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Điem Cave: A Stratified Late Pleistocene and Early Holocene Site in Northern Vietnam

This study presents the findings of excavations at Điem Cave, a Late Paleolithic site in Vietnam. Several lithological units and cultural layers are identified. Archaeological materials, including stone and bone artifacts, are described in detail. Findings from the three lower layers include sumatraliths, axes, bone tools, and ornaments. All of these, as well as features of the funerary rite, are typical of the Hoabinhian period. Human bones in the earliest burial were found in anatomical order, whereas those in other burials were crushed and charred. The authors demonstrate that the three lower layers date to the Pleistocene and belong to the Hoabinhian stage, whereas the upper layer dates to the Holocene and belongs to the Đa Bút culture. Micromorphological and stratigraphic observations suggest that the sedimentation of two of the Hoabinhian layers occurred under a humid climate, whereas one Hoabinhian layer attests to a more arid environment. Judging by the absolute dates, the Hoabinhian period appeared in Northern Vietnam before 23 ka BP. During certain stages of the Pleistocene, human populations in the region were rather numerous.

Keywords: *North Vietnam, Điem Cave, Hoabinhian lithic industry, sumatraliths, human burials, paleoecology.*

Introduction

Paleolithic evidence appears at a large number of Pleistocene sites in Vietnam. However, given the absence of reliable geochronology, it is very difficult to reconstruct the dynamics of prehistoric human populations with the use of only traditional methods, such as analysis of artifact typology, as well as fauna and flora species composition analysis. These difficulties are due to the specific aspects of the natural environment and sedimentation in the region. Application of modern geoarchaeological methods

allows for a qualitatively new level of study of the important issues relating to the activities of Pleistocene hominines in North Vietnam.

Cave sites with evidence of the Hoabinhian culture have been studied in the karst regions of Vietnam. The term "Hoabinhian" also means "Mesolithic culture" (see, e.g., (Matthews, 1966)); "technocomplex" (Gorman, 1970; Ha Van Tan, 1997; Forestier et al., 2015), reflecting an adaptation to environmental conditions; or "stone industry" (Shoocongdej, 2000). Some scholars consider the Hoabinhian to be a transition point for the cultures whose carriers participated in the Late Glacial settlement in tropical regions of Southeast Asia (Ji et al., 2016). The discovery of a unique archaeological complex in North Vietnam by the French scholar M. Colani in 1926–1931 (Colani, 1927, 1929) initiated discussion on the essence of this phenomenon, its periodization, as well as its geographical and chronological boundaries, which has continued until this day (Gorman, 1971; Reynolds, 1989; Shoocongdej, 2000; Ha Van Tan, 1997; Marwick, 2013; Sophady et al., 2016).

About 150 open and cave sites with Hoabinhian evidence are known in Vietnam, mainly in the karst areas of North Vietnam in Thanh Hoa and Hoa Binh Provinces (Nguyễn Khắc Sử, 1984). Unfortunately, most of these sites do not have ^{14}C dates; they were attributed to the Hoabinhian period on the basis of typological analysis of finds (Hoang Xuan Chinh, 1989). Lithic artifacts were often described briefly, only indicating tool components specific to the Hoabinhian (sumatraliths, short axes, and side-scrapers of various kinds) (Nguyễn Viet, 2000). Some studies contain information on paleobotany (Nguyễn Viet, 2004, 2006, 2008). There are problems in establishing technical and typological differences, as well as a chronological boundary between the Hoabinhian and the preceding Son Vi culture (Nguyễn Khắc Sử, 1992). The interpretation of lithic industries of Southeast Asia is complicated by the fact that the changes in reduction technique and toolkit were insignificant; this was fostered by relatively stable natural and climatic conditions over a long period of time, and by availability of alternative raw materials, primarily bamboo (Derevianko, 2018). This article introduces new findings in the study of Điem Cave, including data on technical and typological analysis of artifacts, paleontological, anthropological, micromorphological, and stratigraphic analyses, as well as estimates obtained by absolute dating. Such large-scale research has been carried out at ten archaeological sites in North Vietnam (such as Con Moong Cave (McAdams et al., 2019) and Boi Cave (Rabett et al., 2011)).

Material evidence

Điem Cave (20°12′43.8″ N, 105°55′56.6″ E) is located in the northern foothills of the Truong Son Bak Mountains (northern part of the Annam Highlands), in Ban San village, Thái Nguyên Commune in Thạch Thành District of Thanh Hóa Province, on the territory of the Cuc Phuong National Park (Fig. 1). The cave was discovered in 2012 by the Russian-Vietnamese expedition (Derevianko et al., 2013). Trial trenching showed the presence of rich Paleolithic archaeological evidence in the sediments. After the works in 2013–2014, the trench was expanded into an excavation pit; the total area of research was 9 m^2 (Derevianko et al., 2014, 2015; Kandyba, 2015; Le Hai Dang et al., 2015). In 2018, an additional study of the cave clarified the stratigraphy and established the absolute chronology and micromorphology of loose deposits (Derevianko, Kandyba, Chekha, 2018; McAdams et al., 2022). For determining the absolute age of two samples from layers 2 and 3, the OSL method was used. One sample from layer 3 was subjected to radiocarbon dating (Fig. 2).

The cave, which is a part of a limestone massif, is a system of karst cavities with a total area of 500 m^2, with large calcined concretions, stalactites, and stalagmites, containing a large number of shells of forest aquatic mollusks on the walls. The entrance, facing northeast, is located at a height of 25 m from the valley surface and at a height of 100 m above sea level. Loose deposits have been found only at the entrance part, which has a tubular shape 30 m long and 5–10 m wide.

Field research has revealed seven lithological units and four cultural layers. The upper layer consists of a mechanically mixed and rewashed loose dark brown dusty silt, 0.05–0.2 m thick, saturated with well-preserved mollusk shells, which remained intact within the deposit. The layer contains archaeological and paleontological evidence spanning various periods (from the Holocene to the present). This lithological subdivision could have been associated with water erosion of the cave, potentially occurring in relatively recent times.

The first lithological unit (cultural layer 1) is made up of a very loose ash-gray dusty silt, saturated with clastic material and intact snail shells, with inclusions of calcite sinter-drop formations 0.1–0.4 m thick.

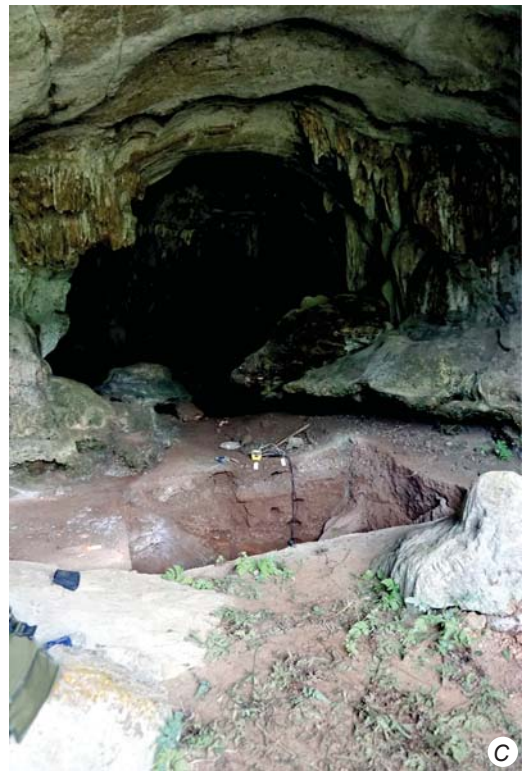
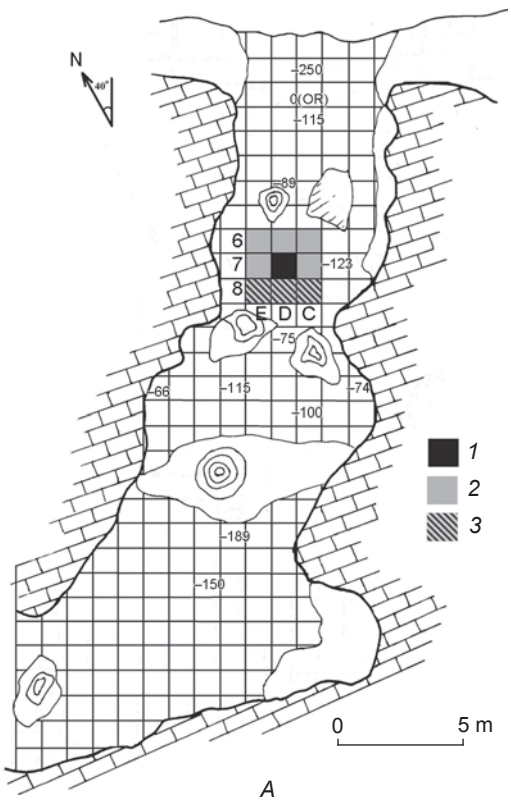


Fig. 1. Location of Điem Cave (*A*), a general view of the rock mass with indication of the cave (*B*), view of the excavation area in the cave from the northeast (*C*).



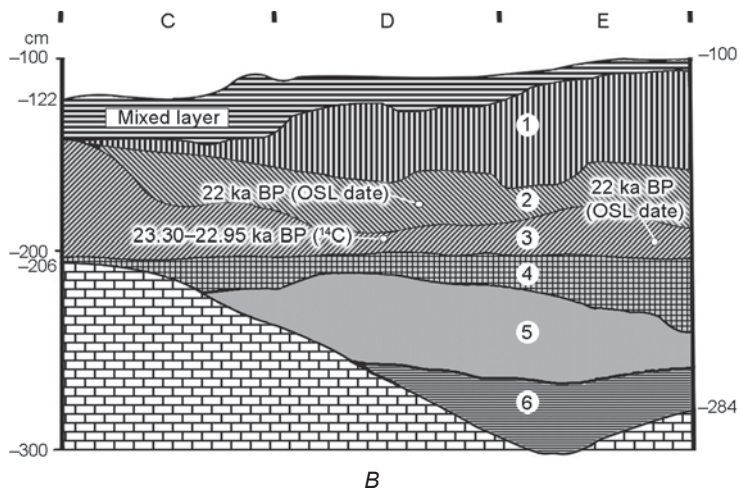


Fig. 2. Map of Điem Cave (*A*), stratigraphic profile of deposits in 2013 along line 7 (*B*).
1 – probe trench of 2012; *2* – excavation area of 2013; *3* – excavation area of 2014.

The archaeological evidence consists of 429 artifacts, including 15 large pebbles (with long axis over 5 cm). Primary reduction is manifested by seven large chipped pebbles and two large core-shaped fragments. The category of spalls includes 365 items. There are 16 primary (removal of natural crust) spalls, mostly small (1–3 cm) and short (with ratio of length and width 1:1), and 39 secondary spalls (with the dorsal surface partly covered with natural crust), usually medium-sized (2–5 cm) and short. Residual striking platforms are natural in 90 % of cases. There are 251 flakes; 95 % are small and short specimens, bearing parallel unidirectional dorsal faceting. Residual striking platforms (natural, plain, and unidentified) occur in equal shares. The assemblage contains 39 fragments, 7 debitage items, and 13 chips.

The toolkit consists of only two items: a fragmented almond-shaped axe made from a limestone pebble, with its working edge created by continuous scaly retouch (Fig. 3, *1*), and an axe fragment, with traces of unifacial processing. The working edge of the latter tool was originally formed by trimming and was rejuvenated in the same way as the first tool. The assemblage also contains 39 pottery fragments, decorated by zigzag discontinuous comb dragging.

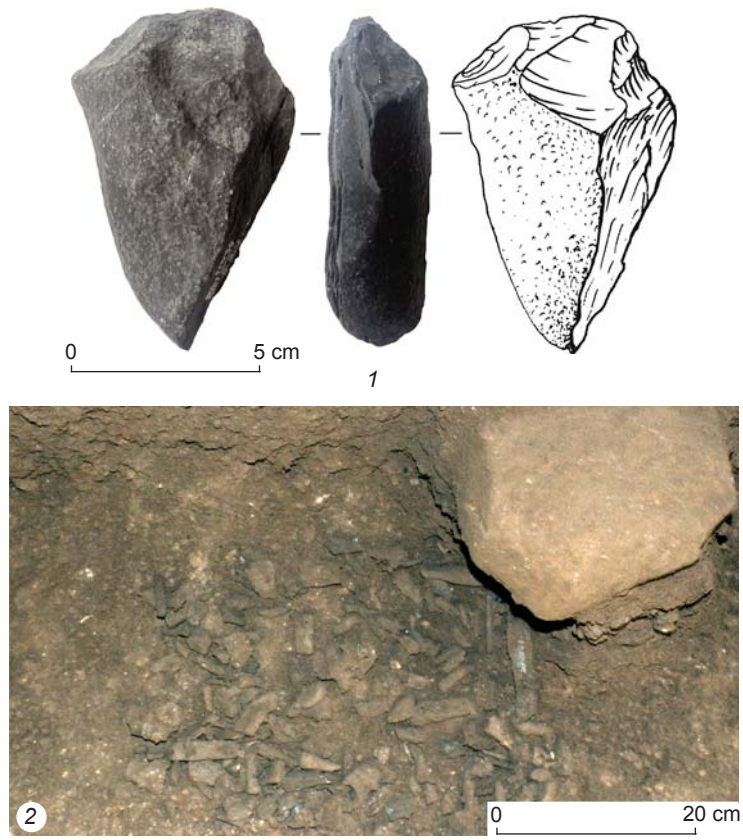


Fig. 3. Axe (*1*), accumulation of human bones (*2*). Điem Cave layer 1.

The anthropological evidence consists of an accumulation of bones, probably of a single individual, heavily charred and crushed, which precludes its more detailed description (Fig. 3, *2*).

The second lithological unit (cultural layer 2) has loose reddish-brown silt with fragments of mollusk shells; 0.25–0.3 m thick. The archaeological evidence consists of 551 specimens, including two large pebbles. Primary reduction is manifested by five large items: two split pebbles, two core-shaped fragments, and a double-platform bifacial transverse core (Fig. 4, *1*). The spall industry amounts to 537 items. There are 402 flakes, dominated by small and short or medium-sized and short specimens, with traces of parallel dorsal faceting. There are also 20 primary spalls, which can be divided into two equal parts: small and short, or medium-sized and short. Secondary spalls (31 spec.) are mostly medium-sized and short, or small and short. Identifiable residual striking platforms (90 % of all the spalls) are natural. The industry includes 15 fragments, 16 debitage items, and 53 chips.

The toolkit consists of eight artifacts. Intact tools include two convex side-scrapers, with their working edges created by continuous scaly retouch, and two flakes: one with ventral faceting, the other retouched. The toolkit also includes two fragmented disc-shaped side-scrapers (sumatraliths), and an axe fragment. Unusual elements in this assemblage are an awl-type bone tool (Fig. 4, *2*) shaped by planing, and a trapezoidal hematite pendant with a hole, which was first cut and then drilled (Fig. 4, *3*). Small pieces of ocher were also found in the layer.

The anthropological evidence consists of an accumulation of highly fragmented human bones, presumably of two individuals (Fig. 4, *4*).

The third lithological unit (cultural layer 3) consists of loose reddish-brown silt of grayish hue, with numerous inclusions of mollusk shell fragments; 0.25–0.6 m thick. Archaeological evidence is made up of 477 items, including 2 large pebbles. Five large split pebbles are associated with primary reduction. The assemblage includes 459 spalls and 300 flakes. The overwhelming majority of flakes are small and short, or medium-sized and short with parallel dorsal faceting. There are also 19 primary small and short,

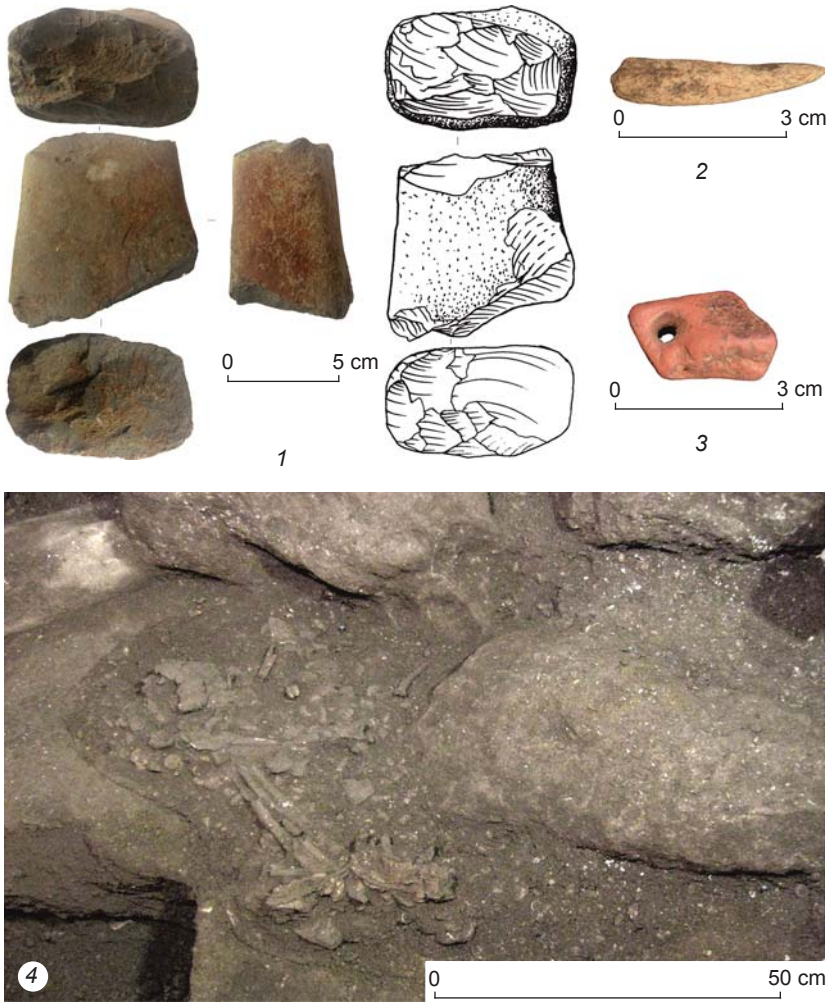


Fig. 4. Double-platform bifacial core (*1*), awl-type bone tool (*2*), pendant (*3*), accumulation of human bones (*4*). Điem Cave layer 2.

or medium-sized and short spalls (almost in equal amounts); 40 secondary spalls, mostly medium-sized and short, or small and short; 22 fragments; 22 debitage items; and 55 chips. Features of the spall industry from this layer completely coincide with those of the previous unit. One item is a technical spall, which is a removed flaking-surface or a flattening spall of a sumatralith. The toolkit from layer 3 is the same as in layer 2. It consists of 11 large items, including four convex side-scrapers, two of which are intact and two fragmented (Fig. 5, *1*, *2*), two fragmented disk-shaped (sumatraliths) side-scrapers, a retouched flake, and an axe fragment. In this layer, for the first time, two choppers were found (Fig. 5, *3*) made on rounded pebbles, initially by trimming and later with continuous scaly steep retouch, as well as an adze fragment.

The fourth lithological unit (cultural layer 4) has loose red-brown silt of yellowish hue, with small fragments of shells and inclusions of veined quartz, strongly travertinized in some places; 0.15–0.3 m thick. Archaeological evidence, confined to the top of the layer, consists of 757 specimens, including 23 intact large pebbles. Primary reduction is manifested by 25 large items: 10 chipped pebbles, 12 core-shaped fragments, an intact core, and two core fragments. A single-platform unifacial core demonstrating traces of transverse reduction was made on a large pebble; it was reduced without preliminary preparation (Fig. 6, *1*). Two core fragments show traces of a radial flaking system.

The spall industry includes 709 specimens: 416 flakes, 28 primary spalls, 32 secondary spalls, 157 fragments, 25 chatters, 49 chips, and 2 technical spalls. As in the previous cultural layers, the industry from this layer is dominated by small and short, or medium-sized and short flakes with parallel dorsal faceting. Identifiable residual striking platforms are mostly natural, with a few plain platforms. Primary spalls (small and short, or medium-sized and short) occur in equal amounts. Secondary spalls (95 %) are small and short, or medium-sized and short. Residual striking platforms in spalls of both categories are natural. There are two technical spalls in the assemblage: removed flaking-surfaces or flattening spalls of sumatraliths.

The toolkit consists of ten large items. An end-scraper was made on a flake by marginal scaly retouch (Fig. 6, *2*). A side-scraper with working edge along 3/4 of the perimeter and natural butt was made on a rounded piece of limestone by trimming and continuous stepped retouch (Fig. 6, *3*). A heavily fragmented side-scraper was shaped in a similar way (Fig. 6, *4*). A spurred tool was made on a quartz fragment of trapezoidal shape; its working part was shaped using the natural contour of the blank. The spur-like protrusion was fashioned by continuous steep, scaly retouch. A piercing tool was made on a small, short flake. Its working edge was shaped in the medial part by continuous scaly

retouch. An awl-type bone tool has been identified, which was made from a piece of rib by planing. The assemblage contains two flakes with sporadic ventral retouch, and two fragments of retouched pebbles.

The upper part of this layer yielded a female burial (Fig. 7). The bones were found in anatomical order. The woman was buried on her side, with bent knees and head oriented toward the cave. There were no grave goods except for a few scattered small flakes. Notably, the burial was located basically on the rocky base of the cave, which rose in the southeast direction, and was partially covered with travertine deposits.

The dense travertine sequence of red-black-yellow-brown (layer 5) and white-yellow (layer 6) silts, with numerous rounded quartzite fragments and small quartzite pebbles, was archaeologically sterile.

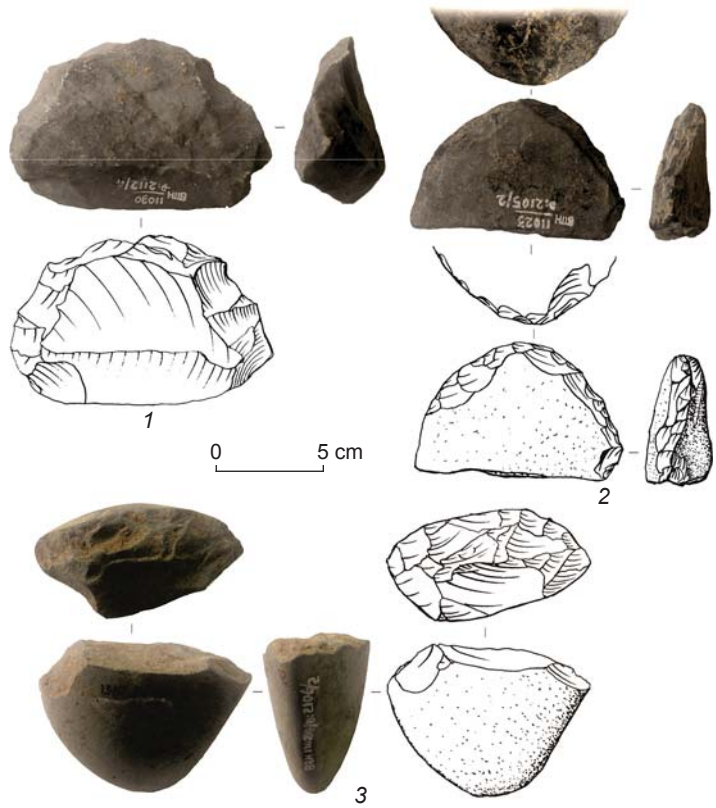


Fig. 5. Convex side-scrapers (*1*, *2*), chopper (*3*). Điem Cave layer 3.

Discussion

Field and laboratory research in 2012–2014 and 2018 made it possible to establish features of early human habitation in Điem

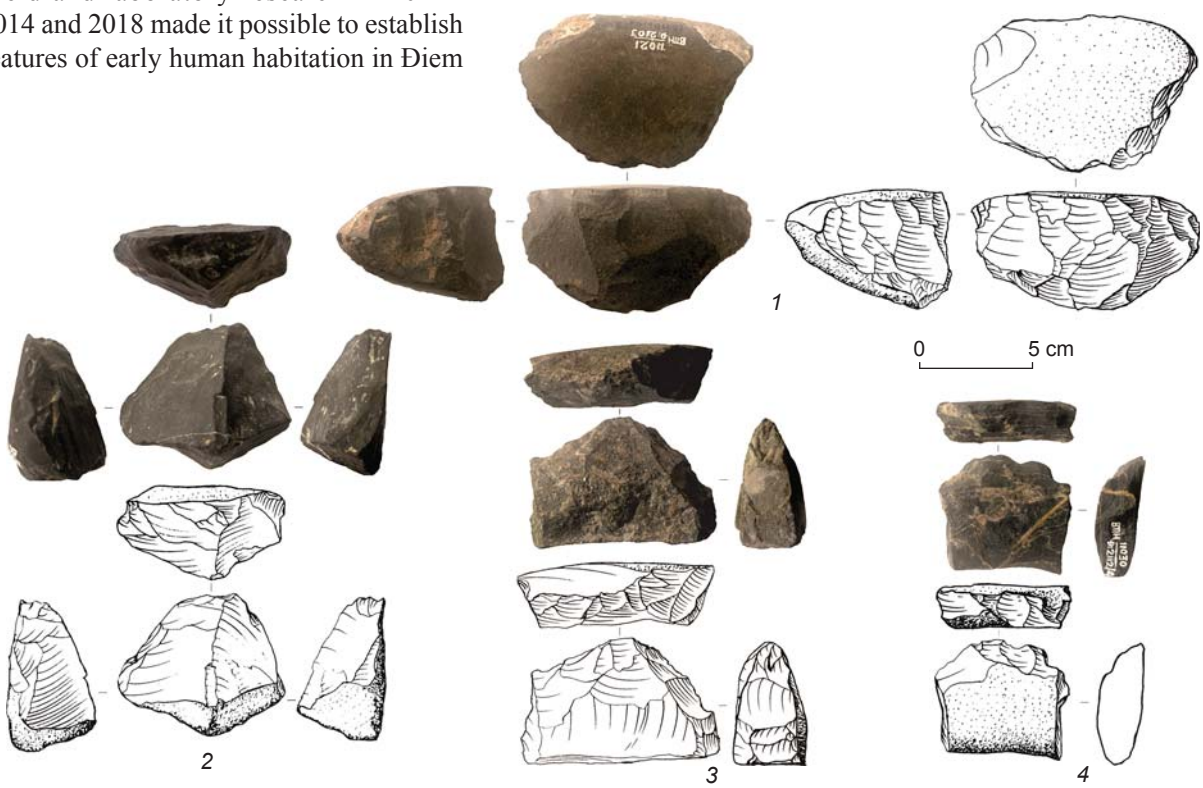


Fig. 6. Single-platform unifacial core (*1*), end-scraper (*2*), side-scrapers with working edge along 3/4 of the perimeter (*3*, *4*). Điem Cave layer 4.

Fig. 7. Female burial. Điem Cave layer 4.

Cave. Layers 5 and 6, which correspond to the initial stage of sedimentation, yielded no traces of prehistoric humans. According to micromorphological studies, during that period, the cave had an active watercourse and humid climate (McAdams et al., 2022).

The lithic industry from layer 4 is difficult to classify, because it is dominated by spalls. Primary reduction was based on the system of parallel flaking. The toolkit is poor and consists of items typical of the Late Paleolithic of Vietnam. Dates for the overlying lithological layers indicate that the age of this cultural and chronological unit is over 23 ka BP. Sedimentation occurred in the conditions of a humid climate (Ibid.). The inhumation burial found in the layer is similar to the Hoabinhian burial in Con Moong Cave located 3 km west of Điem Cave (Kandyba et al., 2020; Nguyễn Khắc Sử, 2009).

The lithic industry of layer 3 includes the same components of primary reduction as the previous assemblage, but the toolkit shows typical Hoabinhian artifacts, such as disk-shaped side-scrapers (sumatraliths), as well as fragments of axes and adzes. The age of this cultural and chronological unit is 22–23 ka BP; it was accumulated in a dry climate. According to microstratigraphic studies, at that time, humans already actively used Điem Cave (McAdams et al., 2022).

The lithic industry of layer 2, in its technical and typological features, is a typical Hoabinhian complex, as represented in the two previous lithological units. However, layer 2 contains ornaments and traces of using ocher. The age of the second cultural and chronological unit is 22 ka BP; sedimentation occurred in a humid climate, with occasional human habitation in the cave (Ibid.).

The material evidence from all three cultural layers is Hoabinhian in terms of typology; during the formation of these layers, Điem Cave was actively used by prehistoric humans. Significant production waste (flakes, fragments, etc.) associated with the final stage of stone processing testify to the manufacture of tools. Habitation in the cave is evidenced by the burial practice, as well as by over one thousand bone fragments of reptiles, birds, and mammals, which were collected within the three cultural and lithological units (layers 2–4). Among them, 286 bones and teeth were identified, in some cases on the level of species, and most on the level of order (by A.N. Tikhonov). Over 50 % of the identifiable bones and teeth belong to medium-sized deer (*Cervus nippon* – sika deer, *Cervus porcinus* – hog deer). A large portion consists of the remains of wild pig (*Sus scrofa*). As herd animals, pigs could have been hunted more effectively than solitary species. Bone remains of large mammals—a tiger (*Panthera tigris corbetti*), large bull (possibly a new species), and probably a rhinoceros (*Rhinoceros sondaicus annamiticus*)—were found. A mandible fragment, with unusually large premolars, might have belonged to a stump-tailed macaque (*Macaca arctoides*). Turtle remains were discovered in almost all the layers; birds were represented by two bones. Three human bones (one of them burnt) were discovered apart from the burials. The humerus of a sambar deer

(*Cervus unicolor*) showed a predator bite; judging by the width of the traces, most likely from a dog. All the layers contained shells of terrestrial mollusks (*Bradybaena jourdyi* and *Cyclophorous sp*).

Archaeological and paleontological evidence from the Hoabinhian layers of Điem Cave correlate well with the finds from similar layers of the nearby Con Moong Cave. Moreover, the remains of the same animals were also typical of the Son Vi culture, which leads to the conclusion that species composition of faunal complexes in North Vietnam was relatively stable in the Final Pleistocene (Derevianko, Kandyba, Chekha, 2019). Despite periodic aridity associated with the last glacial maximum in 26–19 ka BP (Clark et al., 2009), flora and fauna did not undergo significant changes in the mountains of the tropical regions of Southeast Asia (Visser, Thunell, Stott, 2003; Shintani, Yamamoto, Chen, 2011). This is confirmed by the studies of the Late Pleistocene and Early Holocene complexes of Trang An, especially Chong Cave (Rabett et al., 2017). Karst areas like Cuc Phuong and Trang An were inhabited for thousands of years by prehistoric populations due to guaranteed access to natural resources. According to the evidence from Điem Cave, this also occurred in the Holocene. The last cultural unit (layer 1) contained scarce stone implements belonging mainly to the spall industry, but the cultural affiliation of the pottery suggests the time when that layer was accumulated and correlates it with the Neolithic Đa Bút culture (7000–4000 BP). The data obtained indicate that the cultural phenomenon of the Hoabinhian appeared before 22 ka BP.

Conclusions

In addition to North Vietnam, Hoabinhian sites widely occur on the Indochina Peninsula, Sumatra Island, and South China. The artifacts found at these sites were made of river pebbles by trimming. Scholars regard sumatraliths as the most common tools, acting as a kind of cultural marker. Some experts differentiate the items of this category by their morphology (Zeitoun et al., 2019) and purpose (Kandyba et al., 2021). There are numerous short and rounded oval and oval-pointed axes, and side-scrapers of various kinds. Interestingly, the Hoabinhian complexes retained features inherent to the Son Vi industry (traces of "citron" cleavage, presence of various choppers), while the Son Vi industries began to show some Hoabinhian elements, such as isolated sumatraliths, axes and adzes, including polished ones. The analysis of archaeological evidence relating to the industry of Paleolithic humans in Southeast Asia, including North Vietnam, has revealed that a techno-typological industry fundamentally different from that of the rest of Eurasia evolved in this region in the Final Pleistocene. The results of the interdisciplinary research of cave complexes in North Vietnam of the last decade give grounds to consider the Hoabinhian culture as a unique example of relatively stable human adaptation to tropical latitudes in the Final Pleistocene and Early Holocene.

Acknowledgment

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