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Thạch Lạc and the Neolithic transition in north-central Vietnam, 3000–2000 BCE

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ABSTRACT

The initial arrival date of Neolithic populations into Mainland Southeast Asia from the region of modern southern China remains ambiguous. In the existing literature, this arrival is often considered to have occurred between 2500 and 2000 BCE, but this is far from certain. Here we report on our archaeological excavations at Thạch Lạc, Hà Tĩnh Province, north-central Vietnam. The site produced evidence of three cultural phases of pottery-using occupation, separated by brief hiatuses. These three phases are termed successively the Quỳnh Văn, Thạch Lạc, and finally the Bàu Tró, each defined by a distinct pottery tradition. Our radiocarbon chronology, based on a large sample of 26 charcoal and deer dentin samples, indicates that the overall Thạch Lạc sequence extended from ca. 3100 until after 2200 cal. BCE. These results raise new questions about our understanding of the timing for the initial arrival of “Neolithic” populations into Mainland Southeast Asia and their relationships with pre-existing local communities.

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Introduction

The earliest rice and millet agriculturalists in East Asia emerged in the Yangtze and Yellow river regions between 6000 and 4000 BCE, before spreading southwards through southern China and into Mainland Southeast Asia (hereafter MSEA; Bellwood 2017; Wang et al. 2022; Zhang and Hung 2008). Northern Vietnam, the subject region of this

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project, occupies a strategic location between southern China and the rest of MSEA. Its riverine and coastal soils contain many deeply stratified archaeological sites that offer some of the best-preserved records to investigate the regional Neolithic transition available anywhere in Southeast Asia. Neolithic is the term used here to reference the dynamic changes that can be identified in the archaeological record during this period, with a reshaping of economic strategies from the late middle Holocene hunter-gatherer occupation of the Đa Bút and Quỳnh Văn cultures, attested mainly in limestone caves and riverine or coastal shell-mounds in northern and north-central Vietnam, to sedentary settlements in lowland villages (Figure 1). The Neolithic transition in Vietnam is also marked by the first appearance of pottery with attributes that include decorative incision and impression (including punctation; Rispoli 2007, 2022), ring-feet, and angular rim and neck profiles, in addition to the continuous cord-marking and other kinds of paddle impression typical of the pre-existing Đa Bút and Quỳnh Văn. Other cultural and biological attributes of the Vietnamese Neolithic in this context include (but are not restricted to) supine (as opposed to the earlier flexed and squatting) burials with skeletal remains with East Asian craniofacial affinities, nephrite ornaments (in northern Vietnam), and quadrangular-sectioned quarried and ground stone adzes, mainly shouldered in early contexts (Piper et al. 2021). There is also evidence from many sedentary riverside settlement sites for deliberately laid floors using imported sediments and sometimes lime mortar (Grono, Piper, et al. 2022), and for the introductions of domesticated rice (*Oryza sativa*, *japonica* subspecies), millets (especially foxtail, *Setaria italica*), pigs, and dogs (Piper et al. 2021; Wang et al. 2022).

Although authorities have sometimes cited the centuries around 2500 BCE as the likely timing for the emergence of the Neolithic in MSEA (e.g., Bellwood 2013, 186; Zhang and Hung 2010), there has so far been little solid chronometric dating evidence to support such a time span with any precision. As a result, significant chronological gaps exist in our knowledge of the emergence of the Neolithic in Vietnam during the crucial millennia between 4000 and 2000 BCE. One of the aims of our research project is to bridge these gaps where possible and to create a solid chronological framework for the emergence of the Neolithic in Vietnam, and MSEA more broadly.

In this paper, we report on our investigations at Thạch Lạc, a key archaeological site in north-central Vietnam (Figure 1). Previous excavations at this site between 1962 and 2014 uncovered archaeological deposits that hinted at an occupation sequence within the targeted period, in this case between 3000 and 1500 BCE. The most recent investigations in 2015 by our collaborative team from the Vietnam University of Social Sciences and Humanities, Hà Nội, the Australian National University, and the Hà Tĩnh Provincial Museum, recorded three clear phases of occupation at Thạch Lạc (Lâm et al. 2021). Our results present a new radiocarbon chronology for the site, one which confirms that Neolithic communities were already present in northern MSEA by, or shortly after, 3000 BCE. The implications of these results for our understanding of the early coastal mobility of Neolithic communities into MSEA are also discussed.

Thạch Lạc: Excavation history

The archaeological site of Thạch Lạc is located in Thạch Lạc Commune, Hà Tĩnh Province, about 7 km from the town of Hà Tĩnh, at coordinates 105°57'42.68E/

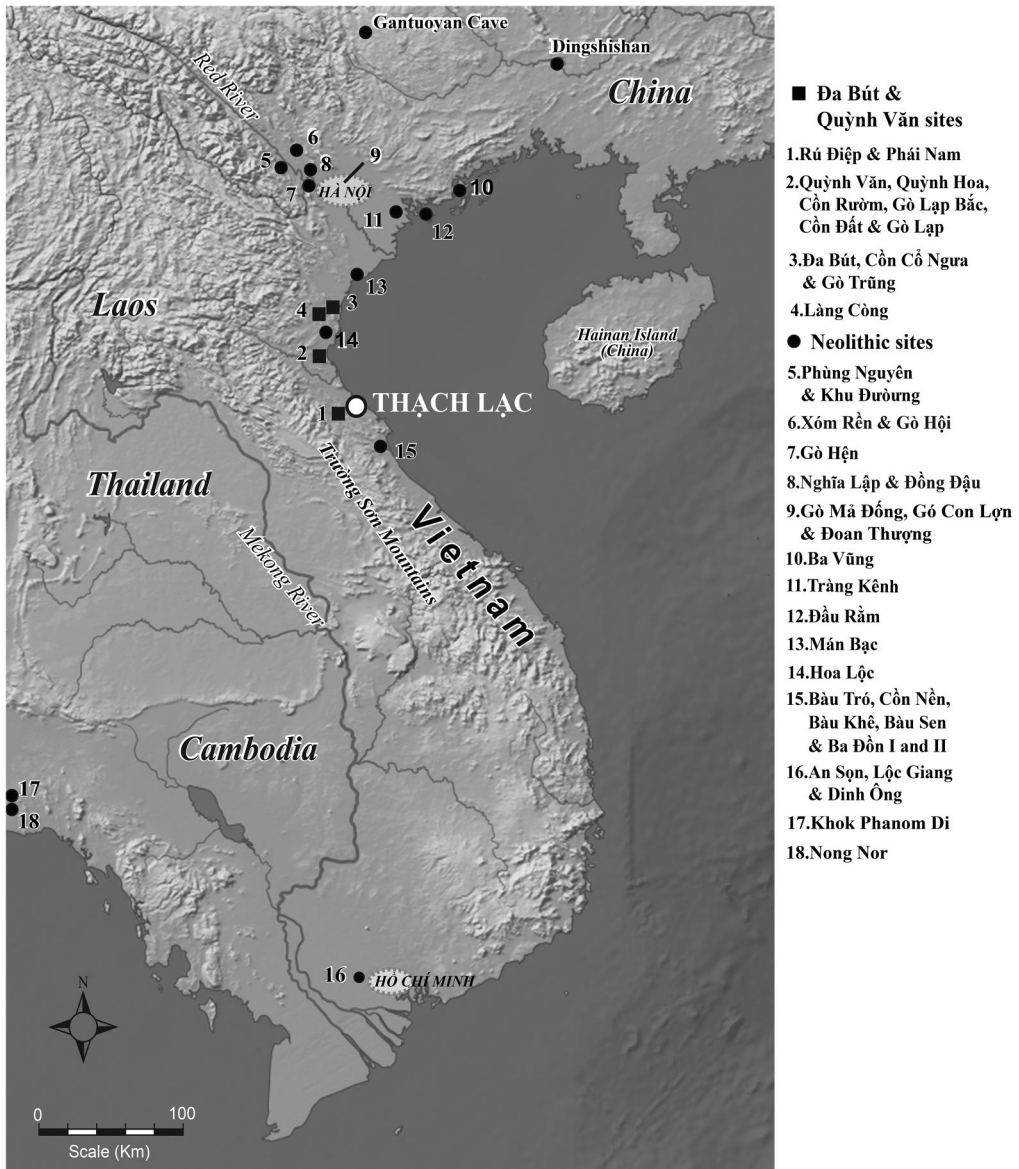


Figure 1. Archaeological sites discussed in the text and [Supplementary Information 1](#) and [2](#) (background map modified from [Treehouse-maps.com](#)).

18°21'59.09N (Figure 1). It now lies 4km inland from the modern coastline but adjoined directly the former middle Holocene coastline when it was first occupied around 3000 BCE.

The landscape surrounding the site is low and relatively flat, generally not higher than 2 m above modern sea level. The dominant landforms between Thạch Lạc and the modern coast are relict sand dunes that occupy a 2–3 km wide strip parallel to the present-day shoreline. This dune belt comprises a succession of individual dunes separated by low-lying sand plains and deflation surfaces, partially stabilized by vegetation, but

eroded and intensively modified by human activity. These relict dunes were formed as the sea receded from its high middle Holocene level and as alluvial and colluvial sediments accumulated along the coastline, and they record the positions of former coastlines (Boyd and Lam D. D. 2004; Grono, Friesem, et al. 2022).

The Thạch Lạc archaeological reserve, managed by Hà Tĩnh Provincial Museum, covers an area in excess of 12,000 m². The main mound is a 70 × 50 m oval that rises to a maximum of ca. 2 m above the modern landscape surface, located in the grounds of the Tăng Phúc temple (Figure 2).

Thạch Lạc had been surveyed and excavated on six previous occasions between 1962 and 2014 (Figure 2; Supplementary Information S1, Tables S1 and S2). Two were by the Institute of Archaeology, and its predecessor the Archaeology Team, in 1962–1963 and 2014. Other investigations were undertaken by the National Museum of History, Hà Nội; the Hà Tĩnh Department of Culture and Information; the Institute of Linguistics, Academia Sinica, Taipei (2002); the Department of Archaeology, University of Social Sciences and Humanities in Hà Nội; and the Hà Tĩnh Provincial Museum (2002–2005). These investigations identified a sequence of between four and six deposits (including the upper modern horizon and the basal natural sands and clays) of varying depths. This sequence sometimes included one or two hiatuses between the upper and middle cultural layers, and/or toward the bottom of the sequence between the middle and initial phases of activity.

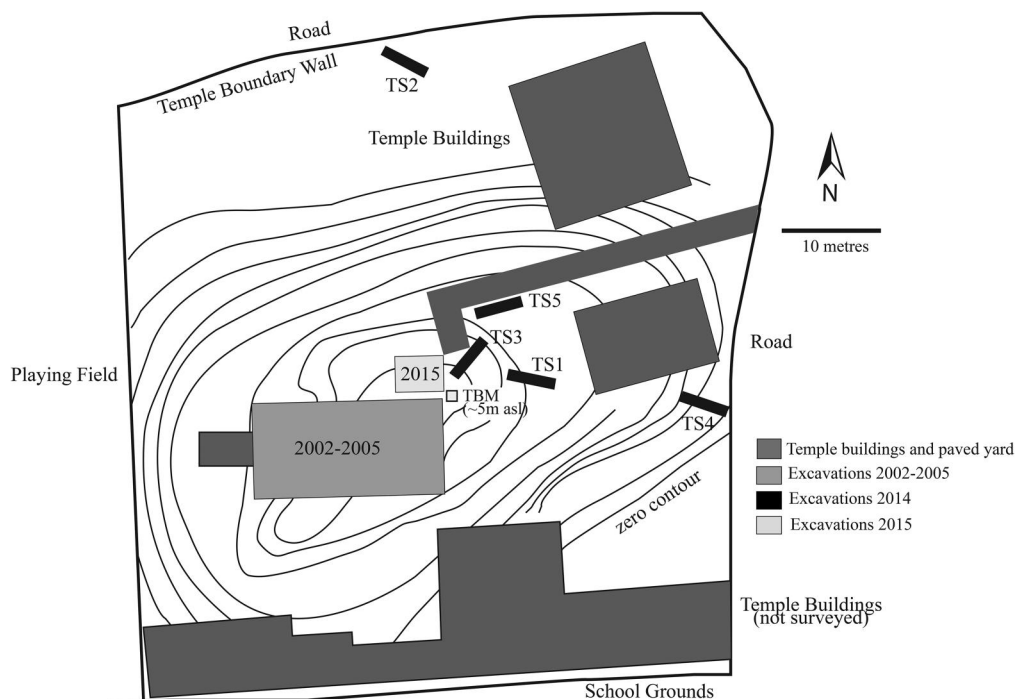


Figure 2. Thạch Lạc trench location map (contours—0.1 m height increments). It is unclear where the 1963 excavations were located so they are not mapped. Illustration by Thạch Lạc archaeological team; modified from Lâm et al. (2021).

Table 1. The contextual and material information, and calibrated unmodelled radiocarbon dates from the 2015 excavations at Thạch Lạc (CRA = conventional radiocarbon ages).

Phase	Lab no.	Context no.	Material ID	CRA $\pm$ error (BP)	Calibrated age BCE (68.2% prob.; un-modelled)	Calibrated age BCE (95.5% prob.; un-modelled)
Bàu Tró	Wk-41888	C.102	Charcoal	3863 $\pm$ 20	2450–2290	2460–2210
	Wk-41889	C.102	Charcoal	3887 $\pm$ 20	2460–2340	2460–2300
	Wk-41890	C.102	Charcoal	3888 $\pm$ 20	2460–2340	2460–2300
	Wk-41891	C.102	Charcoal	3911 $\pm$ 20	2460–2350	2470–2310
	Wk-42415	C.102	Dentine: Cervidae	3787 $\pm$ 20	2280–2150	2290–2140
	Wk-42416	C.102	Dentine: Cervidae	3854 $\pm$ 20	2400–2210	2460–2210
	Wk-42417	C.102	Dentine: Cervidae	3826 $\pm$ 20	2300–2210	2400–2150
	Wk-42418	C.102	Dentine: Cervidae	3831 $\pm$ 20	2340–2210	2400–2160
Thạch Lạc	Wk-42419	C.102	Dentine: Cervidae	3921 $\pm$ 20	2479–2350	2470–2310
	Wk-41894	C.104	Charcoal	4106 $\pm$ 23	2850–2580	2860–2570
	Wk-41895	C.104	Charcoal	4182 $\pm$ 20	2880–2700	2880–2670
	Wk-41898	C.106	Charcoal	4117 $\pm$ 20	2850–2630	2860–2560
	Wk-41899	C.106	Charcoal	4165 $\pm$ 20	2870–2700	2880–2640
	Wk-41903	C.108	Charcoal	4217 $\pm$ 20	2890–2780	2300–2700
	Wk-41905	C.109	Charcoal	4213 $\pm$ 20	2890–2780	2900–2700
	Wk-42425	C.109	Dentine: Cervidae	4160 $\pm$ 20	2870–2680	2880–2640
	Wk-42426	C.109	Dentine: Cervidae	4130 $\pm$ 20	2850–2630	2870–2580
	Wk-41907	C.110	Charcoal	4190 $\pm$ 20	2880–2710	2890–2680
	Wk-41908	C.110	Charcoal	4144 $\pm$ 20	2870–2640	2870–2630
	Wk-41910	C.111	Charcoal	4137 $\pm$ 23	2860–2630	2870–2590
Quỳnh Văn	Wk-42429	C.111	Dentine: Cervidae	4174 $\pm$ 20	2870–2700	2880–2670
	Wk-41912	C.112	Charcoal	4160 $\pm$ 20	2870–2680	2890–2640
	Wk-41914	C.113	Charcoal	4449 $\pm$ 20	3310–3030	3330–3020
	Wk-41916	C.114	Charcoal	4363 $\pm$ 20	3010–2920	3070–2910
	Wk-41917	C.114	Charcoal	4389 $\pm$ 20	3020–2930	3090–2920
	Wk-41919	C.114	Charcoal	4423 $\pm$ 20	3100–3010	3310–2930

The excavations produced considerable quantities of material culture, including thousands of pottery fragments, shouldered and quadrangular stone adzes, clay “ling-ling-o” earrings, and bone tools. Eight radiocarbon dates (three from 2002 and five from the 2003–2004 excavations) suggested a chronology for the site that extended from ca. 3300 to 1500 cal. BCE at the outer limits (Hà Nội Institute of Archaeology and Hà Tĩnh Museum 2014; Nguyễn T. H. 2005; Nguyễn T. T. 2006; Nguyễn V. H. 2005; Nguyễn C. and Nguyễn T. T. 2013; Nguyễn T. K. and Hà N. Đ. 1963; Trần 2004).

The various excavations undertaken at Thạch Lạc between 1962 and 2014 had provided varying, and slightly contradictory, insights into the site’s archaeological record. Although most scholars agreed that Thạch Lạc possessed evidence of a well-preserved archaeological sequence that encompassed three important cultures in north-central Vietnam, these being successively the Quỳnh Văn, the Thạch Lạc, and the Bàu Tró, differences in interpretation of the archaeological record had resulted in differing hypotheses (Hà V. T. 1978, 1982; Hà V. T. and Nguyễn X. N. 1978; Hoàng X. C. 1966, 1981; Nguyễn T. C. 1998; Phạm T. N. 2000, 144–5; [Supplementary Information S1](#)). The stratigraphic and chronological links between these three phases remained unclear, as did the overall chronology. Hence our decision to re-excavate the site in 2015.

Thạch Lạc chronostratigraphy

The 2015 excavation consisted of a single 5 $\times$ 4 m trench positioned parallel to, and 2 m north of, the main trench (since backfilled) excavated in 2002–2005 ([Figure 2](#)). The

(A)



(B)

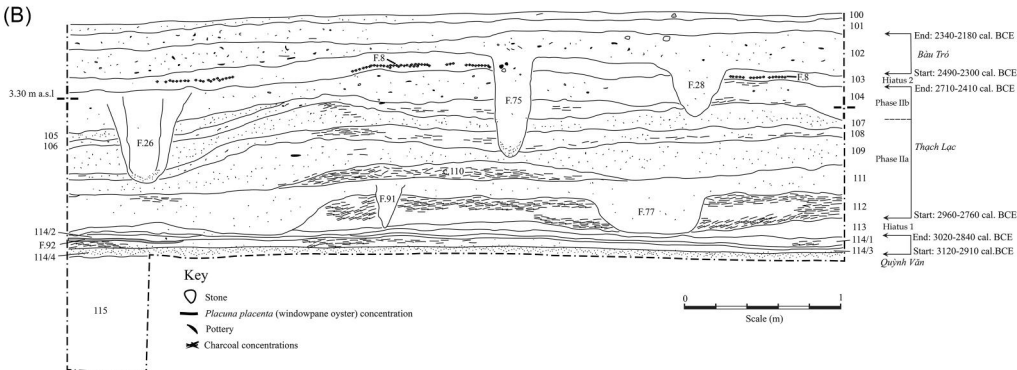


Figure 3. (A) The north wall of the 2015 Thạch Lạc excavation trench, illustrating the different depositional contexts (numbered 100–115 from the topsoil to the base of the site) and intrusive features (with F. numbers), the radiocarbon chronology, and the stratigraphic separation of Phases I–III (here labeled Quỳnh Văn, Thạch Lạc, and Bàu Tró respectively from bottom to top; horizontal scale = 1m). The start and end dates for each phase are based on Model B durations; see [Figure 4](#) and [Supplementary Information S3, Tables S4 and S5](#) and [Figure S1](#). (B) Diagrammatic explanation of the stratigraphy of the north wall of the 2015 Thạch Lạc excavation trench, as shown in [Figure 3A](#).

excavation employed a range of sampling and recovery techniques, including context recording, wet-sieving, flotation, geomorphological bulk sampling for sediment thin-sectioning, and phytolith sampling ([Supplementary Information 2](#)). Our 2015 excavation demonstrated that the site stratigraphy included 11 depositional layers of combined cultural and natural origin ([Figure 3A](#) and [B](#)), termed “contexts” for recording purposes during the excavation (see Grono, Friesem, et al. [2022](#); [Supplementary Information 2](#)). These were grouped into three phases of human occupation, denoted Phase I (context 114), Phase II (contexts 112–104), and Phase III (context 102). These occupation contexts were separated by two short hiatuses (contexts 113 and 103), when occupation appears to have been interrupted ([Figure 3A](#) and [B](#)).

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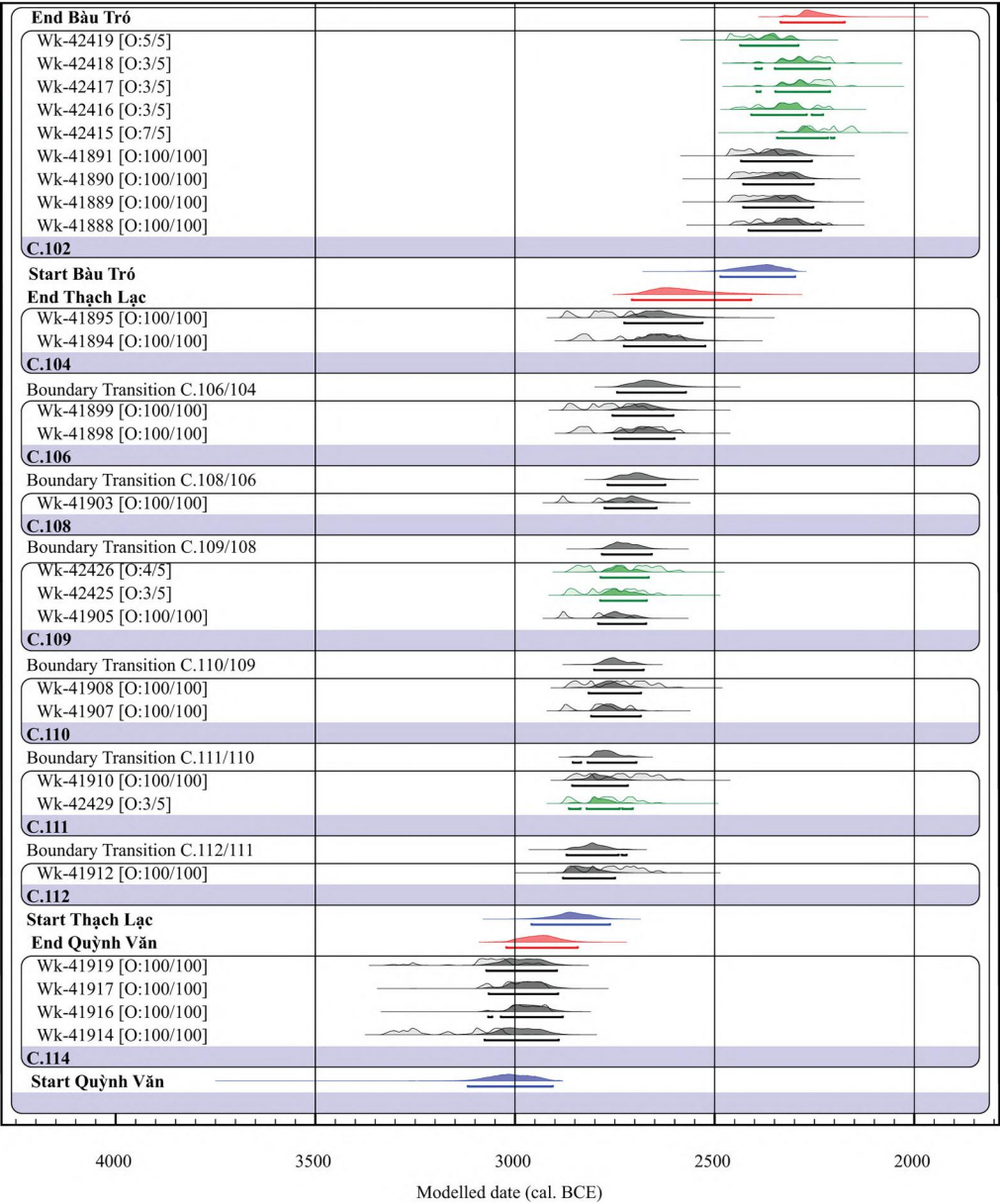


Figure 4. Calibrated and modeled ages (cal. BCE) from Thạch Lạc, in stratigraphic order with the oldest at the bottom. Probability distributions on charcoal were modeled using Model B, the Charcoal_ Plus Outlier Model, those on bone (highlighted green, online version) the General T-type Outlier Model (Model B, [Supplementary Information S3, Table S4](#)); Blue = Phase start dates; Red = Phase end dates, online version).

The Thạch Lạc radiocarbon chronology is built around 18 charcoal and eight Cervidae (deer) tooth dentin samples dated at the University of Waikato Radiocarbon Laboratory, using protocols described and illustrated in [Table 1](#), [Figure 4](#), and [Supplementary Information S3, Tables S3–S5](#) and [Figure S1](#). This chronology indicates



Figure 5. Thạch Lạc pottery features. Not reproduced to the same scale. Photography by Nguyễn Thị Thúy, Peter Bellwood, and Maggie Otto. Figure assembled by Peter Bellwood.

that the site was occupied between 3120 and 2840 cal. BCE (Table 1, Figure 4), and the three phases of occupation are as follows (depositional history is based on Grono, Friesem, et al. 2022):

Phase I (Context 114): During this short-lived basal phase (overlying the natural clays of context 115), the first people to visit the site were exploiting the nearby active sandy shoreline. Human activity was intermittent (resulting in a series of thin discontinuous layers referenced as contexts 114/1–114/4 and F.92) and focused on the collection of mollusks (Figure 3A and B). Based on Bayesian modeling (Model B; four dates on charcoal), Phase I (the Quỳnh Văn phase) at Thạch Lặc lasted no more than 200 years, from 3120 to 2840 cal. BCE at outer limits (Figure 4; Supplementary Information S2, Tables S4 and S5).

The thin and ephemeral shell midden layers of Thạch Lặc Phase I contained little material culture. The assemblage was classified as belonging to the Quỳnh Văn culture because it included two pottery pointed bases (Figure 5, top left). Such pointed bases are common in some Quỳnh Văn sites including the basal layer at the shell-mound site of Rú Điệp near Thạch Lặc, also excavated by us in 2015 (Lam et al. 2020, see below). Pointed bases do not occur in later contexts at Thạch Lặc. Phase I had no rim or vessel profiles that could be usefully reconstructed. Otherwise, the surface markings (“decoration”) on sherds of this phase are like those from both Rú Điệp (see Lam et al. 2020) and the following Phase II at Thạch Lặc in being dominated by relatively fine cord-marking, usually close-set, and either parallel or crossed (Figure 5, top row). One Phase I sherd carried the type of vine-impression that characterized Đa Bút pottery in Thanh Hóa Province to the immediate north (Figure 5, top right, and compare with Oxenham et al. 2018, Figure 3 from Cồn Cỏ Ngựa). However, apart from this and the pointed bases, the Phase I sherds at Thạch Lặc were of the same grayware that characterized Thạch Lặc Phase II above. A few stone artifacts, including pounders and fragmentary grinding stones, but no stone adzes, were also recovered from Phase I.

Hiatus 1 (Context 113): Thạch Lặc Phase I was followed by a short hiatus in human activity marked by a thin deposit of calcitic silty clay, indicative of submergence under marine conditions. Due to the proximity of the site to the former coastline, it is hypothesized that these sediments were deposited during a mid-Holocene period of sea level transgression dated to ca. 2900 cal. BCE.

Phase II (Contexts 112–104): The Phase II archaeological record includes several contexts that were divided into two sub-phases (IIa and IIb), based on changes in depositional regime and intensity of human activity. Phase IIa (contexts 112–105) consisted of a series of short-lived activities that included short stay/transient visits and single dumping episodes. These produced accumulations of discarded anthropogenic debris that included bones (some burned), marine shells (mostly *Placuna placenta* and *Tegillarca granosa*), potsherds (some with burned residues), charcoal, and rare burned sediment aggregates (human derived charcoal and burnt bone). These accumulations were punctuated by periods of human abandonment and accumulation of natural eolian sand. There is some evidence for the erection of small post features (F.91) and other unidentified features (F.77; Figure 3B).

Phase IIb (context 104) reflected a more stable environment associated with dense concentrations of archaeological material. The erection of large wooden post structures

(e.g., F.26, [Figure 3A](#) and [B](#)) suggests a permanence of occupation that had been absent in the earlier phases. However, there were no discernible changes in material culture between Phases IIa and IIb.

The Thạch Lạc Phase II pottery, like that of Phase I, is generally dark gray/brown and sand tempered. The Phase II basal contexts, especially context 111, also contained sherds with a distinctive calcareous sand temper that perhaps reflected a contemporary beachside location for the site. Phase II vessels had the same surface modification as in Phase I, mostly cord-marked with varying degrees of coarseness and spacing, and more rarely with linear and close-set surface striations (combing), parallel or crossed. The cord-marking was probably rolled on to pot surfaces before firing using rollers wrapped with twisted cords of varying diameter, with the cords spaced varying distances apart (see the illustrated examples in [Figure 5](#), middle section). Incision and vine-rolling occur, but rarely. Most of this surface “decoration” in Phases I and II seems to have been roughening for holding purposes when vessels were wet and slippery.

Thạch Lạc Phase II rim orientations suggest an assemblage dominated by small bowls with direct rims, mostly restricted/inverted or vertical ([Figure 5](#), middle and [Figure 6](#), lower). Low ring-feet became common in this phase and pointed bases are completely absent. The Thạch Lạc Phase II assemblage has similarities to pottery recovered from three sites bordering Phú Thọ Province and now destroyed by developments in Hà Nội—Gò Mả Đống, Gò Con Lợn, and Đoan Thượng. A single radiocarbon date of 4145 ± 60 uncal. BP (no code) or 2888–2506 cal. BCE from a depth of 0.6 m at Gò Mả Đống also hints at the possibility of an “early” Neolithic occupation (Hà, V. P. 1981; Hà V. T. 1999; Phạm L. H. 1973; Phạm T. L. H. 1972; Phạm L. H. and Nguyễn Q. M. 2001), similar to that in Thạch Lạc Phase II.

Phase II produced several pounders and grinders, like Phase I. The main difference was that quarried and fully ground adzes make their appearance in this phase for the first time ([Figure 7](#)), all shouldered. Gò Mả Đống, Gò Con Lợn, and Đoan Thượng also produced a predominance of shouldered adzes.

Based on the sample of 13 radiocarbon dates on charcoal and deer tooth dentin from Phases IIa and IIb, this occupation lasted for between 100 and 480 years, between 2960 and 2410 cal. BCE ([Figure 4](#); [Supplementary Information S3](#), [Tables S4](#) and [S5](#)).

Hiatus 2 (Context 103): Phase II was overlain by a light yellowish brown sandy loam (context 103) that accumulated during a short period of site abandonment, calculated to be less than 130 years, at some time between 2600 and 2400 cal. BCE ([Figure 3A](#) and [B](#); [Supplementary Information S3](#), [Table S4](#)).

Phase III (Context 102): During this period of occupation there was considerable investment in construction marked by post holes (F.75 and F.28; [Figure 3A](#) and [B](#)). The settlement was now located some distance inland from the contemporary coast and adjacent to the lower course of a former river. Flotation samples of charred macrobotanical specimens (e.g., F.8) from Phase III contexts indicate low presences of rice, coconut, *Canarium*, walnut, and *Celtis* sp., although none of these remains have been directly radiocarbon dated, and it is unclear whether the rice was of a domestic or wild variety (Ceron 2021). However, starch grains from the surfaces of grinding stones from the Neolithic site of Trảng Kênh, located 130 km north of Thạch Lạc on the northern edge of the Red River Delta (which was under shallow sea during the mid-Holocene),

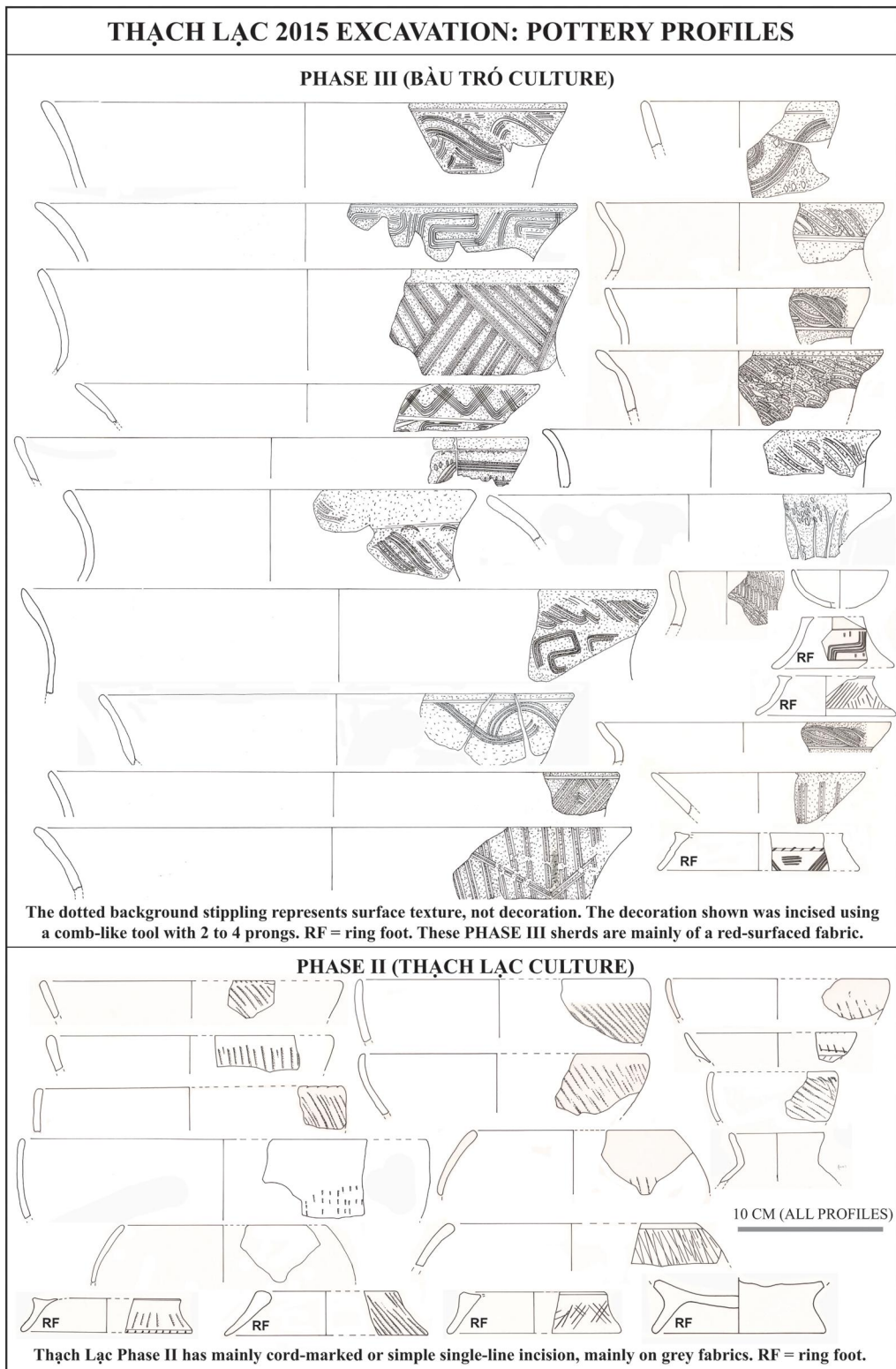


Figure 6. Thạch Lặc rim and foot profiles from Phases II and III. Sherds drawn by Nguyễn Thị Thúy, Nguyễn Thị Lan, and Lê Thị Mơ Man. Adobe Illustrator figure assembled by Peter Bellwood.

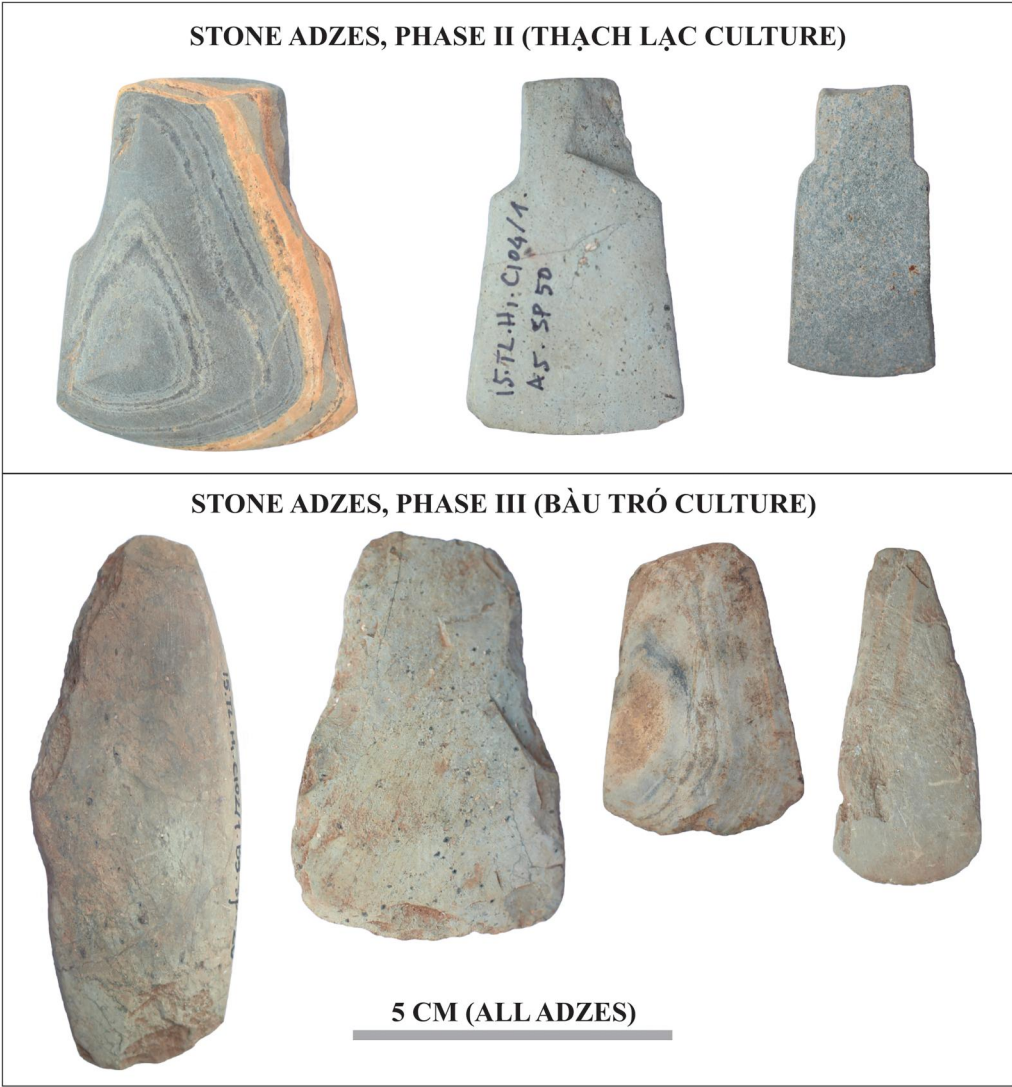


Figure 7. Stone adzes from Thạch Lạc Phases II and III (none were found from Phase I).

have recently revealed high representations of both rice and foxtail millet from contexts dating to the early second millennium BCE (Wang et al. 2022). Furthermore, phytolith research at Gancaoling, close to the Pearl River Delta in Guangdong Province in neighboring southern China, has confirmed a presence of both rice and foxtail millet by 2800–2600 BCE (Deng et al. 2022). So, farmers were clearly approaching the vicinity of northern Vietnam by this time.

Nine radiocarbon dates on charcoal and deer tooth dentin indicate that the Phase III occupation lasted between 10 and 250 years, between 2490 and 2180 cal. BCE (Figure 4; Supplementary Information S3, Tables S4 and S5). The deposits above context 102 had been re-worked by recent activity impacting dating sample recovery, and an end date for this phase of occupation could not be established. A single date on charcoal recovered from a depth of 0.45 m in the 2003 excavations, of 3380 ± 70 BP, or 1880–1510 cal.

BCE (SNU-04-053; Nguyễn T. T. 2006), suggests that several centuries of Neolithic archaeology might have been lost from the top of the Thạch Lạc mound due to later disturbance (Supplementary Information S1, Table S2).

The Thạch Lạc Phase III pottery is predominantly sand-tempered red, often red-slipped, and thus visually different from that in Phases I and II. Large vessels with everted rims were decorated with comb-incision that created swirling curvilinear or rectilinear meander-like patterns. The small bowl forms with direct in-turned or vertical rims that dominated in Phase II appear to have retreated from fashion. However, some cord-marking continued to be applied to vessel bodies below the neck, and ring-feet like those of Phase II continued, but now much higher and decorated with comb-incised designs (Figure 6, bottom).

The Phase III quarried and shaped stone adzes differed from those in Phase II in that they were both shouldered and unshouldered (Figure 7). Simple baked clay penannular earrings (Figure 5) and baked clay bow pellets made an appearance in Phase III.

The hiatus in activity and the considerable differences in material culture evident between Thạch Lạc Phases II and III perhaps indicate abandonment of the site by one population and reoccupation by another sometime during the mid-third millennium BCE.

Thạch Lạc and the Neolithic transition

The 2015 excavations at Thạch Lạc illustrated that the depositional sequence was indeed well-preserved. Based on interpretation of the general archaeological record, micromorphological analyses (Grono, Friesem, et al. 2022), and different comparative attributes of the material culture recovered, three phases of activity can be clearly distinguished, secured by a robust chronological framework. Our research supports Nguyễn Trung Chiến's (1998) proposed chronological sequence of Quỳnh Văn, followed by Thạch Lạc, and then Bàu Tró (Supplementary Information 1). The earliest phase (Phase I) of Quỳnh Văn activity occurred during the late fourth to early third millennia BCE. The Thạch Lạc phase extended through much of the first half of the third millennium BCE, and finally the Bàu Tró appeared in the middle of the third millennium BCE. Within this sequence a transition from coastal foraging to more permanent settlement construction can be observed, as the sea receded.

So, how do the 2015 excavations at Thạch Lạc improve understanding of the regional Neolithic transition? Here, we discuss each of the archaeological phases/cultures in sequence, starting with the oldest, and place them in regional context.

The Quỳnh Văn culture: Ca. 3200–2900 cal. BCE

The Quỳnh Văn culture is known from about 22 sites on the coastal plain of Nghệ An and Hà Tĩnh provinces. All are shell-mounds concentrated in Quỳnh Lưu District (Nghệ An Province), such as Quỳnh Hoa, Quỳnh Văn, and Cồn Ruồm. These consist predominantly of layers of windowpane oyster shells (*Placuna placenta*), some with surviving heights up to 7 or 8 m (Figure 1). Along with grinding stones and pottery (but no ground and/or polished quarried or pebble stone axes or adzes), sites such as Quỳnh Văn and Gò Lấp Bắc have also produced flexed burials (Hoàng X. C. 1963–1964; Lam et al. 2020; Nguyễn T. C. 1998, 14–9).

There is no surviving evidence for the prior existence of a Quỳnh Văn shell-mound at Thạch Lạc, perhaps because the site was directly on the shoreline and thus adversely affected by coastal activity and erosion (Grono, Friesem, et al. 2022). However, the recovery of three loose human bones (an ulna shaft fragment, toe phalange, and metatarsal) suggests that burials might have been placed in the site during this phase.

During the excavation of Thạch Lạc in 2015, we also excavated the Quỳnh Văn shell-mound of Rú Điệp, located 12 km southwest of Thạch Lạc in Thạch Đài Commune, Thạch Hà District, Hà Tĩnh Province. Rú Điệp contained 1.8 m of *in situ* shell-mound, stratified below 0.5 m of debris dumped from the recent quarrying of the shells for lime fertilizer. Lam et al. (2020) considered Rú Điệp to be a possible example of deliberate mound construction with evidence of a consecutive sequence of surfaces associated with postholes and combustion features, indicating that the site was used for habitation. Twenty-two radiocarbon dates on charcoal taken throughout the Rú Điệp archaeological sequence suggest a rapid accumulation of the basal mound that might have lasted no more than a few decades, centered around ca. 3200 cal. BCE (Lam et al. 2020; Figure 8A and B, Supplementary Information S3, Table S6 and Figure S2). The site produced several pointed pottery bases, plus cord-marked and striated sherds, all paralleled closely in Thạch Lạc Phase I. Other, more unusual finds at Rú Điệp not found at other Quỳnh Văn sites so far included a fragment of quadrangular-sectioned adze and an *in situ* adult supine burial (rather than a flexed burial). Unfortunately, samples of human bone sent for aDNA analysis to the Department of Evolutionary Genetics, Max Planck Institute for Evolutionary Anthropology in Leipzig produced no collagen and it was not possible to identify the ancestral affinities of the individual.

In terms of the overall development of the Quỳnh Văn culture, Nguyễn Trung Chiến (1998, 208–10) has argued that it went through two developmental stages in Nghệ An Province before spreading into Hà Tĩnh Province. The oldest sites, such as Quỳnh Văn, Quỳnh Hoa, and Cồn Ruồm, are located on the inland side of the mid-Holocene Quỳnh Lưu Bay, a paleosea that extended inland as far as the limestone massif to the west of the modern AH1 road between Hà Nội and Hồ Chí Minh City. They were occupied when Holocene sea levels were at their highest and before the modern coastal plain had formed (Bùi V. 1979, 93; Nguyễn T. C. 1984; Nguyễn V. H. 1979, 60–1; Nguyễn T. K. and Hà N. Đ. 1963).

The proposed younger sites, such as Gò Lấp Bắc and Cồn Đất, lie close to the modern coastline on sand dunes to the east of Quỳnh Văn and Quỳnh Hoa. Thus, they are considered to have been founded after sea levels had dropped significantly, the gulf had receded, and the coastal sand dune belt had started to form. Finally, the sites of Rú Điệp, Phái Năm, and Thạch Lạc Phase I in Hà Tĩnh Province are considered by Nguyễn Trung Chiến (1998) to belong to an even younger phase, reflecting southward expansion of the Quỳnh Văn culture from Nghệ An Province.

However, our new data provide little support for this proposed Quỳnh Văn chronology. Nguyễn T.C. (1998, 93–5) reported 14 radiocarbon dates from Quỳnh Văn sites, mostly on marine shells (*Placuna placenta*). They vary from 3380 to 2790 cal. BCE (Bln-914/I and Bln 914/II) at Quỳnh Văn, to as recently as 170–600 cal. CE (Bln 2696/I) at Cồn Đất. Some fall within the expected range based on the Rú Điệp and Thạch Lạc Phase I chronologies, whereas others appear far too young (Supplementary Information 3, Table S6). Our recent research at Thạch Lạc has shown that dates on *Placuna*

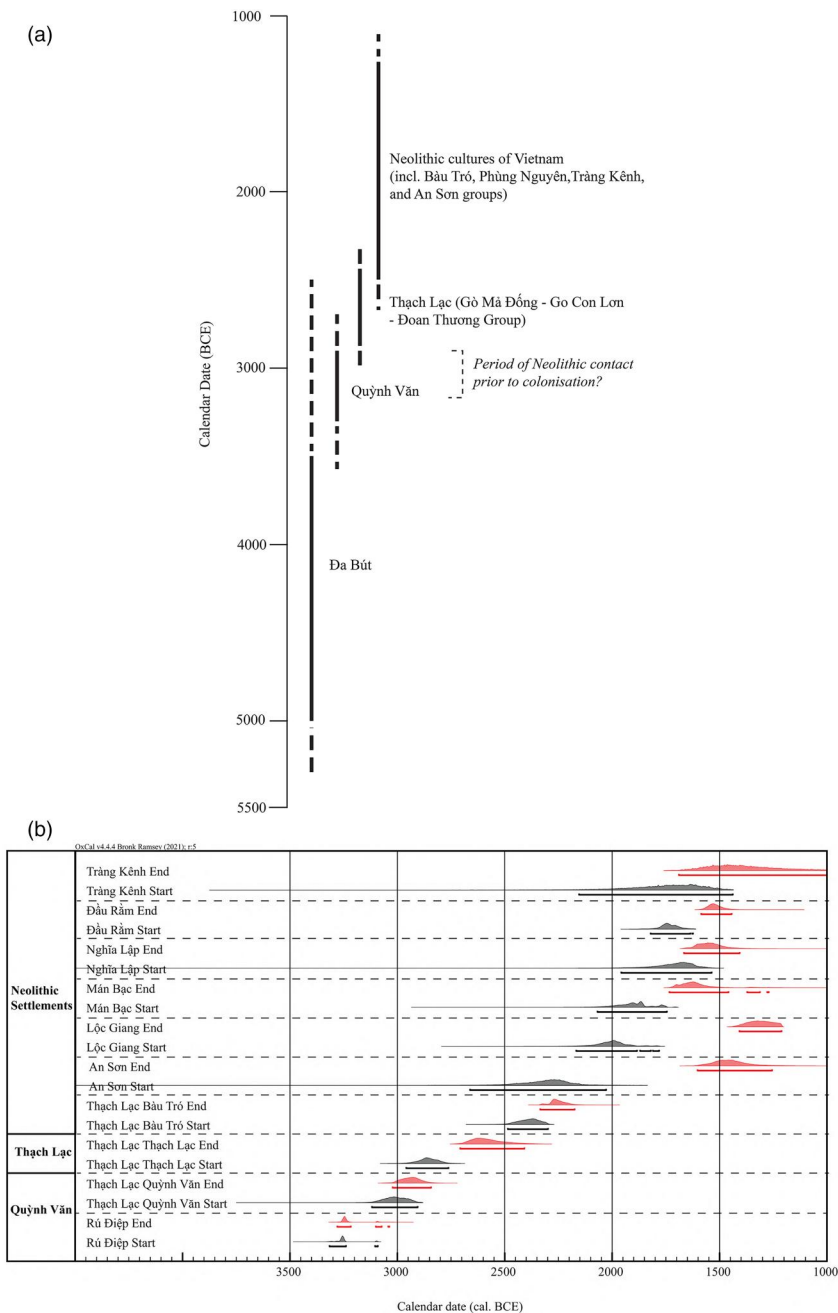


Figure 8. (A) The age ranges for the major cultures and phases discussed in the text (solid lines reflect the robustly dated phase whereas the dashed lines are unverified possible extensions to phase chronologies). (B) The modeled start (black) and end dates (dark grey; red in online version) for sites with more than four radiocarbon dates associated with the Quỳnh Văn, Thạch Lạc, and “Neolithic” cultures of Vietnam (start dates on or before 1800 cal. BCE; see Table 1, Figure 4, and Supplementary Information, Tables S4–S6 and S8–S13 and Figure S1–S8).

placenta may be affected by secondary calcite recrystallization within an open system and this likely means that many dates from Quỳnh Văn sites in Nghệ An Province are inaccurate and too young (Petchey et al. 2022). Further research is required to determine the full chronological span of the Quỳnh Văn culture (Lam et al. 2020).

Nonetheless, there are some features of the Quỳnh Văn culture in Hà Tĩnh Province that might indicate that it is later than in Nghệ An Province. For example, the thin-walled pottery and pointed bases from Thạch Lạc I and Rú Điệp, together with the Neolithic adze and supine extended burial at Rú Điệp, differentiate these sites from the Quỳnh Văn shell-mound culture in Nghệ An Province, with its flexed and seated burial postures. These observations leave open the question of the affinities of the presumed-later Quỳnh Văn assemblages in north-central Vietnam, and it might be that archaeologists will need to differentiate between the potentially earlier shell-mound phases of the Quỳnh Văn culture in Nghệ An and a later phase, represented in Thạch Lạc I and Rú Điệp, in which Neolithic markers were introduced into the region, perhaps existing side-by-side with an indigenous pottery tradition that might have favored pointed bases for pots, similar to many of the Paleolithic pottery traditions (including Jomon of Japan) in East Asia.

What is clear is that there was little relationship between the Đa Bút culture, primarily located in Thanh Hóa and Ninh Bình provinces, and the Quỳnh Văn culture of Nghệ An and Hà Tĩnh provinces. Beyond the fact that both were foraging communities, and Quỳnh Văn and Đa Bút populations buried their dead in flexed positions (as throughout Southeast Asia at this time), the material culture associated with the two communities differed considerably (see Lam et al. 2020). For example, the Quỳnh Văn pottery is finer and more diverse than the Đa Bút pottery. On the other hand, edge and fully ground pebble axes are common in the Đa Bút culture, but completely absent from the Quỳnh Văn.

Outstanding problems with the dating of the Đa Bút culture are reviewed by Lam et al. (2020), but, in short, the chronology accepted by Vietnamese archaeologists for the Đa Bút culture extends from ca. 5000 BCE to 2500 BCE (Nguyễn G. Đ. 2014; Nguyễn X. N. 2014; Oxenham et al. 2018; Trinh H. H. and Huffer 2015). However, none of the directly dated Đa Bút sites have a chronology that is younger than 3500 BCE (Figure 8A; Supplementary Information 3, Table S7). Our radiocarbon sequences place the start of the Quỳnh Văn culture in Hà Tĩnh Province at the end of the Đa Bút culture, though further research might indicate some temporal overlap between the earlier phases of the Quỳnh Văn in Nghệ An Province and Đa Bút. Indeed, the Đa Bút and Quỳnh Văn cultures appear to be quite separate and distinct, both culturally and geographically.

The Thạch Lạc culture: Ca. 2900–2500 cal. BCE

There have long been debates amongst Vietnamese archaeologists about the role of the enigmatic Thạch Lạc culture within the prehistory of north-central Vietnam. It has been variously referred to as a regional variant of the Bàu Tró culture that evolved directly from the Quỳnh Văn (Hà V. T. 1978; Phạm T. N. 2000, 144–5), or as an independent culture situated chronologically between the preceding Quỳnh Văn and the succeeding Bàu Tró cultures (Nguyễn T. C. 1998; Supplementary Information S1). The Thạch Lạc culture at Thạch Lạc (Phase II) is chronologically distinct and has a distinctive material culture repertoire that separates it from the earlier Quỳnh Văn and the later Bàu Tró cultures.

Dating to the first half of the third millennium BCE, Thạch Lạc Phase II is singular in the Vietnamese context. It pre-dates those sites with incised and impressed pottery decoration that characterize the Neolithic in Vietnam ca. 2500–2000 BCE. Such sites include Phùng Nguyên, Mán Bạc, Xóm Rền, An Sơn, and Lộc Giang (see Piper et al. 2021; Rispoli 2007, 2022; Sarjeant 2014; Figure 8A and B). The Thạch Lạc Phase II main vessel forms appear to have been small bowls with direct rims, variously inverted, vertical, or everted, with no clear presence of the large-diameter everted rims and comb-incised decoration that characterized Thạch Lạc Phase III and the Bàu Tró culture (Figure 5, bottom and Figure 6, top). No clay penannular earrings or bow pellets (common in Phase III contexts at Thạch Lạc) could be confidently assigned to this phase, and there is currently no solid evidence for plant domestication (Ceron 2021; microbotanical research is still ongoing).

The now destroyed archaeological sites of Gò Mả Đống, Gò Con Lợn, and Đoan Thượng to the north, within Hà Nội City, could potentially have had cultural horizons contemporaneous with Thạch Lạc Phase II, as discussed above. Interestingly, these sites also produced impressed and incised pottery and clay earrings more typical of Phùng Nguyên culture sites. Some Vietnamese archaeologists suggest that the Gò Mả Đống–Gò Con Lợn–Đoan Thượng group both predated and later contributed to the development of the Phùng Nguyên culture (Nguyễn G. Đ. 2014; Nguyễn X. N. 2014). However, at Thạch Lạc there is a hiatus between the Thạch Lạc and Bàu Tró phases that is not commensurate with arguments for a direct relationship between the two phases of occupation. Thus, there remains the possibility that Thạch Lạc Phase II represents an early arrival of the Neolithic into northern Vietnam separate from that which led to the dominant later Neolithic cultures, such as the Phùng Nguyên, Tràng Kênh, and Bàu Tró.

There are other poorly understood archaeological sites and cultures that might also be associated with this phase of activity. For example, Ba Vững on Cát Bà Island belonging to the Hạ Long culture (Quảng Ninh Province) has a single carbon-14 (^{14}C) date on charcoal of 4130 ± 40 BP, or 2870–2500 cal. BCE (Beta-162878; Chun 2003; Supplementary Information, Table S7). However, further research is required to determine the archaeological record and chronology of the Hạ Long culture.

More broadly, the Thạch Lạc Phase II pottery, with its cord impressed surfaces, low ring-feet, and vessel rim and body shapes has visual parallels in Guangxi Neolithic assemblages such as Dingshishan IV and Gantuoyan Cave (Fu 2002; Guangxi Zhuang Autonomous Cultural Relics Task Force and Napo County Museum 2003). However, chronological uncertainties remain with regards to these Guangxi archaeological sites. Although, Dingshishan IV was originally proposed to date to ca. 4000 BCE, Hung et al. (2017) have argued that the pottery vessels and other material culture from this site resemble that from the Nongshan and Bawang cave burial sites, that date to ca. 2300 BCE. This would place them almost half a century later than Thạch Lạc Phase II. Thus, uncertainties remain with regards to the origins of the Thạch Lạc Phase II, and an indigenous origin, rather than external introduction, remains a possibility.

The Bàu Tró culture and the Vietnamese Neolithic: 2500–1500 cal. BCE

Based on material culture attributes, the final phase at Thạch Lạc (Phase III) can be attributed to the Bàu Tró culture. At least 26 Bàu Tró sites are known along the coastal

plains of central Vietnam, especially in Quảng Bình, Quảng Trị, and Thừa Thiên-Huế provinces (Nguyễn K. S., Phạm, and Tống 2004, 185). They include Bàu Khê, Ba Đồn I and II, and Bàu Sen (Phạm T. N. 2000). The only Bàu Tró site to be radiometrically dated, other than Thạch Lạc, is Cồn Nền (Quảng Bình Province). This has one charcoal date of 3590 ± 80 BP (Bln-2864), or 2190–1690 cal. BCE.

Prior to our 2015 excavations at Thạch Lạc, the Bàu Tró culture was commonly dated between 2000 and 1500 BCE (Phạm T. N. 2000, 219). The firm radiocarbon chronology from Thạch Lạc now anchors the Bàu Tró culture to a time span of 2480–2200 cal. BCE, solidly within the later third millennium BCE and as much as 400 years earlier than previously envisaged. Its date is now older than the Red River Phùng Nguyên settlements, and equivalent to the An Sơn “group” of sites in the Mekong Delta region of southern Vietnam (see below; Figure 8A and B).

Observations on Neolithic sites elsewhere in Vietnam

The earliest Neolithic culture in northern Vietnam has long been considered to be the Phùng Nguyên, with settlements concentrated along the Red River in Phú Thọ and Vĩnh Phúc provinces, close to Hà Nội, and downstream in Ninh Bình Province. Two sites have enough dates with sufficient stratigraphic information for Bayesian modeling. At the settlement of Nghĩa Lập, in Vĩnh Phúc Province, occupation commenced between 1960 and 1540 cal. BCE (Figure 8B; Supplementary Information 3, Table S8, Figure S3). The 16 dates from Mán Bạc in Ninh Bình Province suggest a start date between 2070 and 1750 cal. BCE (Figure 8B; Supplementary Information 3, Table S9, Figure S4). The majority of calibrated dates available for other Phùng Nguyên sites, such as Gò Hện and Khu Đường, also fall within the ca. 2100–1500 cal. BCE range. The sites of Gò Mả Đống, Xóm Rền, and Gò Hội have produced the occasional earlier date, within the second half of the third millennium BCE (Supplementary Information 3, Table S7), but there is little reported stratigraphic or chronological information. These older charcoal samples could reflect a presence of “old wood” and thus be erroneous, or they might indeed be hinting at an earlier Neolithic settlement of the Red River region that is yet to be defined and dated. At present, we do not know.

The sites of An Sơn, Lộc Giang (both in Long An Province), and Dinh Ông (Tây Ninh Province), located on the banks of the Vàm Cỏ Đông River, are considered the oldest Neolithic settlements in southern Vietnam. These sites are large mounds formed through the successive construction of dwellings with floor surfaces of imported alluvial soil and lime mortar (Bellwood et al. 2011; Grono, Piper, et al. 2022; Piper et al. 2017, 2021). The dates for the major occupation layers within the main mound at An Sơn come from the 1997 excavation (Nishimura and Nguyen K. D. 2008; Figure 8B; Supplementary Information 3, Table S10, Figure S5). Nishimura and Nguyen K. D. (2008) split the An Sơn cultural sequence into four phases based on stratigraphy, and pottery typology and fabric. Only the first three phases were dated by ^{14}C , and modeling of the charcoal dates suggests that An Sơn was established sometime between 2670 and 2030 cal. BCE.

The settlement of Lộc Giang, located just 500 m from An Sơn, was probably part of the same Neolithic complex as its neighbor. Modeling the 13 charcoal dates from the 2014 excavations at Lộc Giang suggests a start date between 2170 and 1790 cal. BCE,

perhaps slightly later than An Sơn (Figure 8B; Supplementary Information 3, Table S11, Figure S6). However, Piper et al. (2017) have argued that the excavated sequence from Lọc Giang is unlikely to represent the earliest phases of occupation there. A single date on charcoal recovered during earlier excavations into the basal layers in the site produced a date of 3950 ± 75 BP (no code), or 2840–2200 cal. BCE (Vương T. H. 1995), bringing its chronology potentially into line with that of An Sơn.

Combining our new dates for the Bàu Tró culture at Thạch Lạc with the Bayesian-modeled dates from An Sơn suggests that the north-central and southern Vietnam coastal regions had already been settled by Neolithic communities during the second half of the third millennium BCE. These dates are potentially several centuries older than those of the Phùng Nguyên settlements in northern Vietnam, raising the possibility that there were multiple separate movements of Neolithic communities into Vietnam, possibly from Guangdong, Guangxi, and Hainan, during the early to middle third millennium BCE. Some populations established settlements on the fertile plains along the Red River and around the edge of its future deltaic plain (Phùng Nguyên and Tràng Kênh cultures), while others focused more on coastal and estuarine colonization to the south (Bàu Tró and An Sơn cultures).

In a westerly direction from the Vàm Cỏ Đông and Đồng Nai Neolithic sites, one first rounds the Mekong Delta before turning north along the coast of Cambodia. Archaeological research there has been minimal, but on reaching the estuary of the Bang Pakong River in central Thailand, two key sites present many similarities to the situation in coastal Vietnam. Nong Nor was located on the shoreline of a sheltered marine inlet that gave access to the Gulf of Siam (Boyd 1998). It comprised a shell midden dominated by the bivalve *Meretrix lusoria*, that also contains the bones of many fish species, eagle rays, and marine mammals (Higham and Thosarat 1998). There is no evidence at Nong Nor for the presence of rice or domestic animals. However, the inhabitants made pottery vessels decorated with incised patterns, typically Neolithic bone artifacts, and used quarried and ground stone adzes. A single burial of a woman was excavated, in the seated/flexed position, characteristic of early Holocene hunter-gatherer burials in MSEA. The five radiocarbon determinations from Nong Nor place the occupation probably sometime in the middle of the third millennium BCE (Supplementary Information S3, Table S12), although its duration probably did not exceed a single season (O'Reilly 1998).

This short occupation contrasts with the deeply stratified site of Khok Phanom Di, located 10 km to the north of Nong Nor in a former mangrove habitat in the estuary of the Bang Pakong River. There are many parallels in material culture between Khok Phanom Di and Nong Nor, and the structural evidence for clay floors and painted walls of wattle and daub clearly relate Khok Phanom Di to the Vàm Cỏ Đông Neolithic settlements. The mortuary tradition, apart from one early flexed burial, was based on the standard MSEA Neolithic tradition of extended supine interment with a range of mortuary offerings that included fine incised pottery vessels. While there is evidence for the consumption of domestic rice from the initial layers and onwards, it is considered likely that the rice was obtained through exchange, given the salinity of the local soils. Subsistence otherwise centered on gathered marine and mangal resources, in particular shellfish, crabs, and fish. Domestic mammals were rare.

A new dating initiative calling on charcoal samples from archived structural remains, as well as shell ornaments worn by the dead, has required a revision of the chronology of Khok Phanom Di (Higham and Higham 2022). Bayesian modeling places the occupation from at least 2200 BCE until ca. 1600 BCE. However, this is likely to extend further back into the third millennium BCE since there are no dates from the lowest occupation layer.

These two sites provide evidence for the expansion of Neolithic communities along coastal routes at virtually the same time as the sites in the Vàm Cỏ Đông river system, and those in central Vietnam. Although the cranial morphology of the Khok Phanom Di population closely matches that for other Neolithic sites located as far north as the Yangtze Valley, there is a strong likelihood that there was some survival of indigenous hunter-gatherers, as at Mán Bạc (Lipson et al. 2018; Matsumura et al. 2019). As Hung (2019, 13) has argued, the acquisition of land for farming was probably not the only motivation for the earliest coastal and overseas migrations at the beginning of the Neolithic. Coastal and estuarine environments provide a diverse range of sustainable resources, as well as easy mobility and accessible communication routes.

It is becoming clear that, by the end of the third millennium BCE, not only had Neolithic settlements been established across many regions of Vietnam, but there was also a degree of diversity in terms of their social and cultural trajectories (Sarjeant 2014). In the north, for example, the Phùng Nguyên culture was agricultural, and occupied the Red River Valley and adjacent coastal plain along with the Gò Mả Đống–Gò Con Lợn–Doan Thượng group. The allied Tràng Kênh/Đầu Rằm culture with its nephrite-working tradition was located along the northern coastline of what was later to become the Red River Delta (Shaw et al. 2023; Figure 8A and B; Supplementary Information S3, Tables S13 and S14, Figures S7 and S8), and the Bàu Tró was to the south on the coastal plains of north-central Vietnam.

Based on our new chronological framework for Thạch Lạc and a reconsideration of the dates for sites such as An Sơn and Khok Phanom Di, it is becoming likely that the Neolithic in MSEA, at least around its coastal fringes, had a much longer chronology than previously envisaged. We now face the possibility that it extended back into the earlier centuries of the third millennium BCE.

Conclusion

The archaeological settlement of Thạch Lạc has produced evidence for sequential occupation by the bearers of three different archaeological cultures—Quỳnh Văn, Thạch Lạc, and Bàu Tró—over a combined period of perhaps 1000 years. Occupation at the nearby shell-mound of Rú Điệp, combined with that from Thạch Lạc Phase I, has dated the “late” Quỳnh Văn culture in Hà Tĩnh Province to between ca. 3200 and 2900 cal. BCE. The presence of quarried, shaped, and polished stone adzes and an extended burial at Rú Điệp is intriguing. These are atypical of material culture and socio-ideological traditions in Vietnam during the Quỳnh Văn Period and perhaps reflect contact and exchange between transient coastal Neolithic populations and indigenous Quỳnh Văn communities, commencing by the late fourth millennium BCE. Variations between chronology and artifactual repertoires suggest that the late hunter-gatherer populations of the Quỳnh Văn and

Đa Bút cultures were completely independent of each other, both chronologically and geographically, in northern and north-central Vietnam, respectively.

After a brief hiatus in occupation at Thạch Lạc, the Quỳnh Văn culture was succeeded by the Thạch Lạc culture. The associated ^{14}C dates, between ca. 2900 and 2400 cal. BCE, mean that Thạch Lạc is currently the only known Neolithic site in Vietnam that can be anchored with any confidence within this very significant, but poorly understood, period in MSEA prehistory. A feature of Thạch Lạc Phase IIb that is typical of the Vietnam Neolithic is the construction of large open-air post-built structures that suggest permanence and a move toward sedentism (Carter 2023; Nguyễn T. T. et al. 2024), in this case, during the first half of the third millennium BCE. Thạch Lạc Phase II material culture also possessed some features of the Vietnamese Neolithic, such as shouldered adzes and footed pottery, but lacked others, such as the incised and impressed pottery decoration typical of cultures such as Phùng Nguyên and An Sơn in Vietnam, and the oldest Neolithic assemblages in central Thailand. Although the potentially closely related sites of the Gò Mả Đông–Gò Con Lợn–Đoan Thượng group possess many material culture traits similar to the Thạch Lạc culture, and have been argued to be ancestral to the Phùng Nguyên culture and hence to the later Neolithic cultures of the region, the century-long hiatus between the Thạch Lạc and Bàu Tró phases at Thạch Lạc is not commensurate with an argument of cultural continuity. Thus, the relationships between the Thạch Lạc/Gò Mả Đông–Gò Con Lợn–Đoan Thượng phase and succeeding Neolithic cultures requires further research.

The Bàu Tró culture on the other hand has many of the material culture features paralleled elsewhere in the Vietnam Neolithic such as incised pottery, quarried and polished shouldered and unshouldered stone adzes, baked clay penannular ear pendants, and baked clay bow pellets. There is clear evidence at Thạch Lạc for the construction of large post-built structures during this period of occupation. Our dates from Thạch Lạc Phase III place the Bàu Tró culture firmly within the earliest phases of the Neolithic coastal expansion and colonization in the later third millennium BCE, that can be traced as far as the Bang Pakong River in central Thailand.

In combination with the ^{14}C dates from An Sơn in southern Vietnam, and Khok Phanom Di and Nong Nor in central Thailand (Higham and Higham 2022), our dates for the Bàu Tró culture at Thạch Lạc suggest that Neolithic settlements were established along the coast of Vietnam by the middle of the third millennium BCE. This Neolithic chronology, perhaps half a millennium longer than was accepted a decade or so ago, allows time for the establishment of the diverse cultural landscape, with its trade networks and craft specializations, that can be observed in the Vietnamese archaeological record from around 2000 BCE onwards (Frieman et al. 2017; Sarjeant 2014; Shaw et al. 2023).

Supplemental Material

[Supplementary Information S1](#). Thạch Lạc excavations between 1962–2014 and the interpretation of chronology.

[Supplementary Information S2](#): Excavation and Recording Strategy at Thạch Lạc.

[Supplementary Information S3](#): Radiocarbon evaluation of Thạch Lạc and other Settlement Sites discussed in the Manuscript.

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