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IDENTIFICATION OF FAUNAL FOSSIL FINDINGS FROM TANJUNGAN VILLAGE, KEMLAGI DISTRICT, MOJOKERTO REGENCY

Identifikasi Temuan Fosil Fauna Dari Desa Tanjungan, Kecamatan Kemlagi, Kabupaten Mojokerto

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Abstrak

Mojokerto adalah salah satu wilayah penting untuk studi paleoantropologi-arkeologi di Indonesia. Di wilayah Mojokerto, tepatnya di Desa Perning, ditemukan fosil Homo erectus, selain juga fosil fauna vertebrata. Di area lain, yaitu di Dusun Sumberdadi, Desa Sumbersari, Kecamatan Dawar Blandong juga ditemukan fosil fauna vertebrata. Selain dua area tersebut, fosil vertebrata juga diketahui ditemukan di Desa Tanjungan, Kecamatan Kemlagi, Kabupaten Mojokerto. Tujuan penelitian ini adalah mengidentifikasi temuan fosil fauna dari Desa Tanjungan, Kecamatan Kemlagi, Mojokerto, dan kemudian mendeskripsikan habitat dari jenis temuan fosil fauna tersebut. Identifikasi temuan didasarkan pada ciri morfologis yang tampak pada fragmen fosilnya. Hasil identifikasi memperoleh lima jenis fauna, yaitu Bovidae, Stegodon sp., Carcharhinidae, Ostreidae, dan Potamididae. Hasil tersebut tersebut memberikan gambaran lingkungan purba Desa Tanjungan berupa lingkungan laut, lingkungan air payau, dan lingkungan darat.

Kata Kunci: *Mojokerto, Paleoekologi, Pleistosen, Moluska, Fosil Vertebrata*

Abstract

Mojokerto is one of the important areas for paleoanthropological-archaeological studies in Indonesia. In the Mojokerto area, specifically in Perning Village, Homo erectus fossils were found, as well as vertebrate fauna fossils. In another area, namely in Sumberdadi Hamlet, Sumbersari Village, Dawar Blandong District, vertebrate fauna fossils were also found. In addition to these two areas, vertebrate fossils are also known to be found in Tanjungan Village, Kemlagi District, Mojokerto Regency. The purpose of this study is to identify the findings of fauna fossils from Tanjungan Village, Kemlagi District, Mojokerto, and then describe the habitat of the types of fauna fossils remains. The identification of the findings is based on the morphological characteristics seen in the fossil fragments. Five fauna species were obtained from the identification results, namely Bovidae, Stegodon sp., Carcharhinidae, Ostreidae, and Potamididae. These results provide an overview of the ancient environment of Tanjungan Village, in the forms of an original marine environment, a brackish-water environment, and ultimately a continental environment.

Keywords : Mojokerto, Paleoecology, Pleistocene, Mollusk, Vertebrate Remains

INTRODUCTION

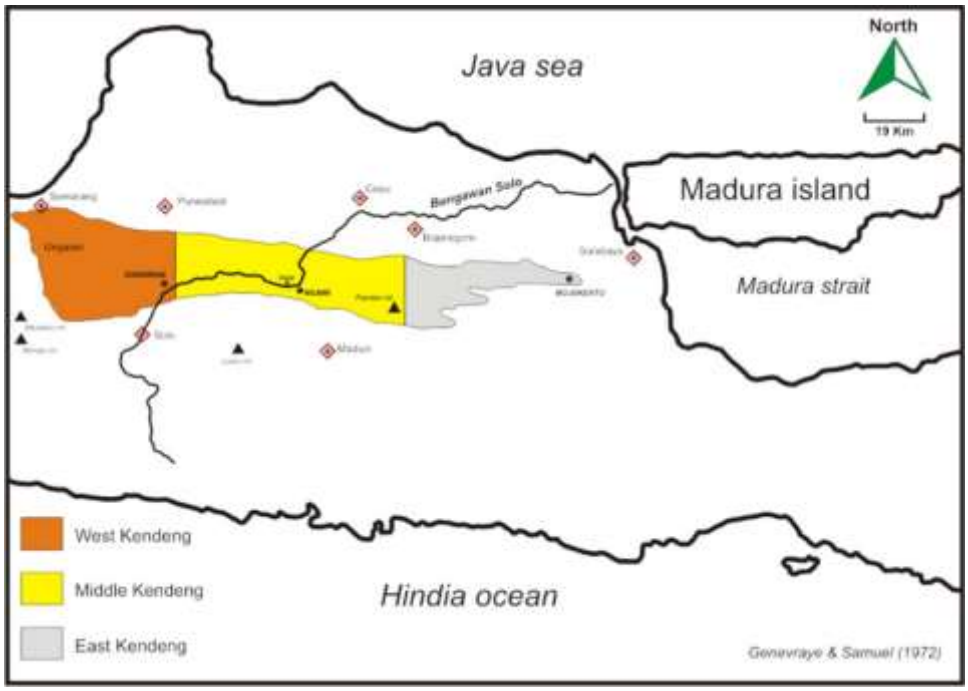

Figure 1. Kendeng Zone and its divisions
(**Source:** Kapid et al., 2016)

Pithecanthropus modjokertensis or currently known as *Homo erectus modjokertensis* (cf. Groves, 2017) is the first ancient human fossil found in the Mojokerto region. The findings were in the form of a child's neurocranium, obtained in 1936 by the Dutch East Indies Geological Survey team in a sandstone outcrop of the Pucangan Formation conglomerate located north of Perning Village, Mojokerto (Huffman et al., 2005). Since the discovery of *Homo erectus modjokertensis*, research on prehistoric life in the Mojokerto area has been continuously carried out. In the 2001-2002 period, the *Homo erectus modjokertensis* site and its surroundings were re-examined leading to research results, especially faunal remains, such as *Panthera tigris*, *Proboscidea*, *Sus sp.*, *Hexaprotodon sivalensis*, *Axis lydekkiri*, *Deer sp.*, *Duboisia santeng*, large-bodied Bovidae, *Crocodylus sp.*, *Gavialis sp.*, *Trionyx sp.*, *Siluridae*, and freshwater molluscs (Huffman et al., 2006). In addition to the *Homo erectus modjokertensis* site, vertebrate fauna fossils were also found in other areas in Mojokerto, namely in Sumberdadi Hamlet, Gunungsari Village, Dawar Blandong District, Mojokerto Regency. The findings from the area consist of several types of vertebrate faunal remains, including *Crocodylus sp.*, *Stegodon trigonocephalus ngandongensis* , Deer *sp.*, *Axis lydekkeri*, and *Bibos* (*Bos*) *palaeosondaicus* (de Vos et al., 2007).

Broadly speaking, the Mojokerto area offers potential for finding fauna fossils. This is due to where the area is located, as the Kendeng Geological Zone traverses through it, wherein in this zone, a large number of hominin and other vertebrate fossils have been continuously found, especially in the Pucangan and Kabuh Formations (Van Bemmelen, 1949). The Kendeng Geological Zone has a length of 250 km and a width of 40 km from the south of Semarang, then narrows 20 km to the east with an altitude of fewer than 500 meters (Van Bemmelen, 1949). The Kendeng Zone is divided into three sub-

zones: the West Kendeng Zone (between Mount Ungaran and Purwodadi), the Central Kendeng Zone (between Purwodadi and Mount Pandan), and the East Kendeng Zone (between Mount Pandan and Mojokerto) (Figure 1) (Kapid et al., 2016).

Geologically, there are three formations in the Mojokerto area, namely the Sonde Formation (another name for the Kalibeng Formation), the Pucangan Formation, and the Kabuh Formation (Kapid et al., 2016). The Pucangan Formation in Mojokerto was deposited during the upper Pliocene, and the Kabuh Formation was deposited in the early-middle Pleistocene. Both formations are older than the formations in Sangiran and Ngawi. The Pucangan Formation in Mojokerto was formed in a marine environment, while the Kabuh Formation varies between marine and continental environments along with fluctuations in sea level. The Mojokerto area during the early-middle Pleistocene was close to the sea (Kapid et al., 2016).

Related to the ancient environment in Mojokerto, research by Huffman & Zaim (2003) explains that the layer where *Homo modjokertensis* was found is a bar of river flow that moved in the delta plain from an ancient delta called the Mojokerto Delta. From the sedimentation sequence in that layer, information was obtained from Mojokerto's ancient environment in the form of shallow seas, marine delta fronts, flood and river waste (delta plain), and interfluve deltas that formed the paleosol, a place where *Homo erectus* may have lived. The findings of pollen, spores, and phyoliths in a layer containing hominin indicate the presence of mangrove forests, swamps, and mountain forest vegetation located some distance away, as well as deltaic plains with extensive grasslands. This environmental condition is reinforced by the findings of various kinds of fossils of aquatic animals such as mollusks, turtles, and crocodiles (*Crocodylus*) as well as fossils of land animals such as Cervidae, *Muntjak*, Bovidae, Suidae, *Hippotamus*, *Rhinoceros*, *Stegodon*, and *Panthera*. Carbon isotope analysis of dental findings of Cervidae, Bovidae, and other vertebrates sheds light on the C-4 photosynthetic trail that characterizes tropical grasses.

Potential faunal remains in Mojokerto was recently discovered in one of its areas, namely Tanjungan Village,

Figure 2. Tanjungan Village location in the geological area of Mojokerto (green arrow) (**Source:** https://geology.esdm.go.id/lexicon/index/1241, 2003, with modification)

Kemlagi District (Figure 2). One of the residents of Tanjungan Village found fragments of vertebrate bones and mollusk shells around the village area. In 2017, a survey conducted by the Geological Agency also reported on the potential for finding fauna fossils in Tanjungan Village (Kementerian Energi, dan Sumber Daya Mineral, 2017), though it did not specifically describe it. In 2019, during the Department of Anthropology's Paleoanthropology course fieldwork in the Tanjungan Village area, fauna fossils remains were found. The findings further strengthened the information on Tanjungan Village's potential for harboring remnants of life from prehistoric times. Thus, the purpose of this study is to identify and describe the faunal remains from Tanjungan Village, Kemlagi District, Mojokerto Regency.

METHOD

The materials used in this study are the faunal remains from the 2019 Paleoanthropology fieldwork, as well as the collection of faunal remains that were found by one of the residents of Tanjungan Village, Mr Sujiyanto. In general, the remains consist of tooth fragments, bone fragments, and mollusc shells. From a total of 13 specimens collected, 9 specimens were selected as research materials, namely teeth, bone epiphyseal fragments, and mollusk shells. The selection of these 9 specimens was based on their relatively intact condition so that identification could be carried out.

The method of identifying the remains to determine the type of fauna is carried out macroscopically, by observing its morphological characteristics. Macroscopic analysis is based on several related works of literature: (a) '*Teeth'* (Hillson, 2005); '*Walking With Indonesian Elephants: Attribution of Isolated Proboscidean Femurs and Tibias to Genus Based on Morphological Differences*' (Wibowo, 2016); *'Identifying and Interpreting Animal Bones'* (Beisaw, 2013); (b) '*The Living Marine Resources of the Western Central Pacific Vol. 2: Cephalophods, crustaceans, holothurians and shark*' (Carpenters & Niem, 1998b); and '*The Living Marine Resources of the Western Central Pacific: 1. Seaweeds, Corals, Bivalves and Gastropods*' (Carpenters & Niem, 1998a). The results of the identification are then described according to the taxonomy of the fauna species.

RESULT AND DISCUSSION

Identification of faunal remains was carried out based on the procedure from Beisaw (2013). Each type of vertebrate and mollusc remains has different morphological characteristics. From these differences, the faunal group was determined for each finding of faunal bones and shells. To complete the description of each type of fauna, original photos of the remains and markings on the characteristics of the bones and shells are included, as well as comparison pictures. As a result, three types of vertebrate fauna and two types of molluscs were identified. Four faunal remains were identified at the family level, and one faunal remain was identified at the genus level (Table 1).

Table 1. List of identified remains

Remains	Taxonomy	Total
Molar teeth fragment	Bovidae	2
Femur epiphyses fragment	*Stegodon sp.*	1
Tooth fragment	Carcharhinidae	2
Left side shell fragment	Ostreidae	3
Shell fragment	Potamididae	1
Total		9

Source: Author, 2021

1. Vertebrate

a. Bovidae

Figure 3 shows two molars from Bovidae, namely the upper and lower molars without root and cusps. In complete condition, Bovidae molars have three root teeth with two roots on the lingual side, and four cusps (Hillson, 2005). In the upper molars, there are three indentations or infolds that divide into five protrusions or ridges on the buccal side (Figure 3). When viewed from the occlusal side, the two molars have two lingual lines forming an occlusal line shaped like the letter 'B' and the presence of a double infundibulum (Figure 4). The lower molars have the same characteristics as the upper molars, but the 'B' shaped protrusion is on the buccal side (Hillson, 2005). When compared to the premolars, the upper and lower premolars of *Bos* do not have a 'B' shape but have a 'D' shape with a single infundibulum that is elongated and forms a crescent when viewed from the occlusal side.

The Bovidae family includes bison, African buffalo, buffalo, antelope, deer, sheep, goats, and some domesticated livestock. The Bovidae family has been undergoing evolution since the early Miocene, about 20 million years ago. There are currently 143 living species of the Bovidae family and 300 extinct species (Siswanto et al., 2016). Fossil findings from the Bovidae family that are commonly found at sites in East Java, such as Trinil, Kedungbrubus, Punung, and Wajak, are *Bibos* (*Bos*) *palaesondaicus*, *Duboisia santeng*, *Epileptobos groeneveldtii*, *Bubalus palaeokerabau*, *Bubalus arnee*,

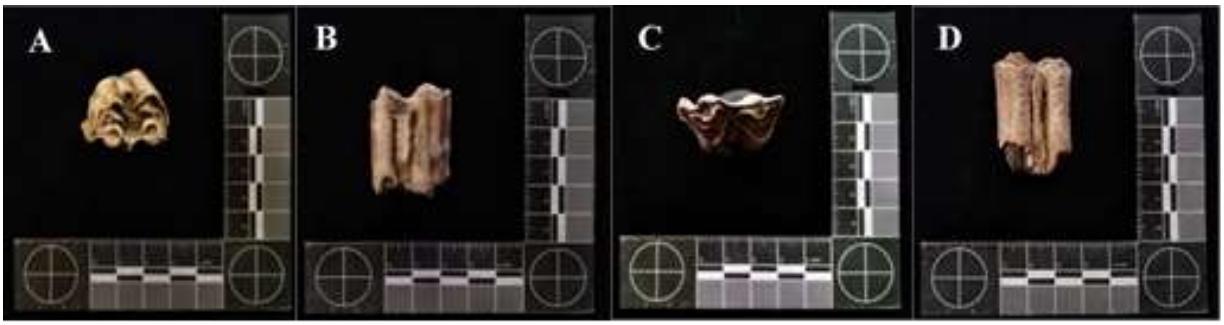

Figure 3. Upper molar fragmen molars (a,b) and lowe (c,d) occlusal and buccal side
(**Source:** Personal documentation, 2020)

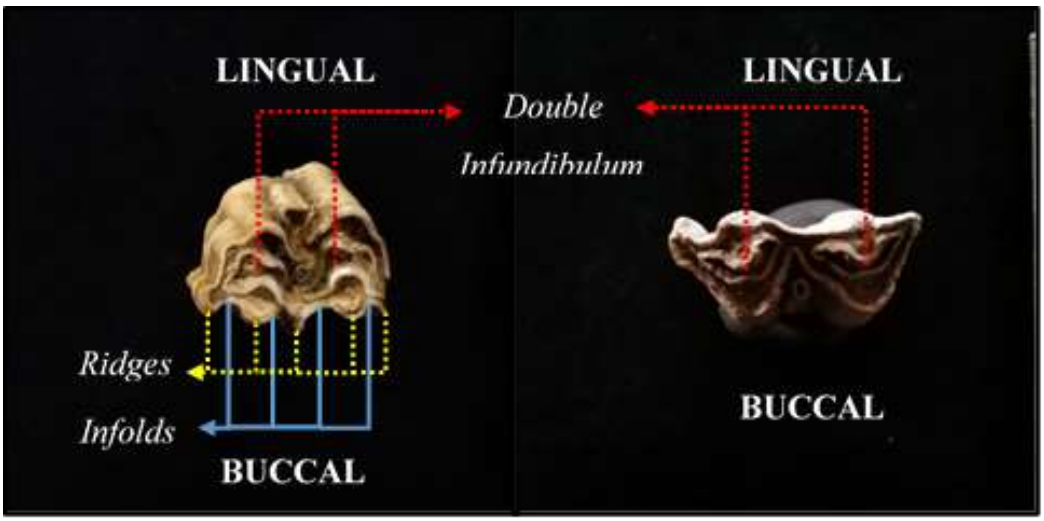

Figure 4. Characteristics of *Bovidae* molar
(**Source:** Personal documentation, 2020)

Bibos sp., and *Bos javanicus* (Van den Bergh et al., 2001).

Kingdom: Animalia; Linnaeus, 1758
Phylum: Chordata; Haeckel, 1874
Class: Mammalia; Linnaeus, 1758
Order: Artiodactyla; Owen, 1848
Suborder: Ruminantia; Scopoli, 1777
Family: Bovidae; Gray, 1821

b. Stegodon sp.

Figure 5 shows a fragment of the right femoral epiphysis identified as a *Stegodon* femur. The indications are based on the slender shape of the epiphysis when viewed on the proximal-craniocaudal side, part of the fovea capitis located close to the epiphyseal plate, the neck of the femur that fuses with the greater trochanter, and the femoral head (Smuts & Bezuidenhout, 1994). The epiphyseal plate is still clearly visible between the epiphyseal and metaphyseal sections, indicating that the bone had not yet matured into adulthood.

In the identification of the Proboscidea femur in Indonesia, there are six distinguishing characteristics according to Wibowo (2016): (1) The distance between the medial and lateral condyles, (2) the depression between the condyles, (3) the lateral border of the diaphysis, (4) the medial crest, (5) the third trochanter, and (6) the most lateral end of the greater trochanter. Of the six characteristics, two are found in this femoral epiphyseal fragment, namely the medial crest which is prominent and sharp, and the most lateral end of the greater trochanter which is proximal with a robust look (Figure 6). In addition, the surface of the neck of the femur on the dorsal side tends to be flat (Unggul Prasetyo Wibowo personal communication).

Currently, *Stegodon* is included in the Stegodontidae family, although Hooijer (1955) previously included it in the Elephantidae family with the subfamily Stegodontinae. During the Plio-Pleistocene, *Stegodon* was the dominant and abundant fauna genus in Southeast Asia, and many of its remains are found in Indonesia (Van den Bergh et al., 2014). *Stegodon* reached the island of Java about 1.5 million years ago, and *Stegodon trigonocephalus* is a type of *Stegodo*n that survived through every change of faunal stage on the island of Java until the late Pleistocene. During the Pleistocene, they lived in groups and inhabited tropical forests, grasslands or savannas, and swamps (Siswanto et al., 2016).

Kingdom: Animalia; Linnaeus, 1758
Phylum: Chordata; Haeckel, 1874

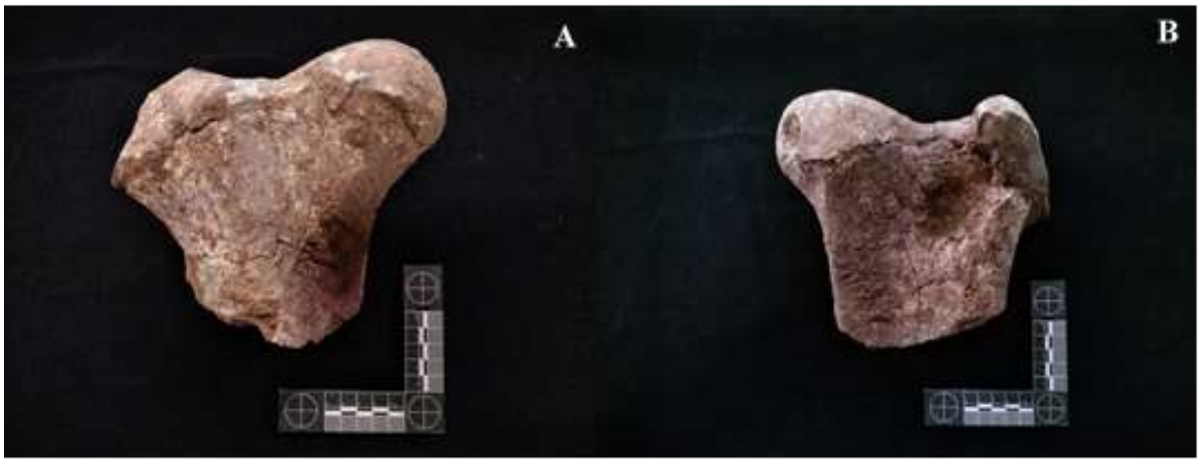

Figure 5. Fragment of the right femoral epiphysis *Stegodon sp.*: (a) cranial side; and (b) caudal side (**Source:** Personal documentation, 2020)

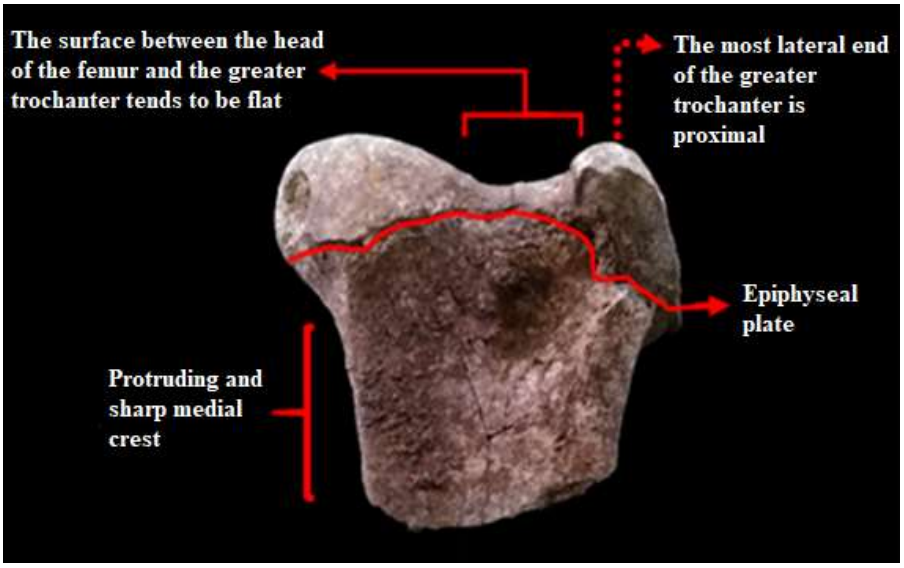

Figure 6. Femur characteristic of *Stegodon sp.* (caudal side) (**Source:** Personal documentation, 2020)

Class: Mammalia; Linnaeus, 1758
Order : Proboscidea; Illiger, 1811
Family : Stegodontidae; Osborn, 1918
Genus : *Stegodon*; Falconer, 1847
Species : *Stegodon sp.*

c. Carcharhinidae

Figure 7 shows two identified shark teeth, with one of the teeth damaged at the root of the tooth. Macroscopically, these teeth are shark teeth from the *Carcharhinidae* family, with the characteristics: resemblance to a sword, the presence of serrations on the mesial and distal sides, and a single cusp (Figure 8) (Carpenters and Niem, 1998b). When viewed directly, the jagged side of the upper teeth is clearly visible, not so much with the lower teeth, requiring palpation. In their complete state, Carcharhinidae have rows of 18 to 60 teeth, or 8 to 56 teeth (Compagno, 1984). The Carcharhinidae family or also known as the Requiem Shark is the largest group of sharks with many species that are widely distributed throughout warm and temperate oceans (Compagno, 1984). In addition, this group of sharks is also dominant in tropical waters, such as in coastal, offshore and oceanic waters. Most of the Requiem Sharks are marine sharks, from near the

Figure 7. (a) Upper tooth, and (b) lower tooth fragment of Carcharhinidae (**Source:** Personal documentation, 2020)

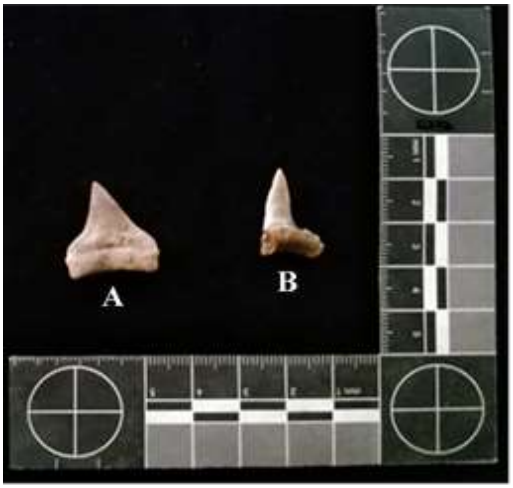

Figure 8. Shark teeth characteristic: serrations (red line) and single *cusp* (green arrow) (**Source:** Personal documentation, 2020)

coast to the outer edge near the bottom of the shelf area and the epipelagic zone.

Carcharhinid sharks in Java are known to have lived during the Plio-Pleistocene (2.8 – 1.8 million years ago) and their fossils were found in Cirebon and the Sangiran area (Yudha et al., 2018). Sharks from this family include the genera *Carcharhinus*, *Negaprion*, *Galeocerd*o, and *Scoliodon*. In addition, Joordens et al. (2009) also found shark remains from the Carcharhinidae family, namely sharks of the genus *Glyphis* from the Trinil site assigned to the species *Glyphis gangeticus*. These sharks lived in muddy rivers, lakes and estuaries. *Glyphis* sharks are river sharks that can adapt to water with low salinity and even freshwater (Chowdhury et al., 2017). *Glyphis gangeticus* is currently distributed within the Indo-Pacific and is known to be found in the Hugli River, Ganges River, West Bengal, and India (Compagno, 1984).

Kingdom: Animalia; Linnaeus, 1758
Phylum: Chordata; Haeckel, 1874
Class: Chondrichthyes; Huxley, 1880
Subclass: Elasmobranchii; Bonaparte, 1838
Order: Carcharhiniformes; Compagno, 1977
Family: Carcharhinidae; Jordan and Evermann, 1896

2. Mollusk
a. Bivalvia
Ostreidae

Figure 9 shows the left shell of an Ostreid mollusk in an incomplete condition. Morphological variations between individuals in the family Ostreidae make identification of these shellfish very difficult (Carpenters & Niem, 1998a). The Ostreid molluscs from Tanjungan Village (Figure 10) are characterised by a thick shell and an irregular shape, as well as a deep inferior part of the shell. On the inferior side, there are a former adductor muscle in the posterior and middle of the shell close to the ventral border of the shell, a hinge without teeth, a ligament area with a shallow depression in the middle and thickening on both sides laterally, and no chomata. The exterior of the shell has a radial rib pattern so that it affects the shape of the edge of the shell. In an incomplete condition, Ostreidae have an inequivalve shell shape where the two shells have different shapes or sizes, with the right shell being thin and flat (Carpenters & Niem, 1998a).

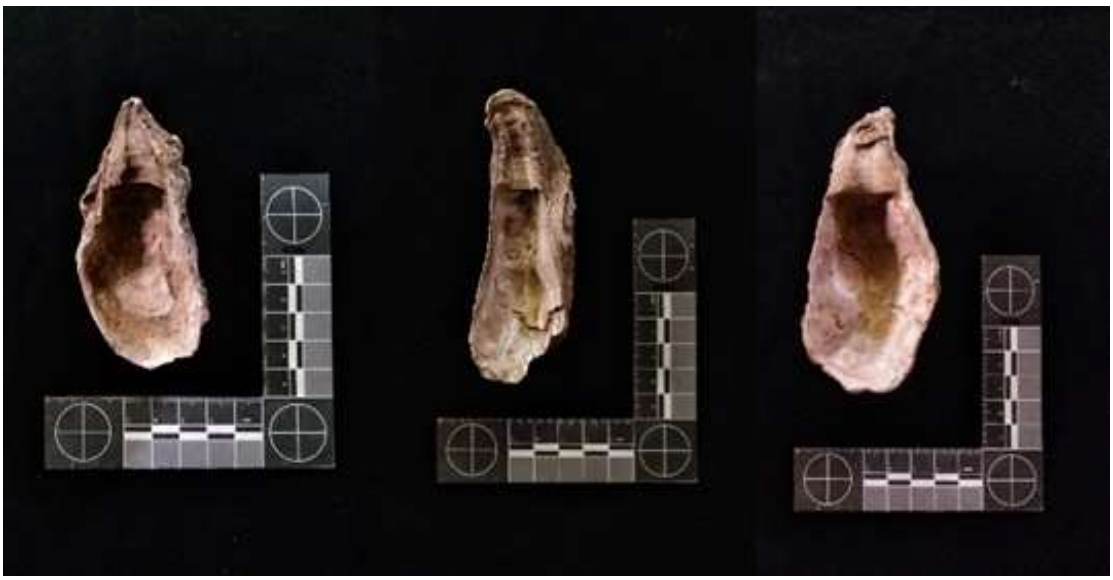

Figure 9. Left side shell of Ostreidae (inferior view)
(**Source:** Personal documentation, 2020)

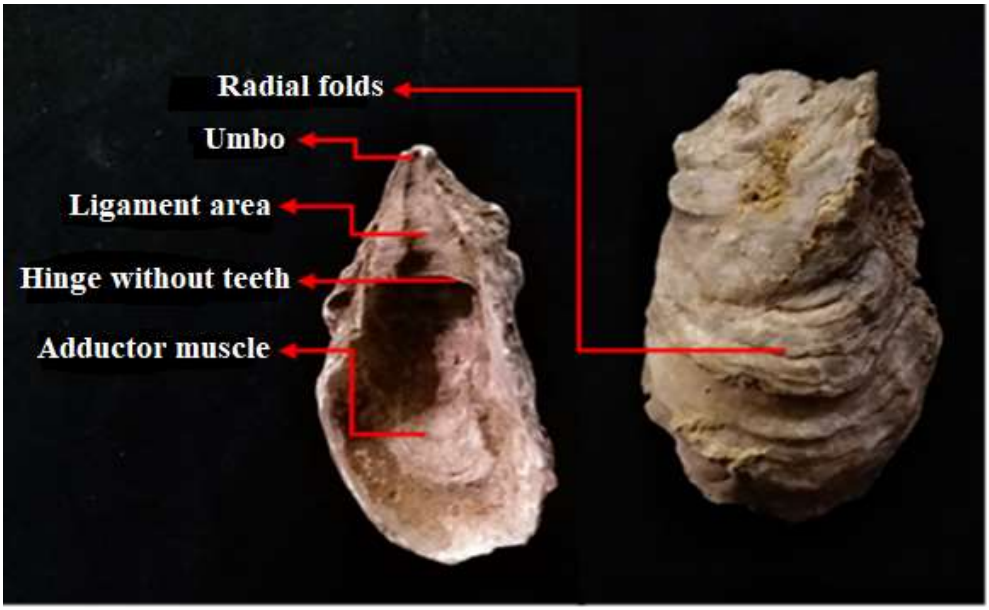

Figure 10. Ostreidae shell morphology
(**Source:** Personal documentation, 2020)

The family Ostreidae consists of a large number of edible and non-edible oysters. They are distributed along the coast between latitudes 64˚N and 44˚S (Galtsoff, 1964). Several species of Ostreidae are the most important shellfish family and are cultivated in various tropical and subtropical regions, such as the *Ostrea*, *Crassostrea*, and *Saccrostrea* clams (Angell, 1986). Ostreids are filter-feeding animals that live by attaching their left shell to the substrate, especially in littoral and shallow subtidal areas. Several species of Ostreidae are associated with mangrove environments in Southeast Asia, such as *Ostrea*, *Crassostrea*, *Dendostrea*, *Magallana*, *Planostrea*, and *Saccrostrea* (Yahya et al., 2020), but not all Ostreidae species live in mangrove environments such as *Crassostrea glomerata* attached to rocks on the beach (Arfiati & Kharismayanti, 2018).

Ostreidae remains around the Kendeng Zone area are known to be found in Kabuh, Jombang, with the genus *Ostrea* (Pandita & Zaim, 2009), and in Perning, Mojokerto, with the genus *Crassostrea* (Huffman & Zaim, 2003). Both findings are known to have lived in a brackish-marine environment and were found in the Plio-Pleistocene Pucangan Formation.

Kingdom : Animalia; Linnaeus, 1758
Phylum: Mollusca; Linnaeus, 1758
Class: Bivalvia; Linnaeus, 1758
Order : Ostreida; Fërussac, 1822
Superfamily : Ostreoidea; Rafinesque, 1815
Family : Ostreidae; Rafinesque, 1815

b. Gastropoda
Potamididae

Figure 11 shows the shell of a Potamididae mollusc. The findings were not found in intact condition, with damage to the apex, eroded outer lip and damage to the body whorl on the aperture. Under normal conditions, the outer lip of the Potamididae shell is generally thick and slightly widened. As shown in Figure 12, there are characteristics of a thick and dense shell, a small aperture size, and an elongated conical shape with many circular patterns on the spire, carvings on the rough shell, with spiral straps and axial ribs forming a net-like shape, strengthening the indications that the findings are Potamididae mollusk shells.

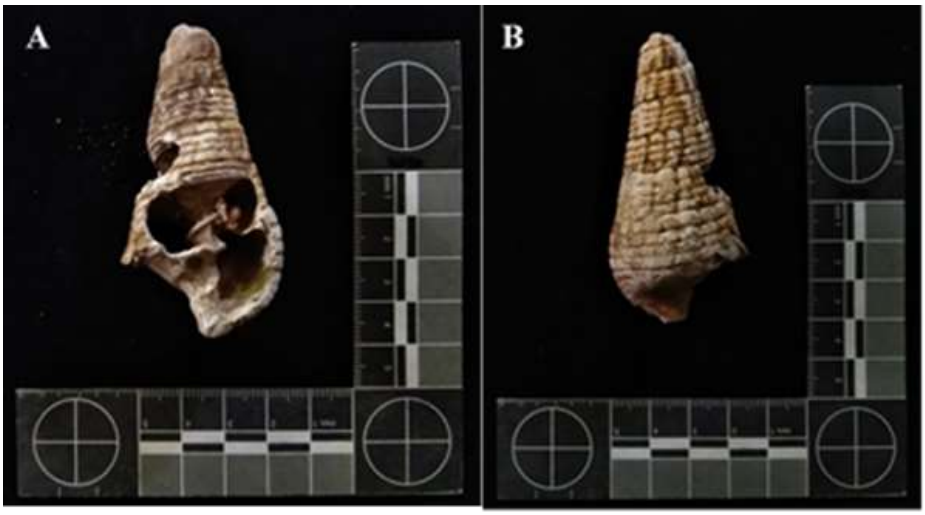

Figure 11. *Potamididae shell* (a) sisi apertural dan (b) sisi abapertural
(**Source:** Dokumentasi penulis, 2020)

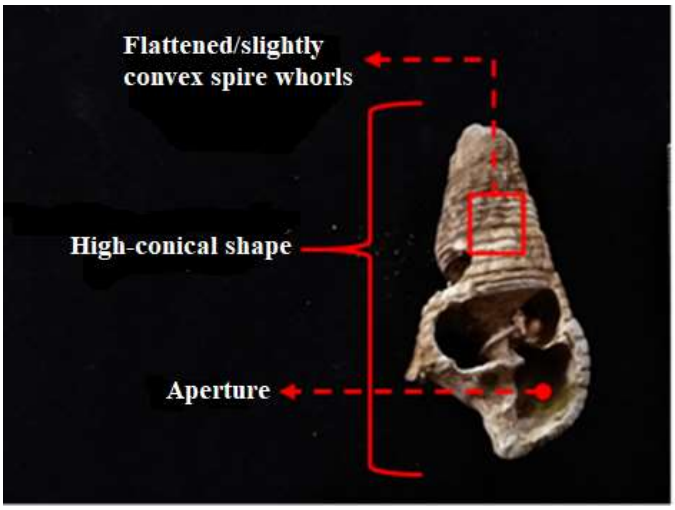

Figure 11. Characteristics of Potamididae shell
(**Source:** Personal documentation, 2020)

Potamididae inhabit brackish water environments, estuary mudflats, and mangrove swamps close to the tide line (Carpenters & Niem, 1998a). All species of Potamididae are associated with the mangrove, and each species have different behaviours towards its environment, such as using mangrove trees as substrate, as food, and as a place to protect themselves from predators (Reid et al., 2008). Algae and detritus are food sources for Potamididae, though adults of the species *Terebralia palustris* feed on fallen leaves from Rhizophora mangrove trees (Fratini et al., 2001). The oldest known Potamididae species are from the genera *Terebralia* and *Cerithideopsis* which appeared in the Tethys Sea during the middle Eocene and began to live in the Indian Ocean area during the Plio-Pleistocene (Reid et al., 2008).

Kingdom : Animalia; Linnaeus, 1758
Phylum: Mollusca; Linnaeus, 1758
Class: Gastropoda; Cuvier, 1795
Subclass : Caenogastropoda; Cox, 1960
Superfamily : Cerithioidea; J. Fleming, 1822
Family : Potamididae; H. Adams & A. Adams, 1854

3. Tanjungan Village's Past Environment

All the faunal remains from Tanjungan Village are surface findings. As the publication of fossil data in Tanjungan Village is limited, the reconstruction process of the area's past environment is based on the correlation of geological formation data with the habitat of the identified fauna. From the faunal remains which habitats are identified in Table 2, there are three past environmental conditions in Tanjungan Village: the marine environment, transitional environment (delta and estuary), and land environment. From the three environmental conditions, it is conceivable that these faunas lived in one area under different environmental conditions within the same period, although alternatively there occurred a gradual change in the environment of a past Tanjungan Village , with an initial marine environment gradually turning into a land environment over a long period. Here is an overview of the Tanjungan Village area's past environment:

a. The Tanjungan Village area likely originated from the marine environment during the Pliocene period, with the area then immersed in water and devoid of land; this is evidenced by the shark fauna (Carcharhinidae) fossil findings that would have had inhabited the seas.

b. The Tanjungan Village area during the Early Pleistocene was a transitional environment characterized by the presence of fauna living in brackish waters such as Ostreidae and Potamididae. Carcharhinidae also likely lived in an estuarine environment.

c. The Tanjungan Village area during the Middle Pleistocene turned into land, with a residual shallow marine environment. Stegodon and Bovidae likely coexisted with coastal environmental fauna such as Ostreidae and Potamididae. If the found Carcharhinidae remains inhabited a freshwater ecosystem, then there might have existed a river system that streamed through the Tanjungan Village area.

Table 2. Vertebrate fauna and mollusk remains from Tanjungan Village and its habitat

Taxon	Habitat
Bovidae	Open forest (Van den Bergh *et al.*, 2001)
Stegodon sp.	Open forest (Van den Bergh *et al.*, 2001)
Carcharhinidae	– near the coast to the epipelagic zone (Carpenters & Niem, 1998b) – Rivers, lakes and river mouths (Joordens et al., 2009)
Ostreidae	– Shallow littoral and subtidal zones (Carpenters & Niem, 1998a) – Brackish water (Huffman & Zaim, 2003) – Mangrove environment (Arfiati & Kharismayanti, 2018; Yahya *et al.*, 2020)
Potamididae	Mud plains at river mouths and in mangrove swamps near the tide line (Carpenters & Niem, 1998a)

Source: Author, 2021

Environmental changes over a long period in the East Kendeng Zone are the result of geological phenomena such as sedimentation in the marine environment since the Upper Pliocene. This can be seen in the Sonde Formation and the Pucangan Formation, where each of these formations was deposited in a marine environment between 50-200 meters and 5-100 meters deep. According to Novian et al., (2014), the black clay facies in the Pucangan Formation developed from marine facies, brackish water, and freshwater. As it goes higher, the freshwater depositional conditions are characterized by the presence of freshwater mollusc fossils. In the

Tanjungan Village area, no freshwater mollusks have been found, only fauna with marine and brackish water habitats.

Fauna that supported the marine and brackish water environment in Tanjungan Village are Carcharhinidae sharks with species that can live in the sea and brackish water, as well as Ostreidae and Potamididae mollusk. If the Carcharhinidae found is a type of marine shark, then the shark has a habitat at a depth of 0-200 meters (epipelagic zone). However, if the shark lived in a brackish water environment, then there is an indication of a river estuary in a past Tanjungan Village. This indication is supported by the findings of Ostreid mollusk that live in shallow littoral (tidal areas) and subtidal areas, by attaching their shells to hard substrates such as wood or rock. The behaviour of attaching shells to wood substrates is found in mangrove environments, as mangroves are found in coastal/littoral/in tertidal environments (Arfiati & Kharismayanti, 2018; Yahya et al., 2020). The findings of Potamididae molluscs—which generally live in tidal areas, muddy substrate, near the estuary, with some living like amphibians (Arbi, 2019),—strengthen the indications of a brackish water environment or river estuary in Tanjungan Village.

The process of environmental change continued until the middle Pleistocene period with the indication from the Kabuh formation showing variations in the terrestrial and shallow marine environment (0-20 meters depth). The existence of a sandstone arrangement with an ambiguous cross structure as reported by the Geological Agency when surveying Tanjungan Village indicates the characteristics of the Kabuh Formation which is part of a fluvial deposit (Novian et al., 2014). The rocks and criss-cross structures also indicate the existence of a river that streamed through the Tanjungan Village area in the past. If there existed a river flow in a past Tanjungan Village area, then Carcharhinidae sharks would have inhabited this supposed river. This hypothesis is based on the fossil evidence of a shark species belonging to the Carcharhinidae family that inhabits freshwater environments, namely the genera *Glyphis* and *Carcharhinus* (Joordens et al., 2009).

The Kabuh Formation is also known as a formation with many terrestrial vertebrate fossil findings. The existence of a terrestrial environment is supported by the *Stegodon sp.* and Bovidae faunal fossil findings. Based on a new biostratigraphy by de Vos and Sondaar (Van den Bergh et al., 2001), the *Stegodon* fauna is known to have started to live on Java 1.2 million years ago, surviving up to the late Pleistocene, while the Bovidae family survived to the present day. At the time of the Pleistocene, *Stegodon* and Bovidae habitats were open forest environments. If the *Stegodon* and Bovidae remains are found in the Kabuh formation based on the same sedimentological structure in Mojoroto (Kapid et al., 2016), it is possible that the two faunas lived in an environment close to shallow marine waters.

CONCLUSION

The faunal remains of *Stegodon sp.*, Bovidae, sharks and mollusks from Tanjungan Village provide additional new information about prehistoric life in the Mojokerto region and the Kendeng Zone area. These findings indicate that the Tanjungan Village area in prehistoric times was a marine environment with evidence of Carcharhinidae teeth remains, a brackish water environment with evidence of Ostreidae and Potamididae shell remains, and a terrestrial environment with evidence of *Stegodo*n and Bovidae bone remains. These faunas likely lived in the same area and over a related period, namely the brackish water environment during the Plio-Pleistocene, and the shallow terrestrial and

marine environment during the Middle Pleistocene. Correlation between the variations of faunal findings with the geological formation structures indicates that these faunas either lived in one place with different habitats at different periods or in one place with more than one different habitat at the same period.

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