# ENIGMATIC PERFORATED STONE DISK AND GROOVED STONES FROM THREE CAVE SITES IN SUMATRA

## *Cakram Batu Berlubang dan Batu Bergores yang Enigmatik dari Tiga Situs Gua Hunian di Sumatra*

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**Abstract.** *Ground stone tools, especially perforated stone disks and grooved stones are rarely discussed in Indonesian prehistory. In terms of quantity and workmanship, these artifacts are fairly unique. They are rare finds, which makes it difficult to compare with the other references. Moreover, their technological aspect still needs to be widely understood by academics. For the first time in Indonesia, this article will discuss perforated stone disks and grooved stones in the context of prehistoric cave sites in Sumatra. Through formal analysis of the attributes at medium to high magnification, we provide a reference for the technological aspects and the context of the artifacts. Our study reveals that both types of artifacts appear to relate to aquatic practices. The practical function of these artifacts is associated with a fishery tradition on the inland rivers. Our argument is corroborated by the remnants of aquatic fauna associated with the two types of artifacts. Additionally, perforated stone disks that have been previously reported in mainland Southeast Asia and this study extends the distribution to Sumatra, suggesting a connection between the cultural entities of prehistoric populations that inhabited insular and mainland Southeast Asia.*

***Keywords:*** *Perforated Disk, Grooved Stone, Ground Stone Tool, Prehistory of Sumatra*

**Abstrak.** Artefak dari batu kerakal, khususnya cakram batu berlubang dan batu bergores jarang dibahas oleh para prasejarawan di Indonesia. Padahal baik dari segi kuantitas maupun kualitas penggarapannya, artefak tersebut dapat dibilang unik. Jumlahnya seringkali terbatas sehingga sulit untuk mendapatkan referensi pembanding. Sedangkan dari aspek teknologi pembuatan, keduanya masih belum banyak dipahami oleh akademisi. Untuk pertama kalinya di di Indonesia, artikel ini akan membahas cakram batu berlubang dan batu bergores yang berada dalam konteks situs hunian gua prasejarah di Sumatra. Melalui analisis formal terhadap atribut bentuk dengan perbesaran sedang hingga tinggi, kami mencoba memperkenalkan aspek teknologis serta konteks dari artefak tersebut. Hasil penelitian menunjukan bahwa kedua tipe artefak tampaknya berkaitan erat dengan budaya perairan di pedalaman. Hal ini juga didukung oleh temuan fauna akuatik yang berasosiasi dengan kedua tipe artefak. Selain itu, cakram batu berlubang yang sebelumnya banyak dilaporkan berasal dari wilayah Asia Tenggara Daratan, berkat studi ini terungkap bahwa distribusinya pun mencapai pulau Sumatra. Hal tersebut semakin mempertegas adanya kaitan entitas budaya dari populasi prasejarah yang menghuni kepulauan Asia tenggara dengan wilayah Asia Tenggara Daratan.

**Kata kunci:** Cakram Batu Berlubang, Batu Bergores, Alat Batu Berbahan Kerakal, Prasejarah Sumatra

## 1. Introduction

It is common that some peculiar specimens are recovered among prehistoric artifact assemblage. Usually, they are limited in number and show atypical morphology, leading to questions about their significance to past civilizations. This is the case here, where we have found several artifacts unearthed from the prehistoric cave sites of Sumatra (Figure 1). These consist of four specimens of clearly modified or worked stone that were recovered from three sites: Gua Mesiu, Gua Harimau and Gua Pondok Silabe 1. The first site is located in Bukit Bulan (BB) karstic area, Sarolangun, Jambi. The latter two sites are situated in the karstic area of Padangbindu (PB), Ogan Komering Ulu, South Sumatra. All four of the artifacts were collected at different times, between 2002 to 2019 by Pusat Penelitian Arkeologi Nasional (Puslit Arkenas), Institut de Recherche pour le Développement (IRD), and Balai Arkeologi Sumatra Selatan (Balar Sumsel). Here we provide a more detail description of these four specimens, along with the associated finds and regional context. The purpose is to introduce their distinctive attributes, generate idea of their function, and provide an insight on the chrono-cultural context.

In Sumatra, the antiquity of lithic technology can be traced back to the Paleolithic period. It is represented by the discovery of heavily patinated, large, and thick stone implements along the riverbed in Kikim, Tambangsawah, Kalianda (Soejono 1961, p. 217) and Ogan River (Forestier *et al*., 2017, pp. 8–9). Apart from their apparently simple technological attributes, these open-air sites lack an absolute chronology, so the deep antiquity is only assumed. More information on the development of lithic technology with robust chronostratigraphic position comes from cave sites (*e.g.* Bronson and Asmar, 1975; Wiradnyana and Setiawan, 2011; Fauzi, 2016; Fauzi and Budisantosa, 2016) and some settlement sites in the highlands of Sumatra (*e.g.* Bonatz, 2004; Guillaud *et al*., 2006). However, most discussions from sites with well-defined stratigraphic contexts are focus on knapped products such as flakes and cores. Other type of artifacts such as ground stone tool usually only briefly referred to as 'associated finds' or as part of a specific cultural entity (Indriastuti and Widianto, 2007, p. 45; *e.g.* see Fauzi *et al.*, 2023, p. 15).

### 1.1 Limitation and Regional Context of Perforated Disks and Grooved Stones

Stone shaping comprises various kinds of intentional modification, such as knapping, abrading, and perforating. The concept of its production is fundamentally based on a volumetric reduction of natural cobbles, pebbles, or stone fragments by any means. This method may produce many types of lithic artifacts, such as choppers, jewelry, spindle whorl, pestle and mortar, and even a portable art. Here we confine our interest to ground stone tools, as defined by Wright (1992) as "*any (stone) tools made by combinations of flaking, pecking, pounding, grinding, drilling and incising*". Furthermore, we focus on perforated disk and grooved modification to ground stone tool, in particular those from the prehistoric cave settlement sites of Sumatra. We realize that these artifacts are rarely discussed among the Indonesian archaeologists and have never been published either.

Perforated disks are one of the types of a ground stone tool that are distributed worldwide with various names. Some of scholars define them by their morphology, such as *donut/ doughnut stone*, *bored stone*, and *perforated stone/disk* (Linehan, 1951; *e.g.* Tomasic, 2012; Imdirakphol *et al*., 2017; Yinghua *et al*., 2021). Some have also named it after its presumed or deduced function, such as *pump-drill flywheel*, *weight stone*, *net sinker*, *spindle whorl*, and *digging/dibble stick weight*. Here, we use the term "*perforated disk*" to describe the general shape (*i.e.* disk) and main attribute (*i.e.* perforation). We define a perforated disk as a stone tool from an archaeological context that exhibits a *quasi*-flat-rounded shape with a single perforation on its middle that goes through its both faces.

The distribution of perforated disks are quite widespread across the countries in Mainland of Southeast Asia (MSEA, Figure 1), such as in Myanmar, Thailand, Laos, and Vietnam (Linehan, 1951; Sørensen, 1975; Imdirakphol *et al*., 2017; Higham, 2021; Yinghua *et al*., 2021). In the Far East, the distribution of perforated disks covers an even broader area, comprising China, Japan, Korea, and Taiwan (Kim, 1978; Aikens and Higuchi, 1982; Solheim II, 1996; Yinghua *et al*., 2021). In contrast to the MSEA, perforated disks are hardly ever found in Insular Southeast Asia (ISEA). Perforated disks are occasionally associated with the production of semi-precious stone bracelets from the Javanese Late-Neolithic sites (Heekeren, 1972; Soejono *et al*., 1993; Sulistyarto *et al*., 2021) that are morphologically different to those found in MSEA sites. Perforated disks from the Javanese Neolithic sites are generally polished with a large hole in the center that appears to fit on the wrist. That is why they are called stone bracelets.

Other types of ground stone tools that are also rarely found or discussed are grooved stones. They are small portable artifacts made of natural cobbles or stones with grooves on the surface. Grooves on a stone or other material in an archaeological context have long been associated with the symbolic behavior of ancient populations (*e.g.* d'Errico and Henshilwood 2011; Hooder 1989; Joordens *et al*. 2015). This interpretation, of course, is elaborated with their contextual information and associated finds. Moreover, others also interpreted the practical use of grooved stones as a weight stone or sinker (Pedergnana *et al*., 2021). In the Near Eastern region, grooved stones are associated with producing and maintaining small-pointed tools such as bone awls (Usacheva, 2016). Unfortunately, in Southeast Asia there is a lack of published information regarding the discovery of grooved stone artifacts. Thus, a description of its morphological characteristic is needed to open broader discussions of this peculiar type of stone tool.

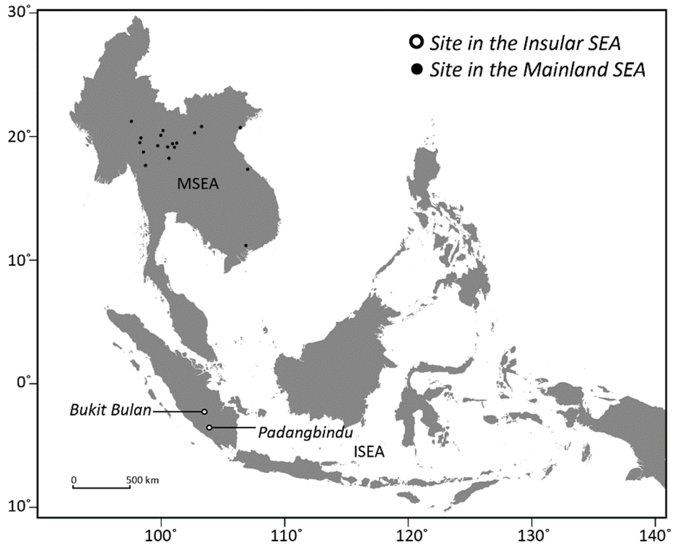


**Figure 1.** Current distribution of perforated disks across the MSEA (for the name of localities, see and refer to Imdirakphol ., 2017) indicated with black dot. Novel findings of perforated disks (Bukit Bulan) and grooved stone (Padangbindu) in Sumatra, in the western part of Insular Southeast Asia, indicated with white dot. Until now, the four artefacts are the very first to be discovered in ISEA (Source: https://freevectormaps.com with modifications by the author)

## 2. Materials and Method

Materials analyzed (Figure 2, 5, and 6) and described here comprised of two perforated disks from Gua Mesiu (now stored in the BRIN co-working space, Palembang) and two grooved stones that originate from Gua Harimau (stored in the si Pahit Lidah Museum, Padangbindu) and Gua Pondok Silabe 1 (stored in BRIN RP Soejono Science Area, Jakarta). All of the four specimens were collected from the excavation of those cave sites. This small number of specimens (n=4) emphasizes their distinctive morphology, as all were recovered from large archaeological assemblages.

Observations encompass both macroscopic and microscopic observation, with low magnification optical Stereo Microscope Euromex SB1903P. We also generated a Scanning Electron Microscope (SEM) image in the SEM-EDS UPP Chevron-ITB facility, indirectly using acrylic resin molded to a polyvinyl siloxane mold that was taken off one of the perforated disks. To acquire an appropriate sample for SEM imaging, we followed the sampling protocols proposed by Camarós *et al.* (2016), Janice Li *et al.* (2012), and Rose (1983). The purpose was to generate a clear topographical image of the altered/modified surface of the artifact. Documentations were made on all four specimens using a digital camera equipped with an EF50mm f/2.5 compact macro lens to produce vivid images of superficial features such as pits and striations. Radiocarbon dates from the sites being discussed here were calibrated using OxCal version 4.4. after Bronk Ramsey (2021) with atmospheric data taken from Reimer *et al.* (2020), provided in calBP (calibrated before present) using 2σ at 95.4% probability.

To allows for replicability and comparison elsewhere, our study used the technical nomenclature for ground stone tools in Levant after Wright (1992). Using a descriptive approach, we observed the metric and morphological attributes of four specimens of worked cobbles as our primary data. We also employed the same observations to the secondary data extracted from the literature, imitated to the Southeast Asian region. To obtain morpho-metrical data from the secondary sources, we performed indirect measurement of perforated stone artifacts from the MSEA. Indirect measurements are carried out on published photographs of perforated stone disks accompanied by a scale bar. Thus, it allows pixel-based measurements by using ImageJ 1.54d software version 1.8.0_345 on the Windows x64 operating system. Afterward, the Zingg diagram (Zingg 1935 in Allaby, 2008) was employed to obtain a robust classification on tridimensional shape of the specimen. This diagram allowed us to compare the primary and secondary data, particularly to the perforated stones disk from the MSEA (*e.g.* Sørensen, 1975; Imdirakphol *et al.*, 2017).

### 2.1 Technical terminology

The formal description in our research is designed to enable replicability and comparative use elsewhere. Hence, we adopted a series of nomenclatures from the fields of archaeology and geology (Wright, 1992; *e.g.* Inizan *et al*., 1999; Odell, 2003; Zingg 1935 in Allaby, 2008; Rapp, 2009) to produce a robust assessment covering the raw material, morphology, and technological aspects.

a. Material (Wright, 1992; Inizan., 1999; after Odell, 2003; Rapp, 2009)

The type, size, and general outline/shape of a raw material can provide a hint to the source type and procurement strategy. Below is an explanation of the raw material aspects and the initial aspects discussed in this paper.

*a.1. cobble or pebble* (after Wright, 1992; Odell, 2003)

Waterworn or riverine stone nodule with a sub-rounded or rounded surface, thus considered as a secondary source from its geological context.

*a.2. blank* (after Inizan *et al*., 1999; Odell, 2003)

A piece of stone intended for further modification or shaping, and may or may not have prior shaping. They can be obtained directly from the source (unmodified) or by detaching a large, thick flake from cobble or other block of raw material.

*a.3. slate* (after Rapp, 2009)

A fine-grained clastic sedimentary rocks, which occurs in various colors and generally shows lamination parallel to their original bedding, resulting in a slaty cleavage. They have a hardness of around 2.5–4 on the Mohs hardness scale, thus are relatively easy to shape or carve but are largely unsuitable for knapping.

*a.4. andesite* (after Rapp, 2009)

A fine-grained, dark-colored igneous rock with hardness between 4–6 on the Mohs hardness scale, moderately easy for shaping by any technique, including knapping.

b. Shape (after Wright, 1992; Imdirakphol *et al*., 2017)

We followed the terminology proposed by Zingg (1935 in Allaby 2008) to describe the shape of a blank being used to making perforated disks and grooved stones. Cobbles can be classified into at least four shape categories as follows.

*b.1. prolate/elongate*

Having an elongated shape with a ratio of width to thickness that is almost equal, but both of which are far shorter than the long axis.

*b.2. oblate*

A flat or disk-shape with a ratio of length to width that is almost equal, but both of which are far larger than the thickness.

*b.3. biconical perforation section*

The shape of a hole in cross-section, which is formed by two conical perforations with opposite faces that meet in the middle to form a biconical or 'hour-glass' shaped perforation.

*b.4. cylindrical perforation section*

The shape of a hole in cross-section, formed by a single conical perforation that travels through the specimen from one side only.

c. *Modification*/Shaping (after Wright, 1992; Inizan *et al*., 1999; Odell, 2003)

The production of a non-flaked stone tool in general, encompasses various techniques to alter the initial shape of a natural cobble that is being used as support/blank. Conceptually, the modifications made emphasize the reduction (remove) of the support/blank.

*c.1. pecking*

The process of removing excess parts of a surface through hammering or battering, to obtain an intended shape or to reduce the dimensions of a blank.

*c.2. grinding*

Abrasion of a specimen by rubbing against an abrasive surface, to remove excess parts uneven surfaces or to obtain an intended shape.

*c.3. incising*

Cutting of fine grooves on the surface of a specimen, resulting in either a narrow, rounded, or rectangular canal in a cross-section.

*c.4. drilling*

Any rotary movement performed with a pointed tip to remove some material, and leaving either a circular or sub-circular hole on the surface. The hole can be partial or fully penetrate a specimen.

d. *Metrics and Orientation* (after Wright, 1992)

To obtain tridimensional measurements of the perforated disk, we measure the specimens's maximum value of length, breadth/width, and thickness. Maintaining its consistency, the measurement of length and breadth were taken with the 'face' (where hole is visible) oriented facing the observer. Meanwhile, the thickness is the maximum dimension taken with the margin oriented facing the observer. In technological orientation, the 'face' of an artifact is where the intentional modification is visible and 'margin' refers to the long lateral sides of the specimen (Wright, 1992).

## 3. Result and Discussion

### 3.1 Perforated Disks of the Bukit Bulan Karstic Area

Two perforated disks (**PD1** and **PD2**) were found during a trial excavation in Gua Mesiu (lat. -2.652846; long. 102.424479; alt. 254 m asl) in 2019. The cave is located at Napal Melintang Village, Limun District, Sarolangun Regency, Province of Jambi (Figure 1). Gua Mesiu is situated on a Cretaceous-Jurassic limestone formation that belongs to the Mersip Member of the Peneta Formation (Suwarna *et al*., 1992). The limestone outcrops in the area are known as Bukit Bulan by the locals, which is also related to their cultural identity as the "*margo (clan) Bukit Bulan*". The general physiography of the area is dominated by residual steep limestone hills and karst towers, each separated by narrow valleys utilized as paddy fields by the locals. Several underground channels penetrated the hills and made their way to the surface as natural creeks. The lowlands are eroded by numerous small creeks that flow to the Sungai Limun and Sungai Ketari rivers. These rivers transport and deposit polymictic cobbles (mainly fine-grained clastic sedimentary rock, such as limestone and shale or slate) along its course. Some silica-rich rocks such as obsidian, petrified-wood, and chert that origins as embedded in cave deposits as allochthonous material are available at some riverine deposits outside the Bukit Bulan karstic area (Fauzi and Budisantosa, 2016; Fauzi, Wibowo and Wibawa, 2019).

The Gua Mesiu site is one of the largest caves located in the southern part of Bukit Raja. The cave is situated on a steep hill on the westernmost part of the Bukit Bulan Karstic area. In 2019, three test pits were placed near the entrance (TP1, 150x150 cm and TP3, 150x100 cm) and the main chamber of the cave (TP2, 150x150 cm). Although the three test pits exhibit the existence of anthropogenic deposits, the densest archaeological findings


**Figure 2.** Perforated disks (PD1 and PD2) made of slate recovered from the excavation of Gua Mesiu at Bukit Bulan karstic area (Source: Fauzi *et al*., 2023)

only appear in TP1 and TP3 squares. Two perforated stones were found from TP3 square at a depth of 40-45 cm below the cave floor (Fauzi *et al*., 2019). These artifacts were made of slate, one of a fine-grained and relatively soft rock that is abundantly available in the rivers and creeks nearby the site. The archaeological context, age, and associated finds are discussed in a later section (3.3).

In general, perforated disks from Gua Mesiu show similar outlines, which is quasi-oval shape on its face side. Meanwhile, on its margin side, both specimens show a plano-convex cross-section. The specimens each weigh 85 grams for PD1 and 184 grams for PD2, which corresponds to their different dimensions. The measurement of PD1 and PD2 yielded oblate shape based on the Zingg Diagram, comparable to most of the perforated disks from Thailand sites in MSEA (Figure 3). With a thickness of between 12-19 mm, the perforated disks from Gua Mesiu site are thinner compared to those found in MSEA (e.g. Changwat Tak, Doi Pha Kan, and Tham Lod rockshelter), which have an average thickness of 41.48 mm (and description from Sørensen, 1975; based on our indirect measurement to the published material by (Imdirakphol *et al*., 2017).

Along their margins several notches were found, most probably carried out by a careful trimming by pecking. Smooth surfaces appear on both faces of PD1 and PD2, probably due to grinding with some abrasion scars, such as linear and concentric striations. Some striations are also driven by a slaty-cleavage along the natural foliation structure in slate. This foliation structure seems to affect the orientation of the artifacts, where the faces of the specimens are parallel to the planar arrangement of the slate that was used as raw material.

The hole have been placed almost in the center of the artifacts, however on PD1 the hole is located slightly away from the center. Both specimens show biconical perforations that penetrated both faces. Low magnification observations revealed some traces of pecking, especially on the outer area of perforations. Moreover, concentric striations also appear on the surfaces of perforated areas, following the slaty-cleavage of the raw material. A high magnification observation using SEM on the PD2 specimen revealed rounded surfaces, evidence of repetitive contact with a soft material. The SEM image also shows a stepped-breakage that became a part of concentric striation on the perforated surface.

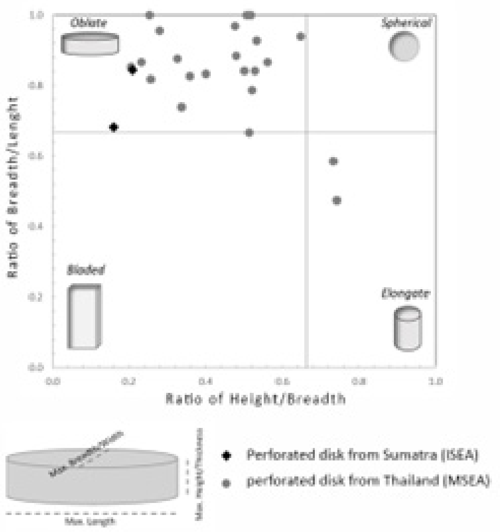


**Figure 3.** Comparison of the shape of blank being used for perforated disk in the MSEA (represented by samples from Thailands) and Sumatra in ISEA using the Zingg Diagram (after Zingg 1935 in Allaby, 2008). The lower picture shows the alignment of measurements taken (Source: Fauzi *et al*., 2023)

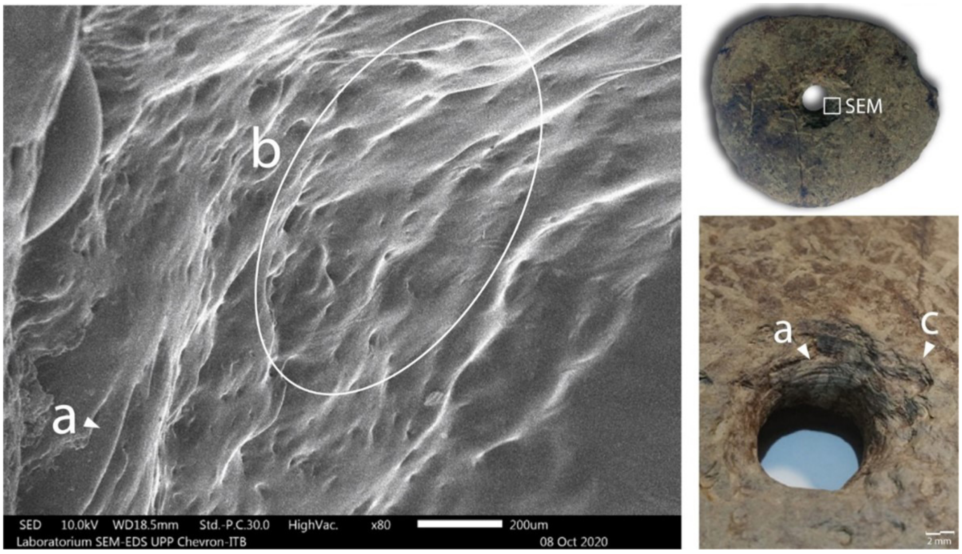


**Figure 4.** Comparison of the shape of blank being used for perforated disk in the MSEA (represented by samples from Thailands) and Sumatra in ISEA using the Zingg Diagram (after Zingg 1935 in Allaby, 2008). The lower picture shows the alignment of measurements taken (Source: Fauzi *et al*., 2023)

## 3.2 Grooved Stones of Padangbindu Karstic Area

Two specimens of small elongated or prolate-shaped cobble stones with thin, narrow grooves were collected from the excavations of two cave sites in the karstic region of Padangbindu, Ogan Komering Ulu Regency, South Sumatra Province (Figure 1). Some similarities occur between the two specimens, especially in their general shape and raw material. The raw material used is a dark-gray andesitic stone that is available locally in Air Ogan, the largest river of the area, as well as its tributaries such as the Semuhun, Aik Tawar, and Aik Aman rivers.

The first grooved stone (GS1) originated from Gua Silabe 1 (lat. -4.067222; long. 103.932069; alt. 110 m asl.). Specimen GS1 was found in LU1 (*Lubang Uji* 1 or test pit 1) during the 2002 fieldwork. It was recorded as 'batu bergores' (incised/grooved stone) with inventory number SLB1/02/LU1/2256. The specimen was unearthed from a light brown sandy-clay layer (layer 2), at the depth of 77 cm below the cave floor. It was found together with potsherds and flake tools made of obsidian, chert, and andesite (Simanjuntak *et al*., 2006).

Specimen GS1 (Figure 5) has dimensions of 48 x 11 x 10 mm and weighs 9 grams. This specimen appears to be broken and missing part of its margin and tip, leaving what we estimate to be 75% of its original shape. The end of the artefact has a 0.5 mm width and 0.3 mm deep groove that has filled with a white hard substance, possibly carbonate concretion precipitating from the limestone cave. Several fine linear striations are observable on its margins or lateral and faces, adjacent to the groove line. These fine linear striations were most likely produced by grinding during the shaping process. A slightly flat surface is observable at one of its intact lateral sides, where the grooved line ended. Most likely, this grove was also produced by a grinding technique. Excepting its broken part, a smooth and even surface occurs on all sides of the artifact, creating a shiny effect when exposed to light.

Another grooved stone (**GS2**, Figure 6) was found during the excavation of 'stratigraphical-unit a' (S.U. a) of D10 square in Gua Harimau (lat. -4.074028; long. 103.931111; alt. 112 m asl.) (Simanjuntak, 2016). The grooved stone from Gua Harimau

(GS2) was found in a dark brown clay layer, at the depth of 50-60 cm below the datum point, or approximately 10-20 cm below the present cave floor. The artefact was found along with a numerous obsidian flakes and potsherds. At the same depth, a human burial in a flexed position was also unearthed, accompanied by a small globular polished-jar as a burial gift. Stratigraphical unit a in Gua Harimau is well-dated to between 1830-1736 calBP (BTN-13024). This date corresponds to the last phase of prehistoric burial activity from the Paleometalic or Protohistoric period of the area (Fauzi, Oktaviana, and Budiman, 2016; Fauzi *et al*., 2023). The date also fits well with the Paleometalic layer from the neighboring site, Gua Silabe 1 which has an occupation phase dated to between 1345-793 calBP (1180±140 BP) and 1867-1602 calBP (1825±47 BP) ) (Simanjuntak *et al*., 2006; no lab number).

Specimen GS2 is a completely intact artifact (Figure 6) that clearly exhibits two fine, narrow grooves on both of its primary faces. The grooves observed on both ends of GS2 specimen are placed at the center, with the same orientation. Both of the linear grooves are unconnected and show tapering ends on both sides. The dimensions of the artifact are 48 x 15 x 15 mm, thus giving an almost symmetric tabular shape with rounded ends. The surface of the artifact is smooth, but some pores are still visible with the naked eye. Notably, some traces of red pigments, possibly of ochre (hematite), occur on the surface of the artifact. However, we found no clear pattern of the ochre distribution, yet no association to the strongest attributes of GS2 specimen (*i.e*. the groove lines). Although there are no striations or abrasion marks left, the smooth surface and evenness of its shape indicate that the manufacturing process for GS2 must have incorporated a grinding technique.

Under a low magnification (Figure 6), the inner part of the grooved lines shows a relatively even and smooth surface compared to the rest of the artefact surface. Moreover, the canal on GS2 specimen shows an 'U-shaped' profile with no striations or abrasion marks that would normally be left by a hard, sharp object. The smooth and even surfaces inside the canals therefore likely resulted from a repetitive contact with a kind of soft abrasive material after the groove line was made.


**Figure 5.** A broken piece of a small engraved elongated cobble stone made of andesite found in Gua Silabe cave excavation 2022 (Source: Fauzi *et al*., 2023)


**Figure 6.** Grooved stone from Gua Harimau (GS2) No. HRM/13/D10/4/NON which show disconnected, thin, narrow grooves on both of its ends. Notice a different degree of smoothness between the inner surface of the 'u shape' canal and the outer surface, which in contrast is quite uneven and more porous (Source: Fauzi *et al*., 2023)

**Table 1.** Morphological description and contextual findings of perforated disks and grooved stones from Sumatran cave sites.

| Code* No. | Site, Artifact ID*, Provenance | Dimension (in mm) and shape | Weight (in gr) | Age (in thousand/ kilo years) | Associated Artifacts | Brief Description |
|---|---|---|---|---|---|---|
| **PD1** | Gua Mesiu MSU/19/TP3/9/No. 7 layer f depth -44 cm below the surface (Fauzi ., 2018, 2019). | 110 x 71 x 12 oblate | 85 | ca. 1.9 ka BP (BATAN, lab number not available Fauzi . 2018; 2019). | Lithic tools (mostly flakes), cord-marked pottery, vertebrate remains | An oblate red-colored slate with a biconical perforation (Ø 12 mm) going through its center. The shape most likely was modified by pecking and grinding, resulting a plano-convex cross-section. |
| **PD2** | Wuida, Desa Rusoh | 108 x 91 x 19 oblate | 184 | ca. 1.9 ka BP (BATAN, lab number not available Fauzi . 2018; 2019). | Lithic tools (mostly flakes), cord-marked pottery, vertebrate remains | An oblate green color slate with a biconical perforation (Ø 13 mm) going through its middle part. The shape most likely was modified by pecking and grinding, resulting a plano-convex section. |
| **GS1** | Ceruk Pampini, Desa Bowon baru | 48 x 11 x 10 prolate/elongate, broken | 9 | ca. 1.8-2.7 ka BP (Forestier ., 2006, p. 187) | Lithic tools (mostly flakes), cord-marked pottery | Broken piece (approximately 75%) of a small smooth elongated andesite cobble with one incision at the middle of its surviving end. Groove is approximately 0.5 mm wide and 0.3 mm deep. Microscopic traces of linear abrasions were observed on the surface. |
| **GS2** | Makatara, Beo Utara | 48 x 15 x 15 prolate/elongate | 32 | ca. 1.7 ka BP (Fauzi ., 2023, p. 8) | Polished globular jar, extended supine human burial (I.71), lithic tools (mostly flakes) | Smooth small elongated andesite cobble with two linear incisions at the middle of its ends. Grooves are 1.5 mm wide and 1 mm deep. Engraved lines are not connected but have the same orientation. |

*Abbreviations: PS=Perforated disk; GS=Grooved Stone; MSU=Gua Mesiu; SLB1=Gua Silabe 1; HRM=Gua Harimau. See the text for calibrated radiocarbon ages.

*Source: Fauzi et.al., 2023*

### 3.3 Contextualizing perforated disks and grooved stones from Sumatran Cave Sites

The perforated disks of Gua Mesiu (specimens PD1 and PD2) were found in association with abundant numbers of heavily fragmented vertebrate remains as well as flakes made of silica-rich rocks such as obsidian, chert, and petrified-wood (Fauzi *et al*., 2018, 2019). These artefacts approximately reflect the general toolkits and subsistence among the prehistoric settlers of Gua Mesiu. However, the most significant information for the context of perforated disks was derived from a small number of potsherds collected at the same depth and layer as the perforated disks. The existence of potsherds indicate that the perforated disks are not associated with the Preneolithic period. Moreover, the absence of other key artifacts, such as metal objects, glass beads, or stoneware suggests that it is also unlikely that perforated disks were discarded during the Paleometalic or Protohistoric periods. Given this, it is most likley that the perforated disks belong to the Neolithic period. Two radiocarbon dates were taken from charcoal at the same layer with perforated disks giving result of 1921±107 calBP and 1904±142 calBP (Patir-Batan Lab. Indonesia, no lab number). These dates are fit well to the regional occurrence of Neolithic culture in caves, especially in Sumatra (*e.g.* Fauzi, 2017; Simanjuntak, 2015; Simanjuntak and Forestier, 2004).

Most of the potsherds associated with the perforated disks of Gua Mesiu are adorned with paddle-impressed decorations on their surface. In Indonesia, paddle-impressed pottery (see Solheim II, 2005), especially the cord-marked variety are distributed widely across Sumatra, Java, and Kalimantan (Ansyori, 2014; Plutniak *et al*., 2014; Fauzi, 2017). Compared to red-slipped pottery, paddle-impressed pottery is more commonly found in the western Indonesian archipelago (Simanjuntak, 2015), giving a hint to a different wave of a Neolithic expansion from the MSEA to the western portion of the Indonesian Archipelago (Simanjuntak, 2017). This hypothesis supports an earlier statement from Solheim II (1996) regarding the post-glacial populating history of ISEA. Recent studies on bioarchaeology and ancient genomes of materials from Sumatra also corroborate this hypothesis (Matsumura *et al*., 2018, 2019).

The finds of perforated disks from Gua Mesiu provides us with new information that strengthens the link between the prehistory of the MSEA and Sumatra. As previously mentioned, perforated disks are fairly widespread across the MSEA (Linehan, 1951; see Sørensen, 1975; Imdirakphol *et al*., 2017). Apart from its practical function, which remains uncertain, this type of ground stone tool has been well-dated in the MSEA region, from at least the Preneolithic (or Mesolithic) period, and associated to the Hoabinhian techno-complex (Imdirakphol *et al*., 2017; Zeitoun *et al*., 2019). However, a different chrono-cultural context is given by the only reported perforated disks from Sumatra. Both the context, associated finds and radiocarbon ages of the two perforated disks of Sumatra seems unlike those from MSEA (see Imdirakphol *et al*., 2017). However, the late appearance of perforated disk in Sumatra might be used as an indication of its origin, to wit, the MSEA. This argumentation of course needs to be verified by more primary data and information, since only two specimens of Sumatran perforated disks are being discussed here.

The grooved stones from Gua Silabe 1 and Gua Harimau exhibit similarity on their raw material, shape, and the positioning of the linear incisions. Two radiocarbon dates from layer 2 in Gua Silabe 1 have bracketed the age of GS1 specimen to between 1867-1602 calBP (1825±47 BP) up to 3212-2351 calBP (2680±170 BP) (Simanjuntak *et al*., 2006; analyzed in New Zealand and Indonesia, published with no lab number), providing an approximate age bracket for this specimen. These ages represent the Neolithic phase at Gua Silabe 1, and supported by a lack of metal artefacts in the assemblage,, and the occurrence of potsherds. A similar age was obtained from a single radiocarbon sample from the layer where the the GS2 specimen was recovered in Gua Harimau, of 1830-1736 calBP (1885±15 BP, BTN-13024). Here the date seems to correspond to the Paleometalic period because the onset of Neolithic culture in Gua Harimau is understood to fall around 2.4 ka BP (Fauzi *et al*., 2023).

Given the meticulous work required to produce the fine, narrow linear incisions on small cobble stone blanks, and with their high symmetry, we suggest that the grooved stones that were found in the Padangbindu karstic area might be related to the Paleometalic Culture. To describe further about the Neolithic layer found in cave sites of Padangbindu, no evidence of a sophisticated and polished stone tool have yet been found (*e.g.* stone bracelet or quadrangular stone adze). This is in contrast to the Paleometalic layer, where numerous bronze objects (*e.g.* socketed axes, knives, and bracelets) have been found with irrefutable association with burial features. Hence, we argue that the grooved stones in Gua Harimau and Gua Silabe 1 may in fact be Paleometalic artifacts.

The final question for an artifact is, of course their practical use by prehistoric societies. Since there is no strong evidence of their association with symbolic practices (*e.g.* cave art paintings and funerals), we find no direct evidence that the perforated disks and grooved stones had ideological functions. Although perforated stone disks have previously been associated with Mesolithic (or Preneolithic) burial practices in the MSEA (see Imdirakphol *et al*., 2017), this is not the case for two specimens of perforated disks we have found in Gua Mesiu.

Looking at the microscopic wear left on the biconical-holes of Gua Mesiu's perforated stone disks, we suggest that it might have resulted from a repetitive contact with soft substances, probably some kind of organic fibers (see also Xhauflair *et al*., 2016; Langley *et al*., 2023). We suggest that they may have been used as a fishing line sinker or attached to a fish trap to make the traps steady underwater. We abandon its other possible functions, such as flyweight or spindle whorl, because the specimen is asymmetric. The biconical hole will not hold firm if attached to a shaft. We also consider that the weight of the two specimens is too light to be used as a mace head. Hence, we prefer to relate the perforated stones to the fishery activity. In addition, there is evidence for the consumption of aquatic animals such as fish and turtles (Figure 7) in the vertebrate collection recovered from Gua Mesiu (Fauzi *et al*., 2018, 2019).. A similar pattern was also observed in Gua Harimau, where some of aquatic vertebrates also appear in the faunal assemblage (Ansyori and Awe, 2015; Fauzi ., 2023). The role of rivers as important resources is also reflected by the intensive use of riverine cobles as the main raw material in the lithic industry (Forestier *et al*., 2006; Fauzi, Wibowo and Wibawa, 2019).

Similarly, it is also possible that the grooved stones from Gua Silabe 1 and Gua Harimau (GS1 and GS2) served the same function as a fishing weight. Both of the specimens show minor traces, dominated by a smooth and even surface. We propose that these artifacts relate to fishery practices during the Protohistoric period. The weight of the complete specimen (GS2) is about 32 grams, a proper weight for a modern fishing sinkers. Like most fisherman nowadays, the local people in the surrounding sites use a fishing weight made of tin/lead with a similar weight, namely "*batu ladung*". The prolate shape also appears on modern day sinkers, especially for bottom fishing to catch various types of catfish (Siluriformes) and also for regular casting to

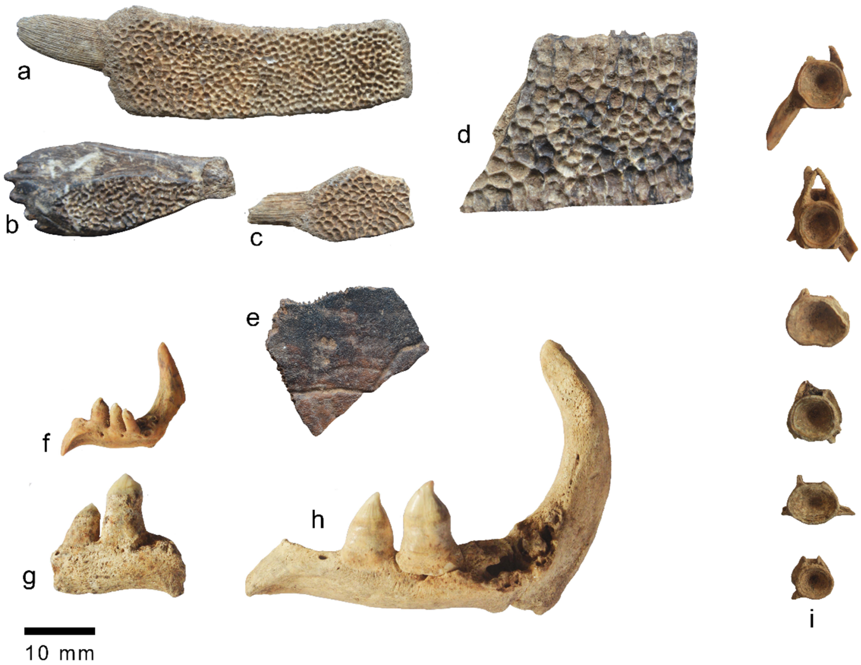


**Figure 7.** Representative specimens of aquatic fauna associated to the perforated disks in Gua Mesiu (Bukit Bulan, Jambi), such as softback turtle, fish, and turtle: carapace of Trionychidae (a-d), a carapace of Testudines (e), pharyngeal teeth of Cyprinidae (f-h), vertebrae of Siluriformes (i)
(Source: Fauzi *et al*., 2023)

catch broad types of Cyprinidae. Moreover, the prolate shape seems provide a more streamlined movement inside the water. If we assume that the double-grooves provide a firm place to attach the fishing-line, then it also resembles to the slide sinkers that are placed between the main fishing-line and the fishing leader that is connected to the hook(s). However, we realize that more studies on the collection is needed to corroborate our assumption, in a broader aspect such as use-wear analysis and ethnography.

## 4. Conclusion

Our study describes perforated disks and grooved stones that are rarely reported from Indonesian cave sites. On their morpho-technological aspects, both the perforated disks and grooved stones were made on cobble stone that is available locally. Although it shows simple shape and minor modification—as generally shown by most ground stone tools—our study reveals that they have undergone various shaping techniques. The production of these kinds of tools at least incorporated pecking, drilling, incising, and grinding. This suggests that there was a strong motive behind the sculpting of these particular types of ground stone tools.

Rivers in Sumatra play an important role for the inhabitants of Sumatra, not only in the present but also for prehistoric societies. The finds of perforated stone disks and grooved stones from these cave sites provides a possible connection to the fishery practices during the Neolithic and Protohistoric periods in Sumatra. The perforated stone disks may have originated from the MSEA, and appear in a later period of occupation in Sumatra. Their occurrence in the prehistoric site should be traced back to the old collection and awareness by the other researchers who will work on the Sumatran cave site in the future. The lack of primary data available, both regarding the perforated disk and grooved stones in ISEA, need to be addressed through more research on the lithic collections, including the other types of ground stone tools that are less common compared to knapping products.

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A broken piece of a small engraved elongated cobble stone made of andesite found in Gua Silabe cave excavation 2022 (Source: Fauzi *et al*., 2023)