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Rise of The Tools and Dawn of The Giants: Defaunation of Paleo Mammals of Pawon 6-9 ka.

Andri Wibowo*

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*U. o. Indonesia, West Java, 16424. Indonesia.
Correspondence email:
paleobio2020@gmail.com
andri.wibowo@sc.ui.ac.id

Abstract

One of factors causing decline of paleo fauna is related to the hunting activities and the use of tools by early hominin. This study aims to observe the relationships of tools and abundances of mammals in early hominin occupancy in Pawon cave for the period of 6000-9000 year ago (ka). The results show low abundances of medium to large mammals. While obsidian tools numbers were observed high. From 8 to 9 ka there were abrupt reductions and followed with the disappearance of medium-large sized mammals included Tragulidae and Bovidae in 6 ka. Simultaneously, uses of obsidian tools in 8-9 ka were common. The reconstructed paleo climate may contribute to the decline of paleo mammal abundances. The temperatures were increasing from 27 ^{0}C in 9 ka to 28 ^{0}C in 6 ka. Periods of 6-7 ka were indicated by declines of Bovidae and obsidian tools as well. Nonetheless in these periods, there were increase in numbers of pottery and Suidae remains indicated the transition from hunting-gatherer to sedentary prehistoric life.

Introduction

The paleo mammals worldwide have experienced similar patterns. Prehistoric earth was dominated by mega mammals including mammoths, mastodons, giant ground sloths, glyptodonts, rhino-sized marsupials, giant kangaroos, gorilla-sized lemurs, and many others. Then those mega mammals were replaced by large deer-to-elephant sized medium mammals and rodent-to-rabbit sized small mammals. Many literatures have discussed the possible explanation for these extinctions range from natural causes like climate change, meteor, to anthropogenic causes. This theory was known as prehistoric overkill. Immediately after arriving in unpopulated landscape, hominin range expansion and population growth were fueled by intense predation and hunting on large game mainly mammals. High kill rates were occurred because naive prey do not respond to an unfamiliar threat in this case an armed hominin. Extinction then occurred rapidly within decades at a regional scale (Koch 2006).

The hunting activities by hominin were related to the development and the use of hunting tools. Those tools were made from obsidian stones and bones. Obsidian was first used for making a flaked stone tool during the early stone age more than 1.7 million years ago (Ma). Obsidian uses reflect adaptations to changing environments by hunter-gatherers (Ambrose 2012). Pearce and Moutsiou (2014) noted the obsidian uses among hunter gatherer prehistoric occupants back to Pleistocene by Neanderthals. The relationships of the obsidian tools to the mammal meat processing can be seen in Ambrose (2001). The adoptions of stone tools are often considered as the determinant factors for game hunting and meat consumption. This indicated by cut marks and hammer stone marks on bones of large mammals

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demonstrate meat and marrow consumption. The consumptions of high quality resources like meat to balance the high metabolic energy demands of the large brain of early *Homo* species.

Pawon is one of caves located in Java island known for its hominin occupations dated 9000 years ago (ka). Like other hominin occupied caves, Pawon contained animal bones and tools (Nurani & Hascaryo 2012, Nurani 2016). While Java island landscape was also known for its prehistoric large mammals weighing < 1000 kg (de Vos et al 1994, de Vos & Long 2001, Leinders et al. 1985, Malhi et al. 2016, van den Bergh et al. 2001, Theunissen et al. 1990) . Those paleo mammals in Java like their relatives in other locations were also experienced extinctions. Correspondingly, this study aims to find the relationships of tools developed by hominin with the declining trends of paleo mammals at Pawon cave.

Methods

The methods used in this study comprised of animal bone remains and tools collected from the assigned study areas. The collected bones and tools were classified based on the soil layers to determine the age.

Study area

The study area was the Pawon cave located in the Gunungmasigit highland of west Java at elevation of 716 m above sea level (Figure 1). The entrance of the cave was on the side of a cliff on south west direction. The length and width of this case were 38 m and 16 m. The landscapes surrounded the cave were dominated by the forest covers.

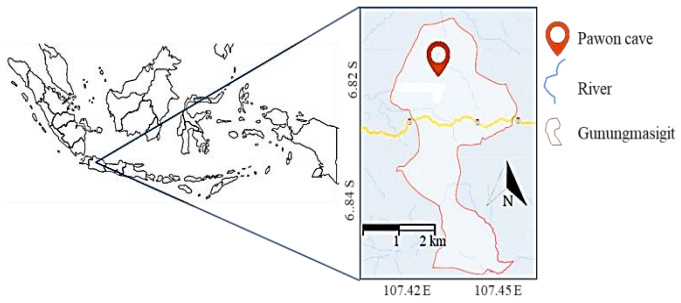

Figure 1. Location of Pawon cave located in Gunungmasigit highland of west Java.

Faunal abundance survey

Faunal survey was following methods by Veatch et al. (2019). Inside the cave, faunal remains were collected within excavation box from each soil layer. The divisions of soil layers were 6, 7, 8, and 9 ka. Those faunal remains included the vertebrata bones and mollusks (shells). Taxonomic identifications of faunal remains were based on diagnostic features and morphology (Sody 1941, Hooijer 1957, Musser et al. 1986, Kitchener et al. 1991). Faunal abundances were estimated based on the numbers of faunal remains.

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Tool abundance survey

Tools were surveyed simultaneously with faunal survey in excavation boxes. Tools were classified into their materials included obsidian and bone. Presence of cut marks appeared on tools were also observed (Dewbury & Russell 2007, Specht 2005, Nurfaridah et al. 2019).

Paleo climate reconstruction

The declining trends of paleo fauna can be related to another external factor involving environmental and climate. The paleo climate was reconstructed for the period of 6-9 ka.

Results

There were 9 mammal taxon groups found in Pawon included Cercopithecinae, Colobinae, Hylobatidae, Carnivora, Suidae, Cervidae, Bovidae, Tragulidae, and Rodentia. The mammal remains were dominated by small size groups (Figure 2) while numbers of medium to large size mammals were low with mammals from Bovidae and Tragulidae were the lowest. The tools were dominated by obsidian and followed by pottery and bones.

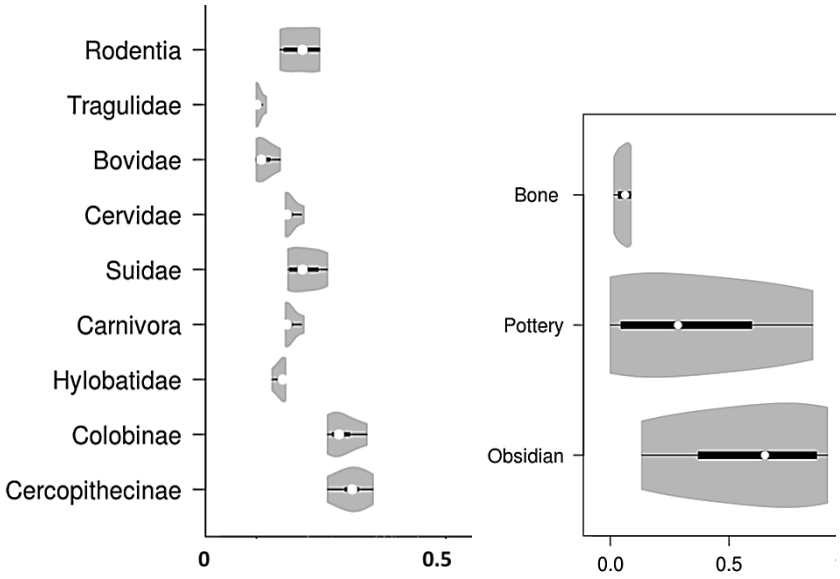

Figure 2. Frequencies of mammal remains (left) and tools (right) at Pawon cave.

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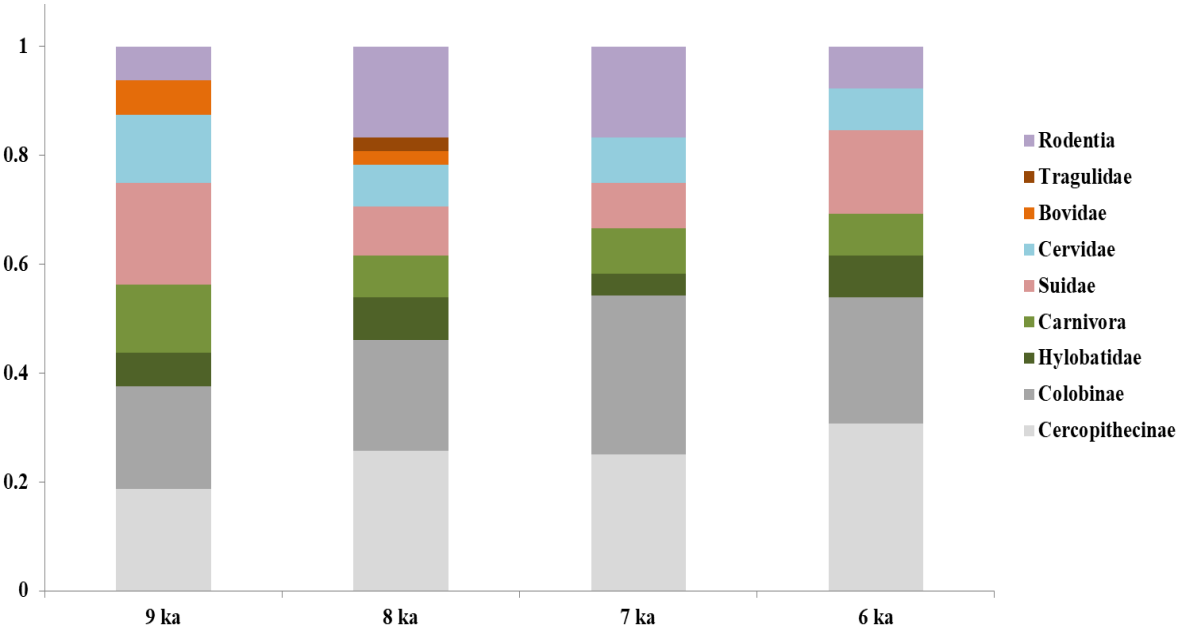

Figure 3. Frequencies of mammal remains in 6-9 ka at Pawon cave.

Figure 3 presents the mammal remain frequencies from 6000 to 9000 years ago (ka). There were temporal variations of mammals for 4000 year period. The small mammal frequencies were observed constant and tend to increase. These trends can be seen in Cercopithecinae, Colobinae, Hylobatidae, Carnivora, Suidae, Cervidae, and Rodentia. While frequencies of medium and large mammals were declining from 8 to 9 ka and absent in period of 6-7 ka. The frequencies of tools can be seen in Figure 4 included the obsidian, bone, and pottery. From 8 to 9 ka, there were frequent uses of obsidian followed by bone tools. While the numbers of obsidians were outnumbered by the presences of pottery.

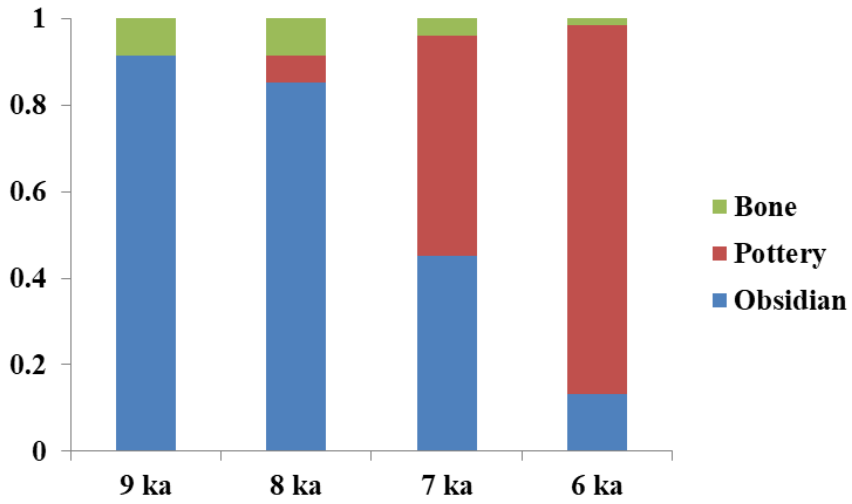

Figure 4. Frequencies of tool remains in 6-9 ka at Pawon cave.

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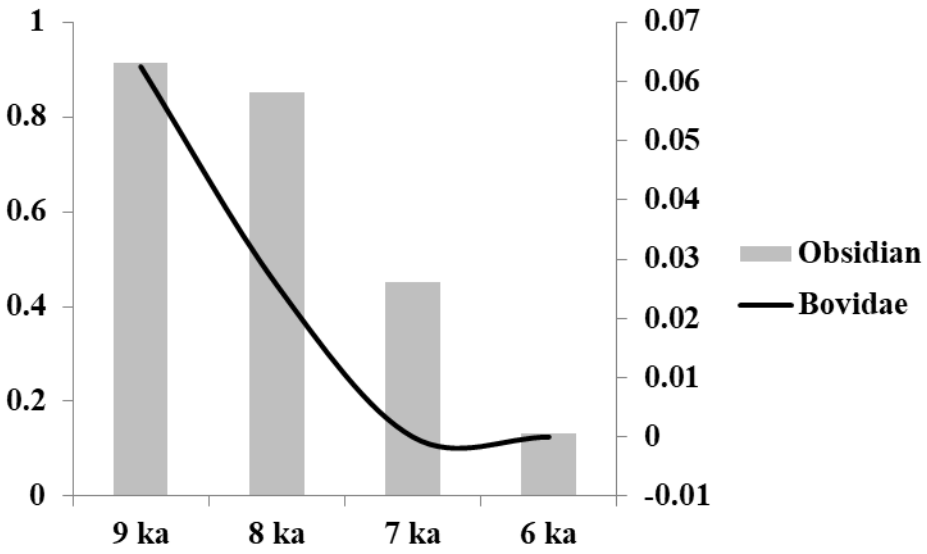

Figure 5. Relationships and trends of obsidian tools and Bovidae abundances at Pawon cave.

Figure 5 shows relationships of Bovidae abundances and obsidian tools. It can be seen that the Bovid was started to decline when the uses of obsidian tools were increasing (Figure 6). This trend occurred in 8-9 ka. While in 6-7 ka, pottery has replaced the obsidian tools and Bovid was absent as well.

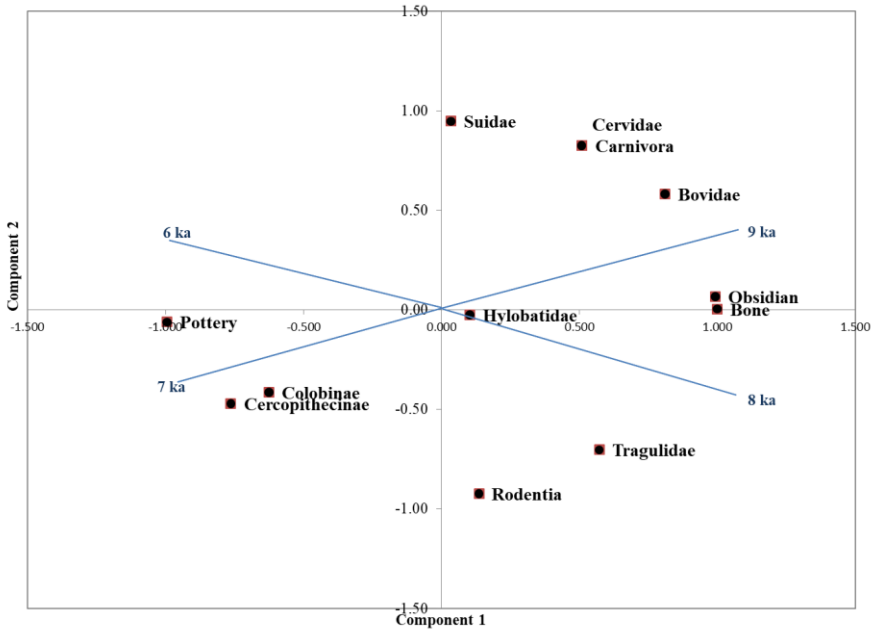

Figure 6. Canonical correspondence analysis of tools and paleo mammal abundances at Pawon cave.

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Discussion

The presence of obsidian tools in Java island is comparable with the findings of obsidian mainly in Asia regions. In Asia, the development of obsidian tools was started at Holocene era or 10 ka ago. During this period, obsidian tools were already used in Papua New Guinea (White et al**.** 2013). The use of tool made of obsidian stones was for processing animal meat (Setzer 2012). Besides obsidian, bones were most frequent tools used by hominin (Choyke & Schibler 2007). Remains of obsidian tools, bones, and even pottery were common inside the cave since cave was the most common hominin settlements (Perlès 2019).

The development of tools that can be used to process the meat has increased the hunting activities and resulted in the reduction of mammals. In this study, the obsidian tools were estimated have been used since 9 ka ago and this period was comparable to the onset of hunting. Grayson (2006) estimated that the tool assisted hunting activities were started at > 10 ka or early Holocene. Mastodon huntings were already started in periods of 11.5-10.9 ka during Clovis era. This era was also characterized with the use of obsidian stone tools (Hamilton et al. 2009). In Mota cave, Africa, early hominin relied on obsidian tools to hunt small to large mammals including Bovid, klipspringer, Suid, monkey, and hare (Arthur et al. 2019).

Reductions of obsidian tools observed in 6-7 ka were related to the cultural transitions. In this study, the presence of obsidian tools which was previously frequent was replaced by abundances of potteries. Previous research suggests that the appearance of pottery was an indication of modern hominin transition to a more sedentary and food production lifestyles in the area surrounding cave. This usually was followed by the proportions of introduced medium mammals include pigs which was noticeably increase. This is supported by an increase in abundance of Suidae remains in 6 ka simultaneously with the increase of pottery and decline of obsidian tools.

Another possible explanation regarding the decline of large paleo mammals is related to the carnivore predatory and paleo climate. Nonetheless, the carnivore predatory was exemption since lack of predator or large carnivore bones surrounded the cave. In this study the temperatures were estimated increasing from 27 ^{0}C in 9 ka to 28 ^{0}C in 6 ka. This condition is comparable to the decline of large sized rodents in Liang Bua cave (Veatch et al. 2019). It was reconstructed that the climate in Liang Bua has shifted from being wet and organically rich (49–39 ka) to dry and organically poor (36–17 ka) with rainfall levels decreasing. The paleo climate can affect the mammals in 2 ways. First, the climate shift alters and even reduces the preference habitats of paleo mammals from closed forest habitat under wet climate to open grass habitat under dry climate. Second, the shifted climate can directly affect the mammals. Some mammals have very specific climatic adaptations and have limited distributions that are dependent on climate. While most mammals will not be able to avoid the effects of climate change. Since mammal life

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span is short and if paleo climate becomes fluctuative, unsuitable, then mammalian responses can be rapid (Ruggiero et al. 2008, Hetem et al. 2014). Likewise, mammal populations were declining in warm and post ice age periods (Mann et al. 2015).

Conclusions

Presence and abundance of large paleo mammals in Pawon cave were related to the uses of obsidian tools. Declines of Bovidae were occurred simultaneously with the increase of obsidian tools. Increase in pottery and abundance of Suidae indicated the transitions of Pawon cave hominin from hunter-gatherer to sedentary and food production prehistoric life.

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