

## **Excavation Results from Gua Bedug: New Insights on the Early-Mid Holocene Prehistory of the Rembang Zone**

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### ***Abstract***

There are not many Early-Mid Holocene sites in the Rembang Zone, moreover that have human remains recovered from excavation. Gua Bedug is one of these sites, and this article presents the preliminary analysis of its excavation results. Currently, dating associated with human remains from Gua Bedug shows occupation from 5.895 - 8.542 cal. BP, showing similarity with the human remains from the southern part of Java that ranged between 9.000-5.000 BP. These human remains at Gua Bedug were recovered in context mostly with shell and bone artifacts, markers of Preneolithic culture. Dating related to the Preneolithic cultural layers in Gunung Sewu shows that this culture lasted between 12,000 to 4,000 BP. Therefore, the cultural layers from the southern part of Java are older than the northern part. Although they share the same markers of Preneolithic culture as the southern sites, the much smaller quantity of lithic artifacts from Gua Bedug, and the abundance of shell and bone artifacts is more likely driven by local adaptation rather than material preference for specific purposes. This local adaptation is also shown in the faunal remains records, which indicate a close interaction between the people of Gua Bedug and their aquatic paleoenvironment.

***Keywords:*** *local adaptation; cave site; Preneolithic; human remains; Java karst*

## **INTRODUCTION**

Discussing the prehistoric research of the Early-Mid Holocene in Java, Gunung Sewu has proven to be the most researched area. Decades of intensive research in Gunung Sewu have been able to produce a comprehensive chronology of the area's habitation. This area provides

most of the description of prehistoric cave occupations in Java, which was claimed to have lasted from 60,000 years ago and reached its peak 4000 years ago (Simanjuntak, 2004).

The other two karst mountain zones in Java, the Rembang Zone and Kendeng have less research when compared to the Gunung Sewu area. The Kendeng Zone contributed more to Late Pleistocene prehistory through several paleoanthropological sites such as Sangiran, Kedungbrubus, and Trinil. Meanwhile, the period of the Early-Mid Holocene was obtained from the Rembang Zone karst area on the north coast of Java. The karst area in the northern part of Java is in the administrative boundaries of Pati, Rembang, Blora, Grobogan, and Tuban regencies.

The Rembang Zone has a smaller number of cave sites than the karst area in the southern part of Java (Wibowo et al., 2019, 2020). Data from this region was first began to be obtained through research by Willems in Tuban (Genootschap, 1939; Heine Geldern, 1945, 1951; van Heekeren, 1972), which was then continued by Indonesian researchers until the early 2000s (Jati, 1998; Jatmiko, 1998; Nitihaminoto & Koestoro, 1980; Suhartono, 2000; Triwujani, 2001), and a few decades later was revisited in 2023. The results from the latest survey in Tuban showed that the sites have been damaged, which will complicate future research possibilities (Wibowo & Ramadhan, 2023). Previous research at Tuban reported abundant mollusk, bones, and lithic artifacts. The artifact assemblage from Tuban was proposed to have distinctive characteristics and might deserve a separate cultural identification (Heine Geldern, 1945, 1951). Besides their ecofacts and artifacts, there is no publication regarding the human remains recovered from excavations (Jatmiko, 1998; Nitihaminoto & Koestoro, 1980).

Moving to the west of Tuban, Gua Kidang in Blora has provided a better understanding of Early-Mid Holocene prehistory for the Rembang Zone. Similar to another karst area on the north coast of Java, the Blora karst also has a relatively small number of prehistoric cave sites, with Gua Kidang as their only (Nurani & Yuwono, 2008). Most of the caves in Blora were considered uninhabitable in prehistoric times because they had underground rivers that were still active (Nurani & Hascaryo, 2015). Gua Kidang itself was known to be inhabited in four phases, which lasted for thousands of years (Nurani et al., 2017). It is also known that the people of Gua Kidang practiced the flexed burial that is commonly found in cave sites from the Early Holocene. Regarding their artifacts, the lithic artifacts are limited compared to the bone and shell artifacts (Nurani, 2016).

Complementing the data of cave sites on the north coast of Java, a new site named Gua Bedug was found in Rembang (Wibowo et al., 2019, 2020). The karst area in Rembang has a total of 51 caves and rock-shelters that were surveyed in 2019, but only Gua Bedug was considered suitable for prehistoric occupation and is still intact (Wibowo et al., 2019, 2020). Excavation carried out in 2021 has produced various archaeological finds. This new data from Gua Bedug is presented in this article, with perspectives to answer questions regarding their occupation period and cultural characters. These two perspectives are employed to provide a preliminary overview of their possible implications on the Early-Mid Holocene prehistoric culture of Java.

## **METHODS**

This study used a qualitative method, with data collection through archaeological excavations. Basic excavation procedures were employed at Gua Bedug, involving carefully noting archaeological finds (artifacts, ecofacts, features, cultural layers) both in the excavation box and in the excavated soil (Schiffer et al., 1978). Excavation in Gua Bedug was carried out by opening test pits. Whether or not archaeological finds can be found through test pits is highly determined by the sampling technique of the excavation site. Therefore, in the excavation of Gua Bedug, purposive sampling was used rather than random sampling. The test pits were chosen in a specific location of the site to address specific purposes (Nance & Ball, 1986). Five 1 x 1 meter excavation units are purposively selected based on their placement in the front and back areas of the site. TP 1, TP 3, and TP 5 were opened in the back areas, and TP 2 and TP 4 were in the front. TP 3 is an extension of TP 1, forming a 1 x 2 meter unit as a whole.

The data collected from the excavation were described and classified considering their archaeological context. This process is an interpretive analysis process to describe the cultural character found in Gua Bedug. Data recovered from the excavation were first separated by material, such as pottery, mollusk shell, stone, and bone. The data classification also considers their provenience/ their exact location within the excavation unit where they were found, including its depth and stratigraphic layer (Harris, 1989). This information is vital as it helps establish the context in which the artifact was used and discarded. The condition of artifacts is also noted, as this can impact subsequent analyses and interpretations.

Based on the results of the initial steps of classification above, the data from the excavation can be identified by their typology (for artifacts), chronology, and more importantly, their cultural affiliation. Typological studies are useful to identify patterns and changes in material culture over time (Forestier, 2007). Radiocarbon dating analyses were carried out to establish the absolute age of archaeological finds, which is crucial for understanding the chronology of human activities at the site (Aitken et al., 1997). Based on their typology and chronology, the data recovered from Gua Bedug are then associated with specific cultures or periods.

## **RESEARCH RESULTS**

Gua (cave) Bedug is the name given by the residents of Karangasem, Bulu, Rembang. In terms of morphological classification, Gua Bedug is classified as a rock shelter. The site is located on the top of a hill and facing south. The condition of the rock shelter deposits is relatively flat and dry. Gua Bedug has two (2) sections, which are separated by a height difference of about 2 m between them (Figure 1). On the side of the second section, there is an entrance that was deliberately dug by residents. The entrance penetrated to the top of the limestone hill. Due to the high possibility of soil disturbance in the second section, the excavation was done only in the first section of the rock shelter. This site itself is surrounded by a teak wood plantation, with corn fields along the path leading to the cave.

### Site Location

- Administrative : Sumberagung, Karangasem Village, Bulu District, Rembang Regency, Central Java Province
- Coordinates (UTM 49s) : 538681 9240432
- Coordinates (Geographic) : 6° 52' 17.732" S -111° -21' -0.405" W
- Absolute Elevation : 269 m above sea level

### Morphology

- Type : Rock shelter
- Entrance (WxH) : 13.67 x 5.41 m
- Activity Area (W x L x H) : 562.88 m
- Orientation/ Direction : South
- Surface Data : None

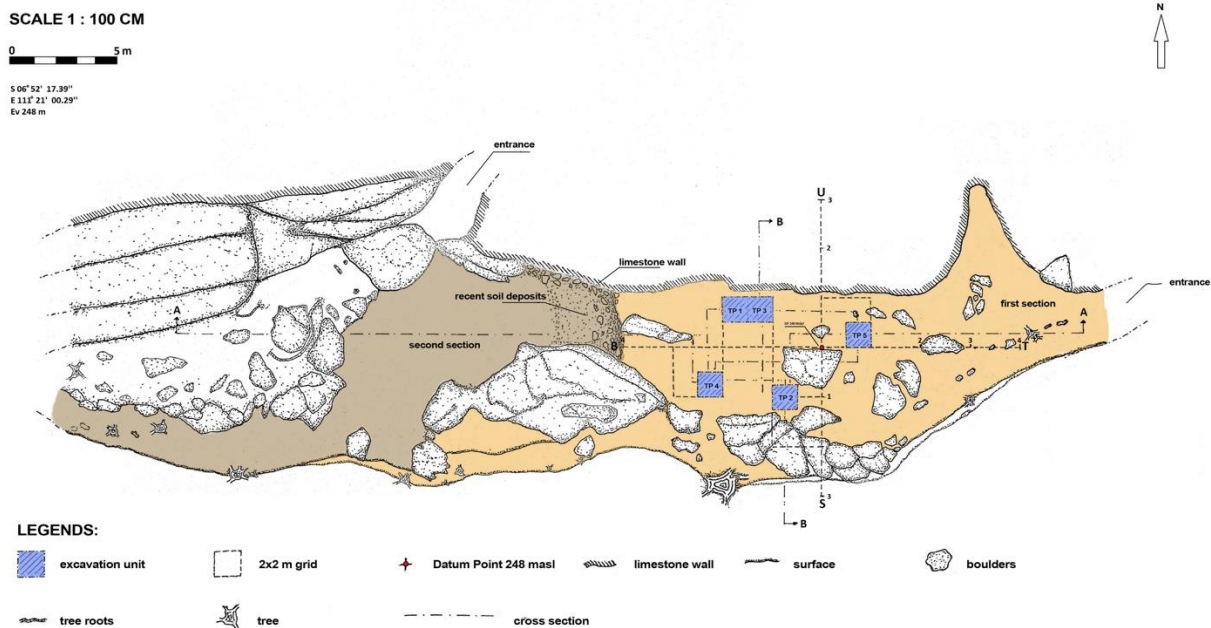


Figure 1. Site plan of Gua Bedug, Karangasem, Bulu, Rembang, Central Java  
(Credits: Balai Arkeologi Prov. D.I. Yogyakarta, 2021)

Most archaeological finds were recovered from the TP 3 unit. TP 3 has yielded more than 50% of the total excavation results at Gua Bedug. The least archaeological finds were obtained in TP 4, with excavations only successfully recovering 80 ecofacts. TP 5, which was excavated deeper to obtain a more complete stratigraphic reference than the other four units, had more archaeological finds than TP 1 and TP 2, which have a relatively equal quantity of archaeological finds between them (Figure 2). TP 5 was excavated up to 150 cm from the surface, compared to the other four units that were excavated to a depth of 100 cm. Overall, excavation was done in three layers of soil, which represents three distinct cultural phases (Figure 3).

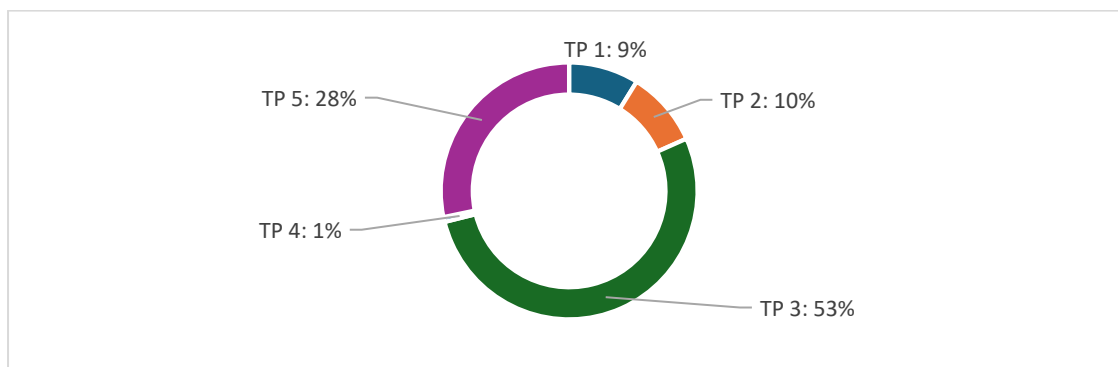


Figure 2. The proportion of archaeological finds recovered from excavation units at Gua Bedug

### Recent Layer

Layer 1 is the topsoil layer formed by recent activities, with very loose density and made of fine grains. Layer 1 is not found in TP 4 and TP 2, which are both in the front area of the rock shelter. The topsoil in these two excavation units may have been lost due to the cleaning process of the front area in recent times. Although missing the first layer, signs of modern-era activities were present in TP2 to depths of 20 cm from the surface. One modern pottery fragment in TP2 at a depth interval of 10-20 cm shows modern characteristics that can be seen in the thin cross-section (1-2 mm), smooth striation, blackish-brown color, and blackish-brown temper with white patches of lime. Until the depth interval of 20 cm, other excavation units also reported the presence of pottery fragments from Layer 1. Beyond 20 cm, there are no pottery fragments that were recovered in all units. These pottery fragments are likely remains of contemporary activities and indicate soil disturbance.

Besides pottery, other finds from this layer include candlenut fragments, faunal bone fragments, and mollusk. The candlenut plant remains show no traces of burning or other traces of anthropic activity. Regarding the mollusk, the majority are gastropods from the Pachychilidae family and were recovered in intact conditions. Meanwhile, the vertebrate faunal bones were recovered in small fragments, and some were able to be identified from the family of Bovidae, Cercopithecidae, and Suidae.

### Peak and End of Occupation Phase Layer

The layer below the topsoil is called Layer 2, which has a different texture and color than the soil layer above. Layer 2 has a mixture of sand grains, which makes it coarser than Layer 1. In addition, the brown color of Layer 2 is lighter and reddish than Layer 1. This layer was found throughout all the excavation units, with varying thicknesses. The thickest layers are in TP 1 and TP 3, which, until the end of the excavation at a depth of 100 cm, have not yet reached the end of Layer 2.

Except for TP 3 and TP 5, during the excavation process, there was no indication of disturbance or intrusion (both natural and anthropic) at a depth of more than 20 cm. Layer 2 in TP 3 in the north part of the unit shows a gray soil lens that is thought to be the remains of a fireplace. The excavation for this grey lens was done separately, and it is known that the lens was isolated only in the northern corner of the TP 3 unit from a depth of 20-50 cm. In TP 5, there is an elliptical hole feature in which it was filled with loose soil. This feature is found at

a depth of 110-120 cm and is thought to form naturally due to the process of soil deposition or sedimentation. Small amount of mollusks and vertebrate bones were found in this feature, but there are no characteristics that suggest this feature is artificial.

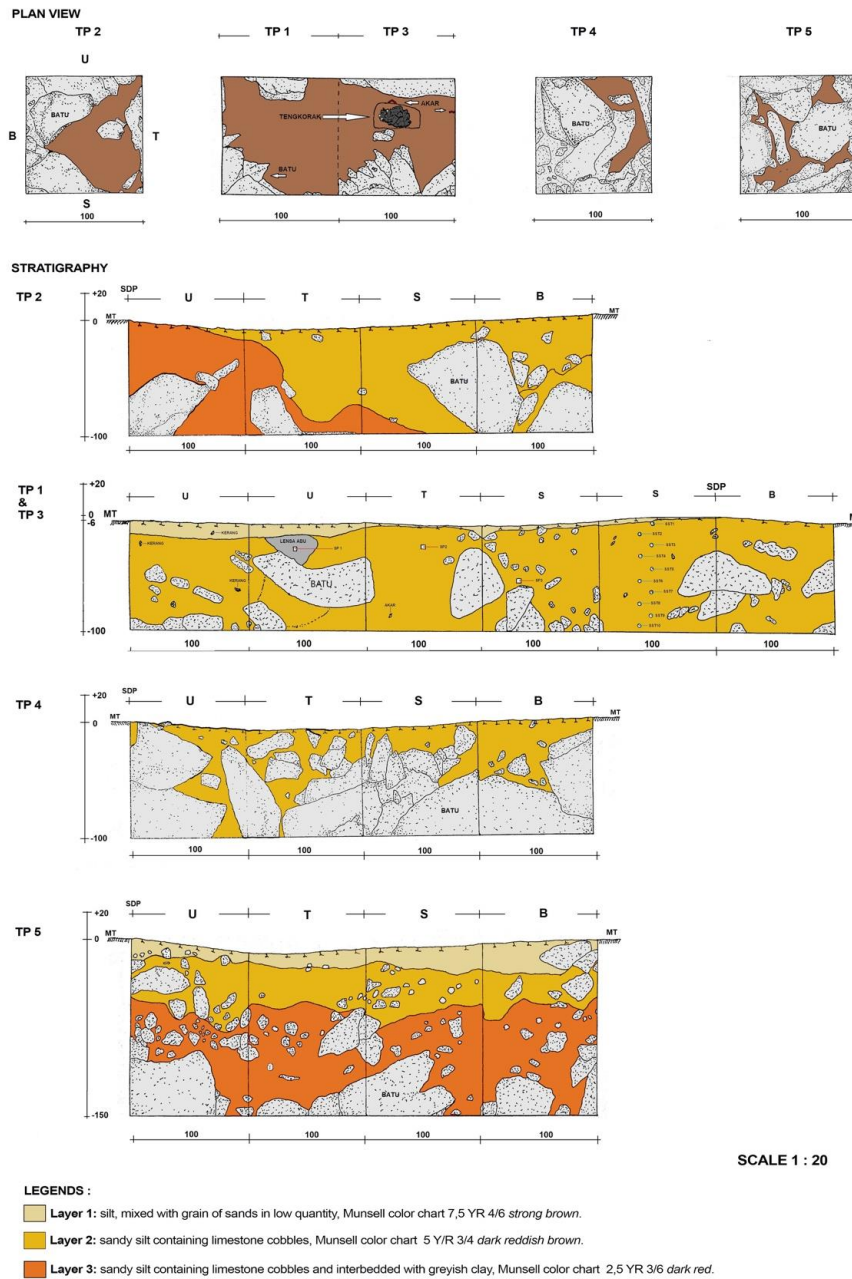


Figure 3. Stratigraphy of excavation units at Gua Bedug (Credits: Balai Arkeologi Prov. D.I. Yogyakarta, 2021)

Trend on the type and quantity of archaeological finds from Gua Bedug shows that most of the occupation traces were found in Layer 2. Based on their quantity distribution, the occupation of Gua Bedug reaches its peak at a depth of 80-90 cm. The quantity then continues to decline until the end of the occupation at a depth of 20-30 cm. It must be noted that in TP 3,

the cultural layer that defines the starting phase of the occupation is not discovered yet. Excavation in this unit was still recovering human remains and other ecofacts in significant quantities at a depth of 90-100 cm (Figure 7).

Layer 2 contains diverse and abundant archaeological finds, including artifacts, human remains, vertebrate faunal bone, and mollusk. The entire collection of Gua Bedug artifacts was recovered solely from TP 3, and they were recovered starting from a depth of 40 cm. Most of these artifacts are shell scrapers, which were recorded abundantly at a depth of 60-70 cm (Figure 4). In addition, bone tools in the form of points and spatula were also found, which were mostly found at a depth of 70-80 cm.



Figure 4. Representative samples of bone (top) and mollusk (bottom) artifacts from Layer 2 (Credits: Hari Wibowo, 2024)

A perforated bone and freshwater bivalve mollusk were recovered, respectively, from TP 5 at a depth of 30 cm and TP 3 at a depth of 75 cm (Figure 5). The perforated mollusk is similar to what has been recovered from Gua Kidang (Nurani, 2016). The perforated bone is questionable as an artifact. This perforated bone might be used as ornaments, but this is not certain yet because the bones were covered in concretion. Furthermore, the perforation on the bone might as well be caused by natural causes such as burrowing by ants. The lithic artifacts were very limited, far fewer in number than shell and bone artifacts. The lithics from this layer include grounded hematite, debitage or flake fragments, and cobblestones that were predicted to be projectiles. These stone artifacts were found in the depth range of 40-60 cm and 80-100 cm.





Figure 5. Grounded hematite and cobblestones (top left-right); perforated Unionidae bivalve mollusk and bone (bottom left-right) from Layer 2. (Credits: Hari Wibowo, 2024)

Mollusk fragments are the dominant eco-fact that were recovered from Layer 2, with a much larger quantity when compared to vertebrate faunal bones. The majority of mollusk that was recovered from the excavation consists of freshwater gastropods from the Pachychilidae family (66%) and freshwater bivalves from the Unionidae family (25%). These mollusk ecofacts were recorded to have a significant increase in number, starting from a depth of 50-60 cm and peaking at an interval of 80-90 cm.

Fragments of vertebrate faunas found in Layer 2 were noted to have a high degree of fragmentation, with irregular and small dimensions (Figure 6). Matching the record from the *mollusk* eco-fact, the number of vertebrate fauna fragments increased significantly at intervals of 50-60 cm and peaked at intervals of 80-90 cm. The vertebrate fauna remains, based on its body size, can be distinguished from small (birds, porcupines, fish, softshell turtles, reptiles), medium (monkeys, deer, pigs), and large (cows/ buffaloes). Represented by 52 identifiable fragments, the primate family of Cercopithecidae is the most common in this layer, followed by Cervidae (38 fragments) and Varanidae (24 fragments). In total, there are 26 families of vertebrate fauna in Layer 2.



Figure 6. Top: Burnt left calcaneus bone of Suidae from TP 1, depth of 40 cm (left to right: anterior, lateral, posterior, and medial view). Bottom: right mandible of Herpestidae from TP 3, depth of 60 cm (left to right: medial and lateral view). (Credits: Dama Qoriy Arjanto, 2022)



Only in TP 1 and TP 3, besides faunal ecofacts, in Layer 2, human bone fragments were also recovered. Two fragments of finger bones, phalanx distal and intermediate, were the first to be recovered in TP 3 at a depth interval of 30-40 cm. A human skull in a fragmentary condition then began to be uncovered at a depth of 40 cm and was fully exposed at a depth of 60 cm. Apart from the skull fragments, six isolated teeth were still recovered between 80-100 cm depth intervals. In total, as many as 29 human teeth were found, both isolated and associated with the skull fragment. Dental records from Gua Bedug consist of 13 molars, eight premolars (Figure 7), four incisors, three canines, and one indeterminable tooth. This indeterminable tooth is most likely the first molar of the mandible. However, the identification process was difficult because the root has post-mortem fracture, and the severe grade 6 attrition was making it unobservable (Wibowo et al., 2024).

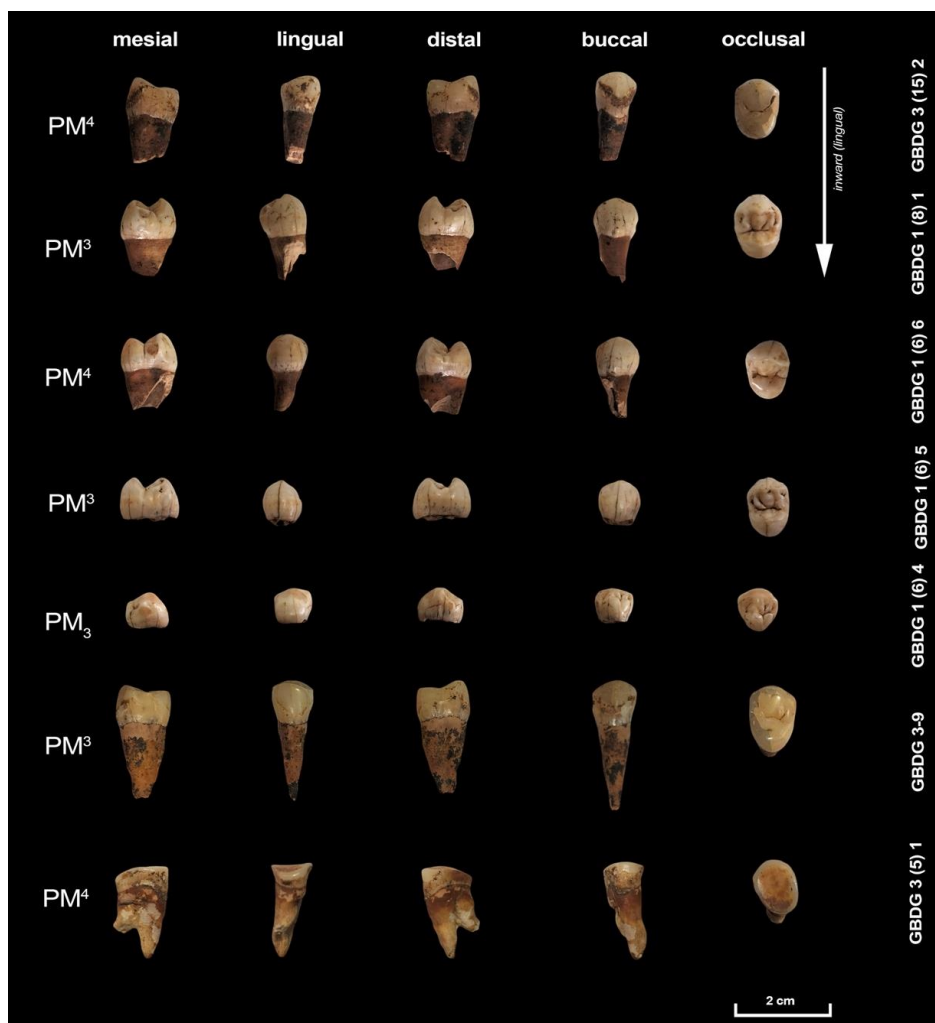


Figure 7. Premolars from Gua Bedug (Credits: Hari Wibowo, 2024)

### Early Occupation Phase Layer

Layer 3 is characteristically distinguished from Layer 2 by the color of the soil and the mixture of clay contained in it. The color of Layer 3 soil is darker and has a mixture of clay grains (*granules*) that are not found in Layer 2. The existence of Layer 3 is only found in TP 2 and TP 5. In TP 2, which is located close to the rock shelter wall, this layer has begun to appear at the top surface. The boundary between Layer 2 and Layer 3 in TP 2 appears diagonal,

indicating the sloping ancient surface level descending toward the front of the rock-shelter. In TP 5, the boundary between Layer 2 and Layer 3 appears horizontal, indicating a relatively flat ancient surface.

Layer 3 mostly starts from a depth of 80 cm to the end of excavation at a depth of 150 cm. Layer 3 has the same type of archaeological finds as Layer 2, although with less quantity. The bone fragments of vertebrate faunas in this unit are also small in dimensions and from small to medium-sized animals. Similar to Layer 2, Cercopithecidae is the most common fauna in Layer 3 (33 identifiable fragments), followed by Hylobatidae (6 fragments) and Cervidae (3 fragments). There are 12 families of vertebrate fauna in Layer 3, much less than Layer 2 (26 family). The majority of fish vertebrae from this site are found in Layer 3, scattered at a depth of 80-120 cm (Figure 8). These fish vertebrae were able to be identified as coming from the families of Perciformes and Clupeidae. Regarding the mollusk ecofacts, only freshwater gastropods of *Sulcospira testudinaria* were recovered from Layer 3 TP 5. The absence of Unionidae bivalve mollusk differentiates this layer from Layer 2.

The end of excavation at a depth of 150 cm in Layer 3 TP 5 was recovering much fewer archaeological finds, indicating a sterile layer beneath. Meanwhile, until the end of the excavation in TP 1 and TP 3, Layer 3 has not been discovered. The last excavation interval of 100 cm in TP 1 and TP 3 was in Layer 2 and was still recovering finds abundantly. The decreasing quantity of finds at TP 5 Layer 3 is suggesting that this layer might represent the early phase of occupation at this site.



Figure 8. Fish vertebrae from a depth of 100 cm in TP 5 (Credits: Balai Arkeologi Prov. D.I. Yogyakarta, 2021)

## **DISCUSSIONS AND CONCLUSIONS**

One of the significant archaeological finds from the site is fragments of human remains in the form of fragmentary skulls and isolated teeth from TP 3 and TP 1. From a regional perspective, this data is significant because there are not many human bones remains that can be recovered from the Rembang Zone. Apart from Gua Bedug, human bones are only found in Gua Kidang and Kompleks Ceruk Pajangan/ Pajangan Rock shelter Complex (Tanudirjo et al., 2022; Wibowo et al., 2022; Wibowo & Nurani, 2021; Wibowo & Ramadhan, 2023). Skull fragments from Gua Bedug were found in an upside-down condition, with the calvaria underneath. Many fragments of mollusk shells and faunal bones were found scattered around and under the skull, some of which are artifacts.

The post-cranial human bones that were recovered from the TP 3 unit are limited only to distal and intermediate phalanges. The inverted position of the fragmented skull and the lack

of post-cranial bones are making the archaeological context determination problematic. We are assuming that these human remains might indicate a secondary burial process. This assumption is reinforced by the results of AMS radiocarbon dating carried out at Beta Analytic. Showing the integrity of the stratigraphy, the dating results show young to old dates for samples taken from the deposit around the skull. Charcoal from a depth of 56 cm produced a date of 6012-5895 cal BP, and *Unionidae* freshwater bivalve from a depth of 70 cm produced a date of 8777-8542 cal BP (Figure 9). Initially, there were also direct dating attempts by using a molar from TP 3, but they failed because of insufficient collagen (Wibowo et al., 2022).

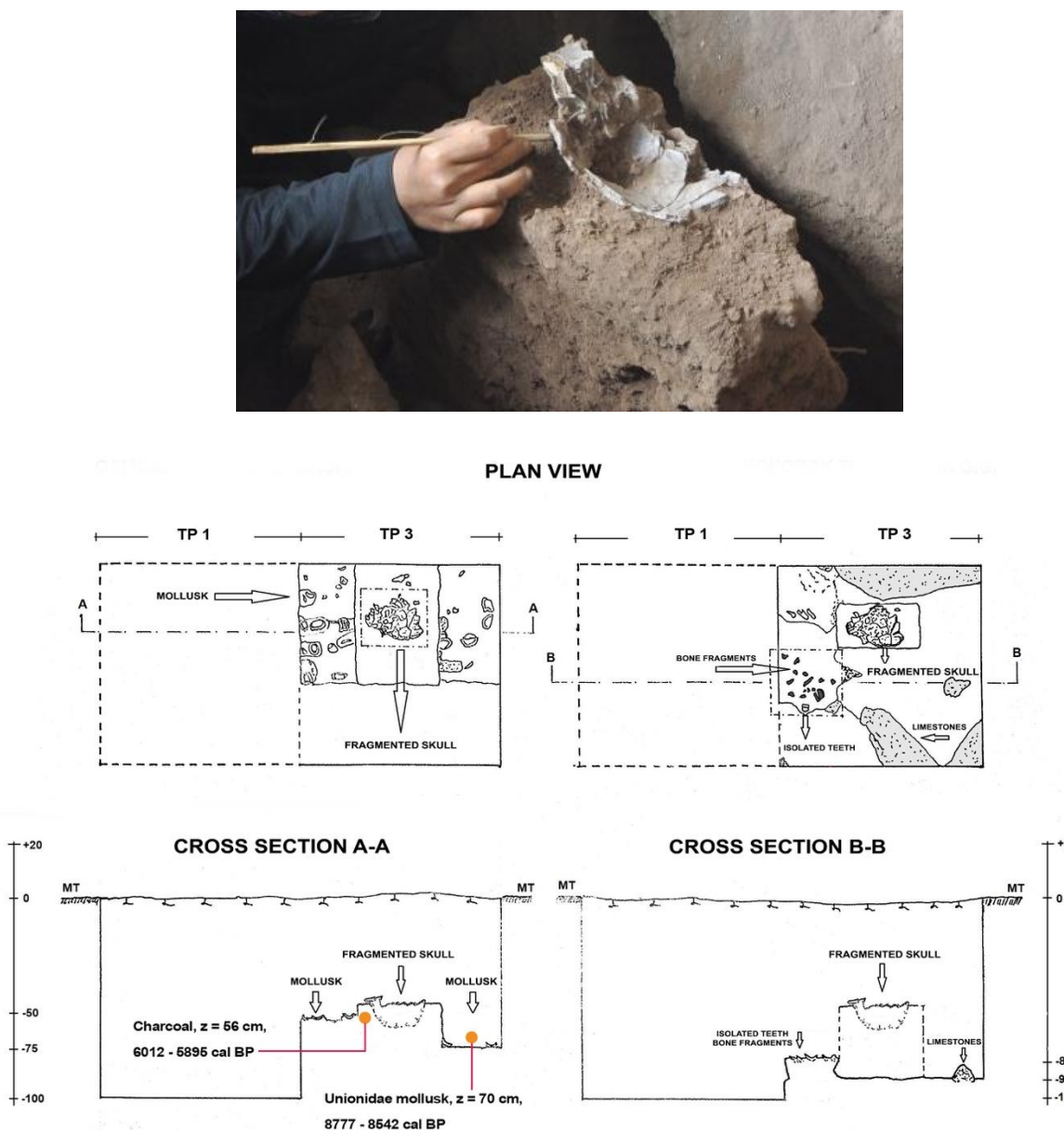


Figure 9. Excavation of the fragmented human skull (top) and their respective position related to the mollusk shells, isolated teeth, and radiocarbon samples (bottom)  
 (Credits: Balai Arkeologi Prov. D.I. Yogyakarta, 2021)

Besides the human remains described above, isolated teeth and fragments of human bones from different individuals were also found at depths of 80-100 cm in TP 1 and TP 3.

Unfortunately, the post-cranial bones were too fragmented to be accurately identified. Therefore, the affinity determination for Gua Bedug individuals depends solely on their dental records. The teeth from the fragmented skull and the isolated teeth from different depths mostly consist of molars. Three left maxillary M<sup>3</sup> indicating three different adult individuals. Additionally, specimens in the growth stage were observed, lacking a fully developed third molar, suggesting the presence of one juvenile. Thus, at least four individuals are represented in the dental records from Gua Bedug (Wibowo et al., 2022, 2024).

These human remains were recovered in context with shell and bone artifacts. Particular arched shell scrapers with fine marginal retouches were reported in great numbers from the Rembang Zone sites of Tuban (van Heekeren, 1972). Lithic artifacts of rounded cobblestones from Gua Bedug are also similar to what has been described from Gua Peturon, Tuban (Jatmiko, 1997). The bone points and spatulas were more common and present not only from sites in the northern part but also in the southern part of Java.

These artifacts are markers of Preneolithic culture that are commonly found in Java. In Gunung Sewu, the Preneolithic culture lasted between 12,000 to 4,000 BP (Simanjuntak, 2004). Therefore, the cultural layer dating from the southern part of Java is older than the northern part. But, from the perspective of dating that was associated with human remains, these two parts of Java were much closer in chronology. The northern and southern parts show that cave sites in Java reached their peak occupation during 9.000-5.000 BP (Table 1). It must be noted that future research might yield older dates from the sites in the northern part of Java since these sites are less studied than the sites in the southern part. For example, the starting phase for Gua Bedug occupation is not yet known, as chronometric data for layers below 80 cm are not available.

Table 1. Dating associated with human remains from sites in northern and southern parts of Java

Region	Site	Dating	Laboratory reference	Publication/ report
Northern part of Java (Rembang Zone)	Gua Kidang	5.719 – 5.578 cal BP	Beta 649557	(Wibowo et al., 2022)
		7.770 ± 220 BP	P3G	(Nurani & Murti, 2017)
		8.600 ± 310 BP	P3G	(Nurani, 2015)
		9.440 ± 220 BP	P3G 2018	(Nurani et al., 2019)
		9.600 ± 160 BP	P3G 2013	(Nurani et al., 2019)
	Gua Bedug	6.012 – 5.895 cal BP	Beta 646483	(Wibowo et al., 2022)
		8.777 – 8.542 cal BP	Beta 646485	(Wibowo et al., 2022)
Southern part of Java (Gunung Sewu)	Song Terus	9.330 ± 90 BP	Beta 124011	(Semah et al., 2004)
	Song Keplek	5.900 ± 180 BP	P3G 1996	(Simanjuntak, 2004)
		7.020 ± 180 BP	P3G 1999	(Simanjuntak, 2004)
	Gua Braholo	9.780 ± 230 BP	P3G 1997	(Simanjuntak, 1999, 2004)
		8.760 ± 170 BP	P3G 1998	(Simanjuntak, 2002, 2004)

Although sharing the same Preneolithic culture, currently, the much smaller quantity of lithic artifacts from Gua Bedug is only similar to Gua Kidang (Nurani, 2016), which is located 17 kilometers apart. In the same karst region, located further to the east, besides their abundant shell scrapers, the sites at Tuban were widely reported as having diverse and abundant lithics

(Genootschap, 1939; Heine Geldern, 1945, 1951; Jatmiko, 1998; Nitihaminoto & Koestoro, 1980; Suhartono, 2000; Tanudirjo, 1985; van Heekeren, 1972). In the southern part of Java, the Preneolithic cultural elements of Gunung Sewu mainly consist of lithic and bone tools (Borel, 2016; Forestier, 2007; Simanjuntak, 2001a, 2001b, 2004).

The small quantity of lithic artifacts in excavation records possibly indicates that the people of Gua Bedug prefer to use mollusks and bones. This preference might be driven by the availability of materials or by a specific purpose. In the literature of Asia-Pacific archaeology, it is often assumed that shells are used as raw materials to produce tools only when reliable sources of stone are lacking or non-existent. This implies that the shell is only a "substitute" material and that tools made of stone and mollusk shells are functionally equivalent. This further implies that shells as raw material for tools are easier to obtain than stones in the islands of Southeast Asia and the Pacific (Szabó et al., 2007).

Recent studies from Gua Golo in North Maluku show that mollusk shell artifacts are not necessarily a substitute, possibly reflecting symbolism and prestige, and therefore, the preference to use shell materials was driven by specific motives and purposes rather than material availability (Szabó et al., 2007). But it was worth considering that besides shell artifacts, many lithics were also found at Gua Golo, in contrast to the limited lithics at Gua Bedug. The lithic artifacts at Gua Golo indicate that the prehistoric people were able to choose between different materials so that they could give preference to the use of available materials for different purposes. Gua Bedug has very few lithic artifacts that might reflect limited/ non-existent stone raw materials. Therefore, the more abundant shell and bone materials were then used as a substitute to produce artifacts. The abundance of shell and bone artifacts at Gua Bedug is more likely driven by local adaptation rather than material preference for specific purposes.

This local adaptation is also shown in the faunal remains records, which are suspected to be a form of adaptation to the paleoenvironment coastal area of north Java. In Gunung Sewu sites, Preneolithic archaeological layers dated to the Holocene showed a dominance of small and intermediate-sized arboreal and semi-arboreal taxa, most notably cercopithecids (Amano, Moigne, et al., 2016; Amano, Rivals, et al., 2016; Sémah & Sémah, 2012). While at Gua Bedug, the degree of habitat variation between mollusk and vertebrate fauna indicates a high dependence on aquatic fauna as a food source, especially from freshwater mollusks of *Pachychilidae* and *Unionidae* (Sulistiyo & Wibowo, 2023).

Representing forest habitats, Cercopithecidae were also significantly present at Gua Bedug, which makes up 31% of vertebrate fauna bone remains. But other vertebrate from wetland (Crocodylidae, Varanidae, Trionychidae, and the fish families of Perciformes and Clupeidae) and coastal (Ardeidae, Carcharhinidae, Cheloniidae, and Pteropodidae) habitats are also clearly recorded. These are indicators of a close interaction between the people of Gua Bedug and their aquatic paleoenvironment.

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