Utilization of marine resources in prehistoric era at Pawon Cave West Java

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Abstracts. Pawon Cave is one of the locations for prehistoric life discovery in West Java. Archaeological research at Pawon Cave was done since 2003 until now. Seven human skeletons from prehistoric era had been found there. Five sample for carbon dating analysis for cultural chronology show the time between 5600-11700 BP. Besides human skeletons, from archaeological excavation at Pawon Cave also found various artefactual made various of stone like chert, obsidian, and andesite, bone tools as deer antlers, and pig teeth. Bone tools are processed into single piercings, double piercings, and spatulas, jewelry from shark teeth, animal fangs, and mollusks. Food indication can know from bone fragments from various animals bone fragment, and mollusks from both freshwater and marine. Based on the results of the forensic odontology analysis, an understanding about types of materials consumed by Pawon Man is more diverse. Hunting and collecting food of Pawon Man in the past, not only show by the excavation findings like animal bones remains, more specifically known from the analysis of calculus (plaque) attached to Pawon Man teeth. Based on archeological found in excavation and the result of calculus analysis can be show the Pawon Man in the prehistoric time also used as artifact and consume some source from marine.

1. Introduction
The interesting data from the existence of the Bandung Basin [1,2] with surrounding areas such as Padalarang, Dago, Lembang, Cicalengka, Banjaran, Soreang and Cililin in archeology terms are a number of evidences of past human life such as a stone and flake tools. The first discovery was proposed [3,4,5]. Some experts disagree on the findings, particularly those of the obsidian flakes. Classify the obsidian flakes as microlithic devices derived from planting [3,6,7]. They are based on the contextual findings with fragment of pottery, hand axe, and metal molds [3,8]. Another opinion was expressed by [1], who was more likely to classify these obsidian tools into older times [8]. The same thing was also forward by [4,10]. They are more likely to attract the cultural age of Bandung obsidian tool as a tool that comes from the time of hunting and gathering food. This opinion appears to be stronger because most of the flakes culture by prehistoric experts has been linked to hunting traps and
collecting advanced foods. Such a cultural period is often referred to as the mesolithic period [8], preceramics [11], or proneolithics [12], a cultural era in which culturally supportive societies have begun to develop semi-sedentary lives, both temporarily and for a longer period of time by making use of the caves or niches available in nature where they carry out their life and culture.

Chronologically the culture is expected to develop from the end of Pleistocene and experience the peak of development at the beginning of the Holocene. The life background of prehistoric society who has utilized the cave as a place of dwelling around the edge of Ancient Bandung Basin began to unfold by the discovery of the Pawon Cave. Administratively the site of Pawon Cave located in Gunung Masigit Village, Cipatat District Cipatat, approximately 25 kilometers to the West of Bandung City.

**Figure 1.** Location and lay out of Pawon cave, located at the north side of Mount Pawon [20]

Geologically, the caves on Gunung Pawon belong to the cliff cave group, in sequence from west to east direction consists of Barong, Peteng, Pawon, and Ketuk cave. The caves are at a height of approximately 716 meters above sea level. On the north side of the cave there is a Cibukur river flow and a vast expanse of hills and plains that are now used by the community as a plantation and rice fields [13]. Based on the geological map of Quarter Cianjur Sheet, this region belongs to the area of Rajamandala Formation, which consists mainly of a group of solid limestones and layered limestones. The limestone cluster is mostly light-colored with foraminifera [14].

**Figure 2.** Geomagnetic contour record at Pawon Cave [18]
2. Discovery and archaeological remain on Pawon Cave

Pawon cave located in the limestones of Gunung Masigit Village, Cipatat District, West Bandung regency or in the wider scale of the area located in the Western part of Bandung highlands which encompasses the area of Ancient Bandung Basin. Before archeological research at Pawon Cave, some prehistoric research was done on West Java, and so far has not found any caves that have an indication of occupancy from older occupancy periods [15]. In 1950, Benthem Jutting is the first researcher who did the area as locations of non-marine mollusks studies and recorded 9 types of non-marine mollusks found in the region [16]. Few years later, in 1959, the Mount Pawon area, including the Pawon Cave, was also recorded as part of a geological survey [17].

Pawon Cave was reinvestigated after the Bandung Basin Research Group (KRCB) conducted a survey and geological mapping in the Pawon Cave area and the surrounding area in May 1999. At that time the KRCB team done the geomagnetic mapping (see Figure 2) and an elongated excavation splitting the middle of the Pawon Cave [18]. From the trail of excavations that they did although they have produced some important indications of past cultures in the form of obsidian, bones, bone fragments findings, and mollusks, it almost destroyed the important findings of the Pawon Cave as it is nearing the depths to which Pawon humans are found.

![Figure 2. Geomagnetic mapping of Pawon Cave](image)

Figure 2. Geomagnetic mapping of Pawon Cave [18]

The archaeological research at Pawon Cave site is still in the process. Since 2003 until Mei 2019 was opened 14 excavation boxes, 6 boxes such as T2S2, T2S3, T2S4, T3S2, T3S3, T3S4 are placed in the space that their geomagnetic surveys have been carried out, and 8 boxes placed in the exterior space. The boxes that have been excavated consist of T1S1, T1U1, T2S1, T2U1, T3U1, T3S1, T1U3, and T2U3. Those of the excavation was done by West Java Archaeological Office, also conducted by collaboration with the Archeology, History and Traditional Value Management Center of West Java Province, as well as research conducted by the direct supervision of West Java Archaeology Office in the framework of archaeological practical students of the Department of History at Pajajaran University.

The excavation results at Pawon Cave site show the presence of multifunction cave in the past, being used as dwelling places demonstrated by findings that refer to flake tools made of obsidian, jasper and chaledony materials, bones tools and fangs in the form of spearheads and spatulas, hammer stones, mollusks remnants, and various of animal bones. In addition to the evidence of relics of living equipment, the excavation results also found other objects used as jewelry, made from fish teeth.
(shark), animal jaws, and mollusks. The evidence of past prehistoric life in Pawon Caves in the past has become more complete with the discovery of its cultural supporters. From the results of research conducted at Pawon Cave, seven human remains have been found that represent seven different individuals (see Figure 3). Three of them consist of skull, lower jaws, and upper jaws, and four skeleton buried with folded position or flexed burial [19]. From the results of the prehistoric cave research that has been done by experts over the years in Indonesia, there are very few buried bodies found in the cave, especially with the folded position found on the Pawon Cave site. Caves in Indonesia that have dead bodies with folded positions include Song Terus, Song Keplek, Sodong Cave, Lawa Cave, and Marjan Caves. The burial with folded cemetery in the caves is about 9800 BP. Meanwhile the human skeletons of the Pawon Cave are between 5600 and 11780 BP [20].

3. Marine resources on Pawon Cave

3.1. Marine resources as artefact

Indications of marine resources utility in prehistoric era at Pawon cave found in some material from excavation. The artefacts are the fragment of marine mollusk, from Pelecypoda group and Shark teeth. It used as jewelry in the past. The artifact from marine mollusk coming the hardest part of shell, which is a shiny layer inside. Remnants made of shark teeth and marine mollusk as a jewelry at Pawon cave were found from 90 to 130 cm depths from the ground, scattered randomly by associations of jewelry from animal fangs, stone tools, mollusks and food scraps in the form of animal bone fragments. Jewelry from shark teeth found from excavations in the Pawon Cave is strongly thought to originate from one species because of its size is a row of front teeth and moves to the back teeth. In this case consists of small sized teeth which are usually located in the front jaw and large ones on the back side. The seven shark teeth found from excavations in Pawon Cave all have holes in the roots of their teeth.

Based on observations of the shape of the hole and the rest of the cracks in the hole on root of Shark teeth can be estimated about the way it is done when making these holes. The hole was made simply by punching from both sides. Location of the holes on both sides is inaccurate, resulting in a slightly slanted through hole. If we look closely the size of the holes in the seven teeth of the Sharks is not same in size, the average is in the range of 1.08-1.67 mm. Some of the holes in the roots of the teeth are not always smooth and even, but some of them also leave cracks. It is probable that the shark's teeth used as jewelry are sharks' teeth that have died or when they have been found, then they are removed from their jawbones, then holes are drilled on both sides. Strong suspicion of a tool used to make a hole in the root of the shark's teeth using a taper (gurdi) made of obsidian stone.

The jewelry artifacts made from shells found in excavations are more than Shark teeth, which are 10 pieces. In addition it is also found in the form of materials in the form of larger fractions. The ten pieces of clam shell used as a pertisan are not the same size or thickness. Based on the physical form with a rough layer on the outside and a glossy layer on the other side, the strong suspicion of the shells used as material for the jewelry comes from the Pelecypoda.sp.

There is no standard form of each shell body fragments used as jewelry. It seems to depend on the shape of the broken part of shell which is broken on the part of shell that has a shiny layer (prism) on one side. With an average thickness between 0.7-2.08 mm. Meanwhile, the technique of making holes as jewelry is different from the technique of making holes in animal teeth and shark teeth. The holes only done from one side. Such punching technique is certainly possible to do considering the thickness of the shell, the average diameter of the hole on one side of 1 mm, while on the other side with an average of 2.31 mm. The hole moved from a large diameter and shows traces of rotating scratches to smaller side.

Now, location of the Pawon Cave is far from the sea, a question arises whether the existence of artifactual findings originating from these marine resources is the result of a system of exchange in the past or is a reflection of the Pawon Man occupation in the past. Based on the results of literature study and archaeological research that have been carried out so far, both in the north coast and south coast, not one archaeological site has cultural patterns and cultural periods with the same date as the prehistoric culture in Pawon Cave.
Figure 4. Prehistoric jewelry made from marine mollusk fragments and shark teeth, the results of excavation at Pawon cave [1]

The existence of marine resources such as Shark Tooth and marine mollusk used by Pawon Man in prehistoric times the range to the coastline can be referred to the results of studies conducted by [21] the distance from Pawon cave to the coast line is not the same as today. Zaim elaborated on the change in the north coast line of western Java with a case study of the North coast of Jakarta. from the period 4500 to 40,000 years ago. In the period 4500 to the coastline it was around 4-5 m above present sea level. While in the period of 40,000 years ago the coastline was between 25-35 above sea level now [21]. The area north of Pawon Cave which was possible to be exploited at that time was most likely the Subang Regency area. If the height of the sea level data, it is probable that the coastal area at that time is in the area around Ciasem, Purwodadi and surrounding areas or areas around the center of Subang City now.

The distance of Pawon Man occupation in the past can be compared with the results of the analysis of obsidian sources found at Pawon Cave. Based on the results of the analysis by looking at the similarities of chemical elements contained in obsidian artifacts found from excavation results have in common with chemical elements of obsidian originating from the Kendan region (Nagrek) which are located more or less with a distance of about 39 km and obsidian stones originating from Kampung Rejeng (Garut), which is located approximately 64 km east of the Pawon cave. It can be assumed that the range of Pawon Man explorations in the past so that it is also possible that the Pawon Man could also get the remains of marine animals which they later made as part of the culture at that time. Because there is no equivalent prehistoric culture in the area, it can be concluded that to obtain cultural material related to the utilization of these marine resources in the past was done by Pawon Man himself.

3.2. Traces of marine resources in teeth of Pawon Man
The collection of animal bones found on the excavations in the Pawon Cave, one question arises, whether the Pawon Man in the past only hunted animals to fulfill their food? is there no other source of food they eat at that time. Before calculus analysis of Pawon Man teeth done, the answer about the source of food consumed by Pawon Man, only show by variety of fragmented animal bones findings obtained from the series from excavation data. Findings that are thought to be related to nutritional patterns at the time representing by fragment of fresh water and marine mollusk, and various animal bone fragments, coming from several types of small and medium arboreal faunas such as Hystrix brachyuta, sp, Paradoxurus, sp, Rattus, sp, Sciuridae, sp, Trangulus, Macaca, sp, Cercopithecidae, Muntiacus, Canidae, large terrestrial animal such as Cervus, sp, Cervidae, Axis, sp, and classify as very large terrestrial animal are Bos Bubalus sp, Bovidae, sp, Elephas, sp, Sus Sucrofa, sp, also as arboreal animal like Felidae (Panthera, sp), and Microchirotea, sp [13].

The type of faunas finding that dominate can be a basic indication of the main consumption types in Pawon cave dwelling. This is reinforced by the fauna function group which can describe the types and main groups of hunted fauna for the inhabitant of Pawon Man based on location of their life. Further and comprehensive analysis such as the Paleoenvironment and ecology layer can provide a more complete picture of the relationship between the inhabitants of Pawon Man and their interactions with the environment of their life [20].
The trace of marine resources in Pawon Man teeth was carried out by analysis using calculus found in Pawon Man teeth. Dental calculus was chosen as a material for analysis because calculus is a mineralized plaque in the tooth that can provide information about the types of daily consumption of man [22,23,24]. The first analysis of calculus Pawon Man teeth used microscope with magnification 100x and continued by using Scanning Electron Microscope (SEM).

To ensure that the chemical content in the calculus of the Pawon Man teeth was also compared with the chemical content in the soil layer near the findings of the skeleton of the Pawon Man. From micro analysis of Pawon Man calculus used microscope with magnification 100x can recognized the starch and fiber on calculus of Pawon Man I and III, teeth 47, presented on table below.

Table 1. The present of calculus on Pawon Man teeth [25]

| Skeleton | Calculus Used | Result | Object |
|----------|---------------|--------|--------|
|          | Maxilla       | Mandible |        |
|          | Present | Absent | Present | Absent | Maxilla | Mandible |
| R.I      | Teeth 27     | -       | Teeth 47 | -       | Absent | Present |
| Second Preparation | | | | | | |
| R.III     | Teeth 18     | -       | Teeth 47 | -       | Absent | Present |
| Second Preparation | | | | | | |
| R.IV      | -             | V       | Teeth 43 | -       | -      | Absent |
| -         | Teeth 48     | -       | -        |        | Absent |
| R.V       | Teeth 17     | -       | Teeth 38 | -       | Absent | Absent |
| -         |              |         |          |        |        |

Based on the analysis result using the Scanning Electron Microscopy (SEM) tool with a magnification of 8000x-12000x [26], can be identified various forms of the matrix of chemical elements contained in the calculus [24,27]. For example dental calculus of Pawon Man IV (see Figure 7, the matrix found in the dental calculus of Pawon Man IV using SEM has a variety of sizes and shapes such as rectangular crystals that are suspected as sodium salt crystals, round like pollen which is suspected as a starch type carbohydrate, and some are like strands of yarn or fiber by being dominated by a mixture of bacteria but in addition to bacteria also found the presence of fiber matrix and extracellular matrix in calculus [28]. The matrix images in the calculus of human teeth Pawon Man can strengthen [28] the suspicion that the type of food consumed contains starch type carbohydrates and also the element sodium. Carbohydrate type of starch is most commonly found in plants while sodium comes from the sea which means that the Pawon Man is likely to consume plants and seafood (see Figure 6,7).
Based on that analysis, can be concluded Pawon Man in his lifetime did not only consume protein as showed by evidenced of animal bone fragments and mollusks found in a context with artifacts and humans, but also information by result of calculus analysts contained in the Pawon Man's teeth.

4. Conclusion
Based on the results of archeological analysis on cultural remain from archaeological excavation can find some artefact used as a part of jewelry by Pawon Man as a marine resources utility in the past. It makes from shark teeth and shell (marine mollusk), and from interdisciplinary analysis using calculus data contained in Pawon Man teeth that were analyzed using the SEM-EDX method apparently also provided additional information in interpreting the diet and types of food consumed by prehistoric man living in Pawon Cave. Beside consuming protein derived from animals that they hunt in the catchment area (around the cave where they live), carbohydrate and fiber from their environment, they also eat some resources from marine that showing by natrium crystal in calculus of Pawon Man teeth.
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