the Bujang Valley entrepôt (Jiecha for the Chinese, Kalah for the Arabs). This is also the period during which the STMP entrepôts first became renowned as a source for precious forest products (Leong 1990; Jacq-Hergoualc'h 2002). New entrepôts had also emerged by the ninth century at Laem Pho and the island of Ko Kho Khao (Thung Tuk site). By the seventh century, Funan was superseded by Srivijaya, based at Palembang in southern Sumatra, as the main maritime power near the Peninsula. Srivijaya exercised some degree of suzerainty over STMP but without any rigour. Jiecha/Kalar is described as a possession of Srivijaya in the late seventh and middle ninth centuries but not at any other time. The Nakhon Si Thammarat stone inscription (near Chaiya), dated to 775 CE, lists seven Buddhist temples constructed on the order of the Srivijaya king. However, this is no basis for inferring Srivijaya's dominance over Chaiya, especially as the reverse side of the inscription extols the virtues of the late eighth century king of Sailendra in Java—and both inscriptions are in Sanskrit, rather than Old Malay as used in Srivijaya's own inscriptions closer to Palembang (Jacq-Hergoualc'h 2002). Further, most of the large corpus of inscriptions and Hindu-Buddhist iconography found in STMP and dated to the sixth to tenth centuries CE appear to bear no relation to Srivijaya, whereas the Mon language and artistic influence are in evidence (Stargadt 1983; Jacq-Hergoualc'h 2002).

Monumental remains corresponding to the 1,500–1,000 bp interval can often be dated by their association with Tang to Yuan dynasty ceramics from China and glassware and glazed ceramics from the Middle East (Nik Hassan and Othman 1990; Jacq-Hergoualc'h 2002; Chaisuwan 2011). The interval also corresponds to STMP's peak period for the number of chronometrically dated sites. Contributors to this peak include the Thung Tuk, Amphur Yarang and Satingpra monumental sites, the most recent of the dated Bernam Valley cist graves, continued occupancy at Kuala Selinsing, and evidence for early gardening from Gunung Jerai.

The eleventh to fifteenth centuries CE was a period of major political transformation in STMP. The rise of the Chola dynasty in ninth century southern India was followed by an early eleventh century expedition in which the Cholas captured the Srivijaya king. They also claimed possession of several polities along Sumatra's east coast and coastal STMP, including

Jiecha/Kalar and Tambralinga. Whatever level of control the Cholas may have temporarily exerted over their conquests, both Jiecha/Kalar and Tambralinga continued to prosper as major entrepôts and suppliers of forest produce into the twelfth and thirteenth centuries (Jacq-Hergoualc'h 2002; see also Leong 1990). Srivijaya's status as a regional maritime power ended during the thirteenth century, but in the next century a Palembang prince, Paramesvara, established a trading capital at Singapore (then known as Temasik) before re-establishing himself at Melaka. A Melayu Malay political presence had already been established on Malaya, as witnessed by the 1303 CE stone pillar at Terengganu inscribed in Old Malay, using an Arabic script, which further recorded Islam as the local religion (Hooker 2003). The Melaka rulers also converted to Islam in the fifteenth century, and asserted Melaka's supremacy over the other STMP polities then claimed as dependencies by Ayudhya (in mainland Thailand), as Melaka grew into the single major entrepôt in the southern seas (Andaya 2007).

Chronometric documentation of Malaya's archaeology for the 1,000–500 bp interval is poorer than for the preceding 500 years. Archaeological research into ancient Terengganu and fifteenth century Melaka is minimal, and while Temasik's brief rise to prominence is well documented archaeologically, its dating relies entirely on artefactual identifications. One of the few dated site uses south of the Thailand border involves the earlier RC date (ANU-9458) from the Gua Chawas hearth which produced a large number of Buddhist votive tablets of baked clay. Jacq-Hergoualc'h (2002) dates these tablets to the ninth century, but ANU-9458 has an effectively 100 percent chance of dating to the 1,000–500 bp interval. The implication would be that not only the Gua Chawas tablets but also the similar examples to the north, found as far north as Chaiya (Adi 2000; Bulbeck 2004), should also be referred to the same period. The Thailand portion of STMP is comparatively well documented archaeologically, including continued occupation at Thung Tuk, Amphur Yarang and Satingpra, and the Koh Moh kiln with its fine ceramic products. A bronze Buddha statue (exact provenance unknown), very similar to the famous Buddha of Grahi, which carries a twelfth century inscription, is dated to the late fifteenth century CE (Cummings 2009; Wade Talkington, pers. comm. 8 August 2013). Jacq-Hergoualc'h (2002) recognises a "Chaiya school of sculpture" based on the Buddha of Grahi and similar works found nearby, and notes the likelihood of Khmer artistic influence from Cambodia.

The sixteenth to twentieth centuries CE were marked by the seizure of Melaka by the Portuguese in 1511 and by the Dutch in 1641, an increasing British presence from the eighteenth century leading to the colony of the Federated Malay States in 1895, and the ongoing importance of the Melayu Malay sultanates which underpinned Malaysia's independence in the 1950s (Hooker 2003). The period is so well documented historically, including maps, images and written accounts on STMP's colonial and sultanate centres, that the sparse chronometric documentation for the period is of minor consequence. An interesting example of dating sites from historical records involves the rockshelter charcoal drawings attributed to the Semang, Aslian speakers who maintained a mobile forager lifestyle through to ethnographic times (Adi 2000). The depictions at Gua Badak and Gua Dayak include an elephant pulling a cart, a horse-drawn buggy, bicycles, motor vehicles and a suspected portrait of the local British District Judge (Mokhtar and Taçon 2011). Nor would there be any basis for dating any of the charcoal drawings to earlier than 1,000–0 bp. This body of cave art is important testimony to Semang ceremonial activities and sacred sites during historical times, undoubtedly the continuation of an ancient tradition that is currently lost in the mists of time.

Various associations have been suggested between the archaeological record of STMP and its Aslian speakers. Early Aslian speakers can be confidently identified with the Neolithic habitation debris at Jenderam Hilir and Nyong. The rockshelter cemeteries at Gua Cha and Gua Harimau have been respectively associated with the ancestors of the horticulturalist Temiar and Semai, both speakers of "Central Aslian" languages (Bulbeck 2011). The habitation debris at these and other Peninsular Malaysia rockshelters has been discussed in terms of their ethnographic use by Central Aslian speakers (including the Lanoh Semang as well as the Temiar Senoi) and their suspected, ancient occupation by the ancestors of the Semang (Adi 2000; Hamid 2007). While most Semang speak "Northern Aslian" languages, Northern Aslian is a late offshoot (Burenhalt et al. 2011). This strongly suggests a "language switch" by foragers who subsequently owed much of their cultural autonomy to their expertise in collecting valuable rainforest produce. Further, the "Southern Aslian" Mah Meri were the traditional inhabitants of the Sungai Lang estuary, where STMP's oldest boat remains have been found. And another Southern Aslian group, the Semelai, may have covered a wider territory in earlier times that could have included the find spots of the Pontian boat and the Kampong Pencu bell (Bulbeck 2003, 2011).

The other candidate for these latter sites are Aboriginal Malay speakers of Malay dialects, who certainly may be reasonably associated with the occupation sequence at Kuala Selinsing (Bulbeck 2011). At the time of the founding of Melaka, its numerically dominant population were its *orang laut* (Andaya 2007), sea people related to the surviving Aboriginal Malays of coastal Peninsular Malaysia (Benjamin 2002). Indeed, an Early Metal Phase presence of Austronesian speakers may be suspected at Khao Sam Kaeo and Tham Tuay, based on locally produced wares with decorations similar to contemporary pottery from the

Philippines, Sarawak and Cham-speaking parts of Vietnam (Bellina et al. 2012). An Early Metal Phase Austronesian presence is also suggested for southern Peninsular Malaysia, based on finds of "red" (red-slipped) pottery which contrast with the paddle-impressed wares that dominate most STMP assemblages (Bulbeck 2011). How these finds may relate to the early dispersal of the Malayic languages, whose homeland is traced to northern Borneo by Adelaar (2004), should be left to historical linguists to assess. Nonetheless an Austronesian genetic signature is evident in a suite of mtDNA lineages found in various locations in Island Southeast Asia but restricted to Aboriginal (and Melayu) Malays in STMP (Bulbeck 2011). Accordingly, the archaeology of STMP is important not just for the prehistory of its Aslian speakers but also the prehistory of its Austronesian speakers.

## CONCLUSION

Quantification of the chronometric record on the Holocene archaeology of the southern Thai-Malay Peninsula (STMP) produces a profile with two main components. The early component, 10,000–4,500 bp, documents occupation of closed sites plus some large, marine shell middens built up at a time of elevated sea-levels around 6,500 bp. The later component, 4,500–0 bp, documents an increasing number and variety of open-air sites, at least until 1,000 bp (after which date, the increasing abundance of textual information relegates archaeology to the status of an accessory data source). The increasing richness of the open-air chronometric record, 4,500–1,000 bp, correlates well with other evidence for rising status differentiation and material prosperity, leading to early state formation in STMP. However, the lack of an open-air chronometric record (apart from the marine shell hillocks) before 4,500 bp reflects these sites' deep burial and/or destruction rather than their non-creation. Closed sites, for their part, show a trend towards decreased levels of documented occupation and/or a shift from habitation to mortuary use at around 6,500 bp. This may reflect a shift in settlement patterns to dispersed hamlets, consistent with the phytolith and archaeological evidence for the origins of the Neolithic, including small-scale crop production, at the time.

The analysis highlights three lines of enquiry that could test the scenario generated here. One is direct dating of ceramic materials reportedly recovered from pre-4,500 bp contexts. The other two involve direct dating of marine shell items and additional human burials from closed sites. More generally, chronometric research into the STMP archaeological record will continue into the future, and confirm, amend or even fully revise the chronometric profile generated on current documentation. The Holocene archaeology of STMP is far richer and more informative than the constrained view available from quantification of its chronometric data, but this is one useful line of investigation into the Peninsula's past.

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# APPENDIX

Table 1: STMP Holocene dates rejected from the analysis for specific reasons.

| Site/object | Cited date | Laboratory code | Reason for rejection | Source |
|---|---|---|---|---|
| Khao Sam Kaeo | 8,412 ± 42 BP (AMS) | Wk 18766 | Natural inclusion in decomposed bedrock | Bellina-Pryce and Silapanth 2006 |
| Khao Sam Kaeo | 6,568 ± 42 BP (AMS) | Wk 18767 | As above | Bellina-Pryce and Silapanth 2006 |
| Buddha bronze | 2,020 ± 50 BP (AMS) | PRI-09-162-Buddha | Far too old compared with other date from same bronze (Table 3) | Cummings 2009 |
| Khao Khi Chan | 5,620 ± 200 BP (RC) | Not stated | Well-dated site (Table 7) so inclusion of dates with a standard error of 200 years or more superfluous | Srisuchat 1993 |
| Khao Khi Chan | 3,250 ± 580 BP (RC) | Not stated | As above | Srisuchat 1993 |
| Khao Khi Chan | 2,510 ± 210 BP (RC) | Not stated | As above | Srisuchat 1993 |
| Thung Tuk | 2,800 ± 270 bp (TL) | TT3-1 | TL date unreliable as dated brick was incompletely fired | Pailoplee et al. 2003 |
| Thung Tuk | 1,100 ± 440 bp (TL) | TT6-1 | Standard error exceeds 400 years | Pailoplee et al. 2003 |
| Gua Kechil | 4,800 ± 800 BP (RC) | Not stated | As above | Dunn 1966 |
| Changkat Menteri 9 | 3,165–2,865 bp (RC) | Beta 82676 | Expected inaccuracy > 5 percent of assignment to 500-year intervals | Leong 2000 |
| Changkat Menteri 9 | 1,600–1,345 bp (RC) | Beta 82671 | As above | Leong 2000 |
| Changkat Menteri 9 | 1,600 ± 600 (TL) | Not stated | Standard error exceeds 400 years | Leong 2000 |
| Kampong Sungai Lang | 2,435 ± 95 BP (RC) | GX-280 (RC) | Just 1 date from same object allowed, so youngest (Table 19) used | Polach et al. 1967 |
| Kampong Sungai Lang | 2,145 ± 100 BP (RC) | ANU 27 | As above | Polach et al. 1967 |
| Kampong Pencu bell | Less than 1,800 bp | Not stated | Date too imprecisely expressed to be assigned to 500-year intervals | Adi 1983 |

Table 2: Accepted dates (all AMS) from Khao Sam Kaeo.

| **Cited date** | **Laboratory code** | **Aspect** | **Site use** | **Material class** |
|---|---|---|---|---|
| 3,367 ± 30 BP | Wk 18763 | Open (pre-monumental) | Mortuary | Charcoal |
| 2,316 ± 45 BP | Wk 16804 | Monumental (fortified) | Habitation | Charcoal |
| 2,295 ± 32 BP | Wk 21177 | Monumental (fortified) | Industrial | Charcoal |
| 2,258 ± 33 BP | Wk 16801 | Monumental (fortified) | Industrial | Charcoal |
| 2,236 ± 45 BP | Wk 16802 | Monumental (fortified) | Industrial | Charcoal |
| 2,234 ± 31 BP | Wk 18768 | Monumental (fortified) | Industrial | Charcoal |
| 2,227 ± 32 BP | Wk 18764 | Monumental (fortified) | Industrial | Charcoal |
| 2,223 ± 31 BP | Wk 18769 | Monumental (fortified) | Industrial | Charcoal |
| 2,217 ± 44 BP | Wk 16805 | Monumental (fortified) | Habitation | Charcoal |
| 2,203 ± 58 BP | Wk 21176 | Monumental (fortified) | Industrial | Charcoal |
| 2,188 ± 47 BP | Wk 16803 | Monumental (fortified) | Habitation | Charcoal |
| 2,184 ± 35 BP | Wk 21178 | Monumental (fortified) | Industrial | Charcoal |
| 2,182 ± 49 BP | Wk 16798 | Monumental (fortified) | Habitation | Charcoal |
| 2,152 ± 39 BP | Wk 21175 | Monumental (fortified) | Mortuary | Cremated human bone |
| 1,507 ± 47 BP | Wk 18762 | Open (post-monumental) | Habitation | Charcoal |
| Post 500 bp | Wk 16800 | Open (post-monumental) | Habitation | Charcoal |

*Sources: Bellina and Silapanth 2006; Bellina-Pryce and Silapanth 2006; Hung et al. 2007; Glover and Bellina 2011. Two additional dates, Wk 23273 and Wk 23277, published as calibrated ranges falling entirely within 2,500–2,000 bp, are not included in the analysis as any information available from them is already covered by the dates in Table 2.*

Table 3: Accepted miscellaneous STMP Holocene dates.

| **Site/ object** | **Cited date** | **Laboratory code** | **Aspect** | **Site use** | **Material class** | **Reference** |
|---|---|---|---|---|---|---|
| Tham Tuay | 2,105 ± 34 BP (AMS) | Wk 3088 | Closed | Mortuary | Charcoal | Bellina et al. 2012 |
| Buddha bronze | 475 ± 35 BP (AMS) | PRI-09-162-Naga | Open | Ceremonial | Ceramic | Cummings 2009 |
| Pak Om | 3,010 ± 190 BP (RC) | Not stated | Closed | Habitation | Animal matter (landsnail) | Srisuchat 1993 |
| Buang Baeb | 4,760 ± 150 BP (RC) | Not stated | Closed | Habitation | Animal matter (bone) | Srisuchat 1993 |
| Buang Baeb | 4,750 ± 210 BP (RC) | Not stated | Closed | Mortuary | Human bone | Srisuchat 1993 |
| Khao Kanaab Naam | 4,410 ± 50 BP (RC) | GX-26109 | Closed | Habitation | Charcoal | Anderson 2005 |
| Satingpra | 1,115 ± 50 BP (RC) | Not stated | Monumental (fortified) | Habitation | Charcoal | Stargadt 1983 |
| Satingpra | 1,065 ± 50 BP (RC) | Not stated | Monumental (fortified) | Ceremonial | Charcoal | Stargadt 1983 |
| Amphur Yarang | 445 ± 85 BP (RC) | Not stated | Monumental (fortified) | Habitation | Charcoal | Pailoplee et al. 2003 |
| Amphur Yarang | 579 ± 17 bp (TL) | Not stated | Monumental (fortified) | Ceremonial | Ceramic | Changkian and Kaewtubtim 1999 |
| Amphur Yarang | 538 ± 15 bp (TL) | Not stated | Monumental (fortified) | Habitation | Ceramic | Changkian and Kaewtubtim 1999 |
| Gunung Jerai | 1,340–930 bp (RC) | Not stated | Open | Gardening | Charcoal | Allen 2011 |
| Gua Sagu | 2,835 ± 70 BP (RC) | Beta 36341 | Closed | Habitation | Charcoal | Zuraina 1998 |
| Gua Sagu | 1,240 ± 100 BP (RC) | Beta 32486 | Closed | Habitation | Charcoal | Zuraina 1998 |

Table 4: Accepted Holocene dates (all RC) from Lang Rongrien.

| Cited date | Laboratory code | Aspect | Site use | Material class |
|---|---|---|---|---|
| 8,430 ± 70 BP | SI-6212B | Closed | Habitation | Charcoal |
| 8,300 ± 85 BP | SI-6215B | Closed | Habitation | Charcoal |
| 7,765 ± 65 BP | SI-6213 | Closed | Habitation | Charcoal |
| 7,655 ± 70 BP | SI-6215A | Closed | Habitation | Charcoal |
| 7,580 ± 70 BP | SI-6212A | Closed | Habitation | Charcoal |
| 7,575 ± 75 BP | SI-6214 | Closed | Habitation | Charcoal |
| 6,950 ± 110 BP | GX-25017 | Closed | Habitation | Plant matter (wood) |
| 3,270 ± 80 BP | GX-25016 | Closed | Mortuary | Plant matter (coffin wood) |
| 2,530 ± 45 BP | PIT T-1245 | Closed | Mortuary | Plant matter (coffin wood) |

*Sources: Anderson 1990; Douglas Anderson pers. comm. 25 February 2013. All other dates from Lang Rongrien have a calibrated range that falls entirely before 10,000 bp.*

Table 5: Accepted Holocene dates (all RC) from Moh Khiew.

| Cited date | Laboratory code | Aspect | Site use | Material class |
|---|---|---|---|---|
| 8,420 ± 90 BP | OAEP-1292 | Closed | Habitation | Charcoal |
| 7,060 ± 100 BP | OAEP-1277 | Closed | Habitation | Charcoal |
| 6,090 ± 150 BP | OAEP-1278 | Closed | Habitation | Charcoal |
| 5,940 ± 140 BP | OAEP-1289 | Closed | Habitation | Charcoal |
| 5,590 ± 70 BP | OAEP-1291 | Closed | Habitation | Charcoal |
| 4,240 ± 150 BP | OAEP-1290 | Closed | Habitation | Charcoal |

*Source: Pookajorn 1996. All other dates from Moh Khiew have a calibrated range that falls entirely before 10,000 bp.*

Table 6: Accepted dates (all RC) from Sakai Cave.

| Cited date | Laboratory code | Aspect | Site use | Material class |
|---|---|---|---|---|
| 9,280 ± 180 BP | OAEP-1371 | Closed | Habitation | Charcoal |
| 9,020 ± 360 BP | OAEP-1371 (*sic*!) | Closed | Habitation | Charcoal |
| 8,700 ± 190 BP | OAEP-1370 | Closed | Habitation | Charcoal |
| 7,869 ± 280 BP | OAEP-1366 | Closed | Habitation | Charcoal |
| 7,620 ± 160 BP | OAEP-1364 | Closed | Habitation | Charcoal |

*Source: Pookajorn 1996.*

Table 7: Accepted dates (all RC) from Khao Khi Chan.

| **Cited date** | **Test pit/layer** | **Aspect** | **Site use** | **Material class** |
|---|---|---|---|---|
| 4,640 ± 140 BP | N-TP-1/Layer 5 | Closed | Habitation | Charcoal |
| 4,770 ± 100 BP | N-TP-1/Layer 3 | Closed | Habitation | Animal matter (bone) |
| 5,810 ± 120 BP | N-TP-1/Layer 2 | Closed | Habitation | Charcoal |
| 6,070 ± 170 BP | N-TP-1/Layer 2 | Closed | Habitation | Charcoal |
| 4,260 ± 180 BP | TP-1/Layer 5 | Closed | Mortuary | Human bone |
| 4,350 ± 90 BP | TP-1/Layer 4 | Closed | Mortuary | Human bone |
| 4,370 ± 90 BP | TP-1/Layer 4 | Closed | Mortuary | Human bone |
| 4,590 ± 130 BP | TP-1/Layer 4 | Closed | Mortuary | Human bone |
| 4,700 ± 110 BP | TP-1/Layer 4 (Burial No. 1) | Closed | Mortuary | Human bone |
| 4,810 ± 130 BP | TP-1/Layer 4 | Closed | Mortuary | Human bone |
| 5,020 ± 170 BP | TP-1/Layer 4 | Closed | Mortuary | Human bone |
| 5,090 ± 120 BP | TP-1/Layer 4 | Closed | Mortuary | Human bone |
| 5,370 ± 160 BP | TP-1/Layer 3 | Closed | Mortuary | Human bone |
| 4,600 ± 180 BP | TP-1/Layer 2 | Closed | Mortuary | Human bone |
| 5,460 ± 180 BP | TP-1/Layer 2 | Closed | Mortuary | Human bone |

*Source: Srisuchat 1993. No laboratory codes provided, so the test pit and layer are cited here.*

Table 8: Accepted dates from Thung Tuk.

| **Cited date** | **Laboratory code** | **Aspect** | **Site use** | **Material class** |
|---|---|---|---|---|
| 1,070–1,310 bp (RC) | Not stated | Monumental (fortified) | Habitation | Charcoal |
| 1,140 ± 120 bp (TL) | TT1-1 | Monumental (fortified) | Ceremonial | Ceramic |
| 1,270 ± 370 bp (TL) | TT3-3 | Monumental (fortified) | Ceremonial | Ceramic |
| 1,100 ± 270 bp (TL) | TT4-1 | Monumental (fortified) | Ceremonial | Ceramic |
| 1,000 ± 340 bp (TL) | TT4-1 | Monumental (fortified) | Ceremonial | Ceramic |
| 840 ± 300 bp (TL) | TT8-1 | Monumental (fortified) | Ceremonial | Ceramic |

*Source: Pailoplee et al. 2003.*

Table 9: Accepted dates (all TL) from Koh Moh kiln.

| **Cited date** | **Layer** | **Aspect** | **Site use** | **Material class** |
|---|---|---|---|---|
| 910 ± 80 bp | 15=IV | Open | Industrial | Ceramic |
| 860 ± 80 bp | 11=IV | Open | Industrial | Ceramic |
| 840 ± 70 bp | 11=IV | Open | Industrial | Ceramic |
| 795 ± 75 bp | 11=IV | Open | Industrial | Ceramic |
| 735 ± 65 bp | 2=IV | Open | Industrial | Ceramic |
| 715 ± 60 bp | 2=IV | Open | Industrial | Ceramic |
| 680 ± 65 bp | 2=IV | Open | Industrial | Ceramic |
| 715 ± 65 bp | 1=IV | Open | Industrial | Ceramic |
| 710 ± 65 bp | 1=IV | Open | Industrial | Ceramic |
| 670 ± 60 bp | 1=IV | Open | Industrial | Ceramic |

*Source: Stargadt 1983. No laboratory codes provided, so the layer is cited here.*

Table 10: Accepted dates (all RC) from STMP marine shell middens.

| **Site** | **Cited date** | **Laboratory code** | **Aspect** | **Site use** | **Material class** | **Source** |
|---|---|---|---|---|---|---|
| Tham Sua | 6,440 ± 100 BP | GX-25018 | Marine midden | Habitation | Marine shell | Anderson 2005 |
| Bukit Kerang | 5,970 ± 50 BP | Not stated | Marine midden | Habitation | Marine shell | Adi 2000 |
| Guar Kepah | 5,700 ± 50 BP | Not stated | Marine midden | Habitation | Marine shell | Tieng 2010 |

Table 11: Accepted dates from Sungai Batu

| **Cited date** | **Laboratory code** | **Aspect** | **Site use** | **Material class** |
|---|---|---|---|---|
| 1,860 ± 40 BP (RC) | Beta 268001 | Monumental (fortified) | Industrial | Charcoal |
| 1,900 ± 100 bp (OSL) | UW2083 | Monumental (fortified) | Ceremonial | Ceramic |
| 1,900 ± 100 bp (OSL) | UW2082 | Monumental (fortified) | Ceremonial | Ceramic |
| 1,740 ± 25 bp (OSL) | Not stated | Monumental (fortified) | Transport | Ceramic |

*Sources: Saidin et al. 2011; Hassan et al. 2011.*

Table 12: Accepted dates (all RC) from Perak rockshelters.

| **Site** | **Cited date** | **Laboratory code** | **Aspect** | **Site use** | **Material class** | **Source** |
|---|---|---|---|---|---|---|
| Gua Kajang | 8,970 ± 140 BP | Beta 28156 | Closed | Habitation | Charcoal | Zuraina 1998 |
| Gua Kajang | 6,380 ± 60 BP | Beta 28157 | Closed | Habitation | Charcoal | Zuraina 1998 |
| Gua Ngaum | 5,990 ± 80 BP | Beta 66233 | Closed | Habitation | Landsnail (animal matter) | Zuraina 1998 |
| Gua Batu Tukang | 3,620 ± 50 BP | Beta 46809 | Closed | Habitation | Charcoal | Zuraina 1998 |
| Gua Harimau | 3,450 ± 150 BP | BM-43 | Closed | Habitation | Charcoal | Adi 2000 |
| Gua Harimau | 3,170 ± 60 BP | Beta 81771 | Closed | Mortuary | Charcoal | Zuraina 1998 |
| Gua Harimau | 3,080 ± 60 BP | Beta 81772 | Closed | Mortuary | Charcoal | Zuraina 1998 |
| Gua Harimau | 1,760 ± 195 BP | GX-13506 | Closed | Mortuary | Charcoal | Zuraina 1998 |
| Gua Gunung Runtuh | 2,620 ± 80 BP | Beta 37817 | Closed | Habitation | Charcoal | Zuraina 1998 |
| Gua Dayak | 1,610 ± 140 BP | Beta 46808 | Closed | Habitation | Charcoal | Zuraina 1998 |
| Gua Keramat Harimau | 1,210 ± 80 BP | Beta 63422 | Closed | Habitation | Charcoal | Zuraina 1998 |
| Gua Keramat Harimau | 600 ± 90 BP | Beta 63421 | Closed | Habitation | Charcoal | Zuraina 1998 |
| Gua Keramat Harimau | 520 ± 90 BP | Beta 63420 | Closed | Habitation | Charcoal | Zuraina 1998 |
| Gua Mesin | 600 ± 50 BP | Beta 46811 | Closed | Habitation | Charcoal | Zuraina 1998 |

Table 13: Accepted dates (all RC) from Gua Cha.

| **Cited date** | **Laboratory code** | **Aspect** | **Site use** | **Material class** |
|---|---|---|---|---|
| 930 ± 100 BP | ANU-2216 | Closed | Habitation | Plant matter (rice) |
| 2,627 ± 99 | BM-946 | Closed | Mortuary | Human bone |
| 3,020 ± 270 BP | ANU-2217 | Closed | Habitation | Charcoal |
| 6,280 ± 250 BP | ANU-2218 | Closed | Habitation | Charcoal |
| 3,790 ± 290 BP | ANU-2219 | Closed | Habitation | Charcoal |

*Sources: Burleigh et al. 1977; Adi 1985.*

Table 14: Accepted dates (all RC) from Gua Chawas.

| Cited date | Laboratory code | Aspect | Site use | Material class |
|---|---|---|---|---|
| 400 ± 60 BP | ANU-9457 | Closed | Ceremonial | Charcoal |
| 820 ± 50 BP | ANU-9458 | Closed | Ceremonial | Charcoal |
| 1,770 ± 80 BP | ANU-9461 | Closed | Habitation | Charcoal |
| 1,840 ± 70 BP | ANU-9914 | Closed | Habitation | Charcoal |
| 2,200 ± 70 BP | ANU-9459 | Closed | Habitation | Charcoal |
| 4,390 ± 80 BP | ANU-9462 | Closed | Habitation | Charcoal |
| 4,560 ± 160 BP | ANU-9915 | Closed | Habitation | Charcoal |
| 6,100 ± 60 BP | ANU-9913 | Closed | Habitation | Charcoal |

*Source: Adi 2000.*

Table 15: Accepted dates (all RC) from Gua Peraling.

| Cited date | Laboratory code | Aspect | Site use | Material class |
|---|---|---|---|---|
| 5,330 ± 100 BP | ANU-9906 | Closed | Habitation | Charcoal |
| 5,720 ± 210 BP | ANU-9905 | Closed | Habitation | Charcoal |
| 5,850 ± 310 BP | ANU-9909 | Closed | Habitation | Charcoal |
| 6,250 ± 80 BP | ANU-9907 | Closed | Habitation | Charcoal |
| 6,910 ± 250 BP | ANU-9910 | Closed | Habitation | Charcoal |

*Source: Adi 2000.*

Table 16: Accepted dates from Jenderam Hilir.

| Cited date | Laboratory code | Aspect | Site use | Material class |
|---|---|---|---|---|
| 3,650 ± 60 BP (RC) | SUA 2401 | Open | Habitation | Charcoal |
| 3,660 ± 80 BP (AMS) | OxA 1932 | Open | Habitation | Ceramic |
| 3,090 ± 60 BP (AMS) | OxA 1933 | Open | Habitation | Ceramic |
| 3,010 ± 70 BP (AMS) | OxA 1934 | Open | Habitation | Ceramic |
| 2,470 ± 50 BP (RC) | SUA 2400 | Open | Habitation | Plant matter (seed) |
| 2,450 ± 50 BP (RC) | SUA 2402 | Open | Habitation | Plant matter (seed) |

*Sources: Leong 2003; Nik Hassan et al. 1994.*

Table 17: Accepted dates (all RC) from the Bernam Valley cist grave sites.

| **Site** | **Cited date** | **Laboratory code** | **Aspect** | **Site use** | **Material class** |
|---|---|---|---|---|---|
| Changkat Menteri Field 9 | 2,325–1,925 bp | Beta 82675 | Monumental | Mortuary | Charcoal |
| Ulu Bernam | 2,345–2,065 bp | Beta 82673 | Monumental | Mortuary | Charcoal |
| Changkat Menteri Field 8 | 1,535–1,300 bp | Beta 82669 | Monumental | Mortuary | Charcoal |
| Changkat Menteri Field 9 | 255–175/ 150–0 bp | Beta 82672 | Open | Gardening | Charcoal |
| Changkat Menteri Field 8 | 295–0 bp | Beta 82668 | Open | Gardening | Charcoal |

*Source: Leong 2000.*

Table 18: Accepted dates (all RC) from Kuala Selinsing.

| **Cited date** | **Laboratory code** | **Aspect** | **Site use** | **Material class** |
|---|---|---|---|---|
| 2,030 ± 90 BP | Beta 31976 | Maritime | Habitation | Charcoal |
| 1,580 ± 70 BP | Beta 31978 | Maritime | Habitation | Plant matter (wood) |
| 1,740 ± 90 BP | Beta 31975 | Maritime | Habitation | Marine shell |
| 1,470 ± 70 BP | Beta 31977 | Maritime | Habitation | Marine shell |
| 1,020 ± 90 BP | Beta 31979 | Maritime | Habitation | Marine shell |
| 1,767±50 BP | BM-959 | Maritime | Mortuary | Boat |
| 1,810 ± 40 BP | Not stated | Maritime | Mortuary | Charcoal |
| 1,760 ± 40 BP | Not stated | Maritime | Mortuary | Charcoal |
| 1,650 ± 40 BP | Not stated | Maritime | Mortuary | Charcoal |
| 1,460 ± 40 BP | Not stated | Maritime | Mortuary | Charcoal |
| 1,450 ± 40 BP | Not stated | Maritime | Mortuary | Charcoal |
| 1,380 ± 40 BP | Not stated | Maritime | Mortuary | Charcoal |
| 1,630 ± 50 BP | Not stated | Maritime | Mortuary | Plant matter (wood) |

*Sources: Burleigh et al. 1977; Kamaluddin 1991; Zuliskander and Nik Hassan 2009.*

Table 19: Accepted miscellaneous Peninsular Malaysia estuarine dates (all RC).

| **Site** | **Cited date** | **Laboratory code** | **Aspect** | **Site use** | **Material class** | **Source** |
|---|---|---|---|---|---|---|
| Dengkil | 2,500 ± 70 BP | NZ4489 | Maritime | Transport | Boat | Batchelor and Fattah 1978 |
| Dengkil | 1,990 ± 50 BP | NZ4490 | Maritime | Transport | Boat | Batchelor and Fattah 1978 |
| Dengkil | 1,700 ± 95 BP | ANTW282 | Maritime | Habitation | Plant matter (wood) | Batchelor and Fattah 1978 |
| Kampong Sungai Lang | 1,850 ± 90 BP (RC) | GaK-864 (RC) | Maritime | Ceremonial | Boat | Leong 1989 |
| Pontian | 1,657 ± 60 BP | BM 958 | Maritime | Transport | Boat | Burleigh et al. 1977 |

Table 20: Occupation of Malaya closed sites as of the Late Glacial Maximum in addition to the closed sites accounted for in Figure 3.

| **Period** | **Additional closed sites** | **Number of additional sites** | **Site number including Figure 3 sites** |
|---|---|---|---|
| 18,000–14,000 bp | GU, GH | 2 | 2 |
| 14,000–12,000 bp | GU, GGR, GC, MK | 4 | 4 |
| 12,000–11,000 bp | GGR, MK, LR, GP, GT, GTK | 5 | 5 |
| 11,000–10,000 bp | GGR, MK, GC, LR, GT, GTK, SC, GTKB | 8 | 8 |
| 10,000–9,000 bp | GGR, GC, GP, GTK, PO, GTKB, GS | 7 | 9 |
| 9,000–8,000 bp | GGR, GTK, GS, GB, GBT | 5 | 7 |
| 8,000–7,000 bp | GGR, GTK, GB | 3 | 5 |
| 7,000–6,500 bp | GTK, GBT2, BB, PO | 4 | 10 |
| 6,500–6,000 bp | GTK, GBT, GN | 3 | 6 |
| 6,000–5,500 bp | BB | 1 | 3 |
| 5,500–5,000 bp | GBT2 | 1 | 4 |
| 5,000–4,500 bp | GH*, PO, BB | 3 | 6 |
| 4,500–4,000 bp | – | – | 1 |
| 4,000–3,000 bp | GC | 1 | 4 |
| 3,000–2,000 bp | GBT | 1 | 4 |
| 2,000–1,000 bp | – | – | 3 |
| 1,000–0 bp | – | – | 3 |

*Note: Additional sites assigned to a period based on their median BP determination (freshwater shell dates) or their median calibrated date (Pleistocene charcoal dates). Asterisked GH determination was a combined sample of bone and freshwater shellfish. Sources for these dates: Anderson 1990; Nik Hassan et al. 1990; Srisuchat 1993; Pookajorn 1996; Hassan 1998; Rahman 1998; Zuraina 1998; Adi 2000; Auetrakulvit et al. 2012. GU = Gua Sagu, GH = Gua Harimau, GGR = Gua Gunung Runtuh, GC = Gua Chawas, MK = Moh Khiew, LR = Lang Rongrien, GP = Gua Peraling, GT = Gua Tenggek, GTK = Gua Teluk Kelawar, SC = Sakai Cave, PO = Pak Om, GTKB = Gua Teluk Kelawar B, GS = Gua Singa, GB = Gua Batu Tukang, GBT = Gua Bukit Ta'at, GBT2 = Gua Bukit Ta'at 2, BB = Buang Baeb, GN = Gua Ngaum.*

Table 21: Association of burial goods with the Gua Cha Neolithic burials' demographic status.

| **Summary of burial goods** | | **Child** | **Female adult** | **Male adult** |
|---|---|---|---|---|
| 1 class | Pottery only | 1 | 0 | 1 |
| | Polished stone tool only | 0 | 0 | 1 |
| 2 classes | Pottery and polished stone tools | 1 | 0 | 3 |
| | Pottery and jewellery | 0 | 0 | 1 |
| 3 classes | Pottery, polished stone tools and jewellery | 1 | 0 | 1 |
| | Pottery, stone tool and spoon | 0 | 1 | 0 |
| | Pottery, jewellery and spoon | 0 | 1 | 3 |
| | Total | 3 | 2 | 10 |

*Child burials (top to bottom): Burials 5 (B.5), 28 (A.4, As.33.5.7), 25 (A.1, As.33.5.7). Female adults (top to bottom): Burials 27 (A.3, As.33.5.8), 8 (B.8, As.33.5.3). Male adults (top to bottom): Burials 11 (H.2, As.33.5.4), 31 (A.7, As.33.6.3A), 7 (B.7, As.33.5.2), 24 (H.13), 30 (A.6, As.33.6.2), 32 (A.8, As.33.5.10), 13 (H.4, As.33.5.5), 1 (B.1, As.33.5.1), 2 (B.2), 9 (B.9). Sources: Sieveking 1954; Bulbeck laboratory observations.*

Table 22: Summary of the Kedah/Wellesley inscriptions (after Jacq-Hergoualc'h 2002).

| **Inscription(s)** | **Context** | **Date (century CE)** | **Language/ script** | **Nature of text** |
|---|---|---|---|---|
| Bukit Meriam | Ruin foundation | 4th–5th | Sanskrit/South Indian | Buddhist homily |
| Kampong Sungai Mas | Associated with habitation debris | 5th | Sanskrit/South Indian | Buddhist homily |
| Mahanavika Buddhagupta | Old ruins | 5th | Sanskrit/South Indian | Buddhist homily plus personal dedication |
| Cherok Tokun | Carved on a large granite stone | 5th | Pali/South Indian | Buddhist homily plus dedication to a king |
| Bukit Choras site NB2 | Building ruins | 4th or 9th | Sanskrit/South Indian | Buddhist homily |
| Sungai Bujang site SB2 | Ruin foundation | 5th or 7th | Sanskrit/Pallava | Mahayana Buddhist homily |
| Sungai Bujang site SB14 | Ruin foundation (7 metal discs) | 8th/9th or 12th/13th | Sanskrit/Javanese | Bodhisattva names (Mahayana Buddhist) |

* David Bulbeck is an archaeologist and human osteologist who has focused his interests on Peninsular Malaysia and Sulawesi. His MA analysed Hoabinhian burials from Gua Cha in Kelantan and late Holocene burials from the Talaud Islands in North Sulawesi. Subsequently he expanded his research to cover all of the Hoabinhian and Neolithic burials from Gua Cha, supplemented by documentation of the burials from Gua Peraling and other sites in Peninsular Malaysia, and research into the dental anthropology and mitochondrial DNA of the Peninsula's *Orang Asli*. For his PhD, Bulbeck investigated the rise of Makassar (southwest Sulawesi) as a city-state through an analysis of Makassar's genealogical records and a reconstruction of the fourteenth to seventeenth century settlement patterns in Makassar's hinterland. His postdoctoral research project documented the prehistoric origins and pre-Islamic history of iron production in Luwuq, at the northeastern margin of southwest Sulawesi. Currently he is employed with a project, funded by the Australian Research Council to researchers in his department, on the prehistory of the lowlands near Lake Towuti in southeastern Sulawesi.

** All tables are in Appendix.