# PALEONTOLOGICAL ASSESSMENT OF MALAWA FORMATION, PADANGLAMPE, BARRU REGENCY, SOUTH SULAWESI

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# PALEONTOLOGICAL ASSESSMENT OF MALAWA FORMATION, PADANGLAMPE, BARRU REGENCY, SOUTH SULAWESI

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**Abstract**. The study area is located at Padanglampe, Barru Regency, South Sulawesi, Indonesia. The objectives of this study are to identify the fossils occurrence and interpret the depositional environment together with age identification based on the fossils occurrence. There are four lithology units found in this study area; volcanic breccias, limestone, sandstone, and intrusion of andesite and trachyte unit. Most of the fossils are found in sandstones unit within the interbedded of limestone, coal, and claystone. The fossils had been soaked with hydrogen peroxide ($H_2O_2$) for a night to disaggregate fossils from rocks. Seven species found from the phylum mollusks, which are *Cerithium salebrosum Sowerby, Cerithium tuberculatum, Cerithium zonatum, Oliva junghuhni, Vicarya* sp*., Septifer* sp. and *Ostrea* sp., while two species from Cnidaria phylum; *Cycloseris* sp. and *Discocyathus* sp. Based on these fossils identification, the age of the study area was ranged from early Triassic to Middle Neogene, and the depositional environment of the study area was interpreted as a shallow subtidal environment with a restricted area of lacustrine or lagoon.

## 1. Introduction

Padanglampe is located at Barru Regency, South Sulawesi. In general, Sulawesi Island is situated in the middle of Indonesia island with the look like alphabet "K" which come from the meetings of the three main plates in the world which are, Hindi-Australia plate that moved to the northeast, Pacific plate that moved to the northwest and Eurasian plate which almost static or slowly shifted to the southeast [1][2]. This palaeontological study has been conducted in a limited area, about 150 $m^2$ of Padanglampe, Barru Regency. Most of the fossil collections (20 samples), were collected in the sandstone unit, which is a part of Malawa Formation with coordinates of S 04º 30' 36.07", E 119º 41' 45.50".

### *1.1 Geology of the study area*

The rock units in Padanglampe can be divided into four formations which are, Malawa Formation, Tonasa Formation, Camba Formation and Volcanic of Camba Formation [3]. The Malawa Formation is the oldest one, followed by Tonasa Formation, Camba Formation and Volcanic of Camba Formation (Figure 1). In this study, the fossils were collected from Malawa Formation which dominantly consisted of quartz sandstones and quartz conglomerate [4]. This formation was interfingered with volcanic of Langi Formation and rest conformably beneath the Tonasa Formation (Figure 1). Based on field observation, this sandstone outcrop from Malawa Formation is interbedded with limestone, coal and claystone, and it is also contains abundant of fossil such as gastropods, bivalve, corals and foraminifera. From the litholog that had been performed during the fieldwork, the lower part of the outcrop is composed from claystone rock with the grain size from clay to silt-sized. Next lithology in sandstone unit is 4.6 m of coursed to medium grain sized coal. After the coal bed, the intebedded between sandstone and limestone is intercalated each other. For sandstone rock, the grains sized become finer upwards and the fossil localities such as spiral coral decreases but the localities of gastropods and bivalve are increase. The presence of limestone in this bedding is in nodule formed where composed of foraminifers' fossils with thickness less than 1.0 metre (Figure 2).

In general, the Padanglampe is dominant with Tonasa Formation or also known as Tonasa Carbonate Platform or Tonasa Limestone [5] is one the formation that deposited at the western part of South Sulawesi near the Makassar Strait in the early or middle Eocene to middle Miocene [6] as part of the transgressive sequence in backarc setting amid in complex tectonic area [5]. The tectonic of Tonasa Formation started by late Eocene's,-shallow-water carbonate deposition in the main platform area located at the Pangkajene area [7] in the north and south part of this platform.

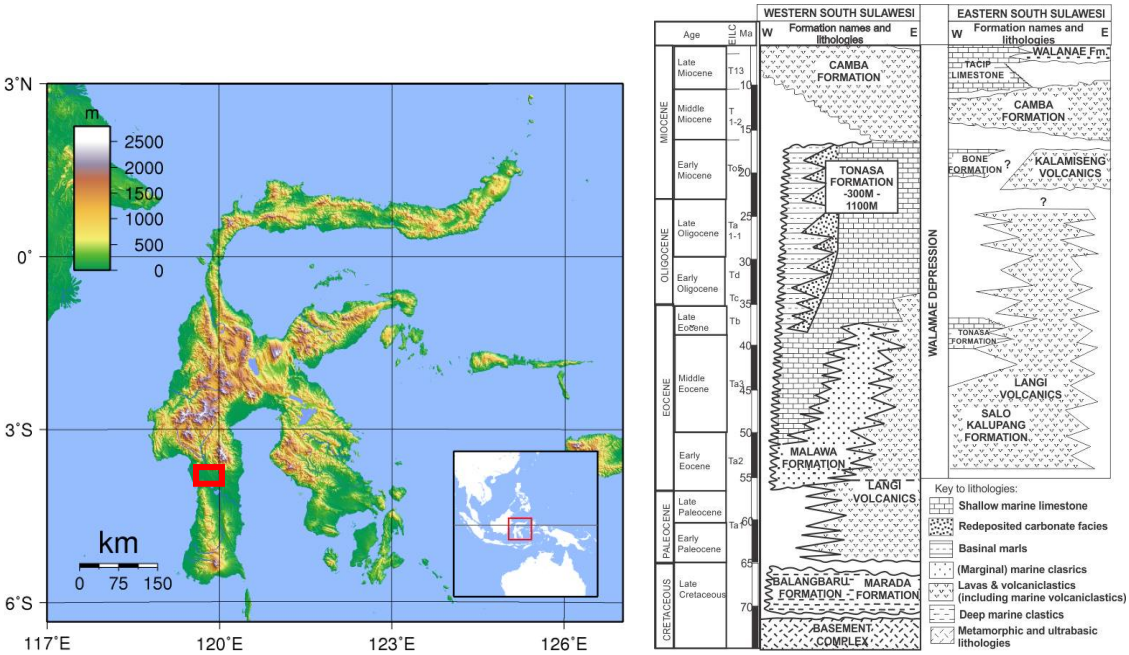


**Figure 1.** The location of the study area in Sulawesi (left-red circle) and stratigraphy of South Sulawesi (right) [3].

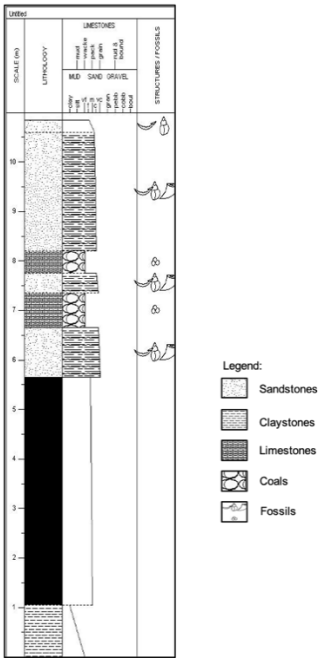


**Figure 2.** The lithology of Malawa Formation in study area, which consisted of sandstones limestone, coal and claystone, with abundant of fossils.

## 2. Methodology

Two methods were applied in order to extract the fossils from rock. The solvent method was used to disaggregate fossils from rocks. This method will be able to reduce the size of the sample to a more manageable fragment as compared to the conventional mortar and pestle methods, where it can resort to the larger foraminifera. Then, the Calgonite method was used for softer rocks. This method was done by soaking the sample with Calgon and distilled water before the sample been washed through the water in order to remove dredged material by using nested sieves with size between of 63-125 µm, 125-250 µm, 250-500 µm and greater than 500 µm. It is advisable to wash material through the coarse sieves first with a sufficient amount of water. After being washed, materials were dried in the open air, and sorting was made.

On the other hand, when the specimen is too dirty, the acid treatment method was done to clean rock specimens for better identification. The hydrogen peroxide ($H_2O_2$) was used to disaggregate hard sediments or rock from the specimens. The sample was soaked in $H_2O_2$ for a night, with 70% concentration per 1L volume. The taxonomic range identification of fossils in this study area is determined until the genus for the least if the species of fossils could not be identified. Hence, it will contribute to the idea of the depositional environment and the age of the study area.

## 3. Results and discussion

Generally, there are two classes of fossil's phyla found in this study, which are Mollusks and Cnidaria.

### *3.1 Phylum Mollusks (Gastropod)*

The first phylum that will be discussed is phylum mollusk. Mollusk is one of the largest animal kingdoms where the range of mollusks is divided into few types such as gastropods, bivalves, cephalopods, and ammonites. There are two classes of phylum mollusks that present in the study area, which are, gastropods and bivalves.

The first class that will be discussed is gastropod with three distinctive families and one unknown family. These distinctive families are Cerithiidae, Olividae, and Potamididae. In the Cerithiidae family, there is one genus with three different species had been identified. On the other hand, the Olividae and Potamididae family has one genus with one species.

#### *3.1.1 Family: Cerithiidae*

*Species 1: Cerithium salebrosum Sowerby* (Figure 3)

Description: these gastropod shells are about 4.6 cm length with 1.8 cm of width, thick, heavy, with sculpture usually turriform, the spire is medium. Anterior canal curved could not be identified as it already broken; a parietal shield could not be seen, with no present of callus. The spire of fossil is consists of approximately about nine whorl exclude the body whorl and apex where these two parts already are broken with spiral incised lines or striae interspaced.

*Species 2: Cerithium tuberculatum* (Figure 3)

Description: these gastropods are about in range 4.0 - 5.2 cm length with 2.0 – 2.5 cm of width, thick, heavy, with sculpture usually turriform, the spire is medium. Anterior canal curved could not be identified as it has broken, parietal shield well developed, with no present of callus. Varices not present. The spire of fossil is consists of approximately about 6 to 9 whorl exclude the body whorl and apex with interspaces structure nodules. The apex and aperture clearly can be seen.

*Species 3: Cerithium zonatum* (Figure 3)

Description: the size of this fossil is about 3.0 - 4.2 cm in length and 1.5 – 3.0 cm width. This thick, and heavy gastropod, has a turriform sculpture with medium spire. Anterior canal curved could be seen, parietal shield well developed, with no present of callus. Varices not present. The spire of fossil is hard to be determined, but the structure of interspaces between it can be seen nodules that interbedded with spiral incised lines or striae. The apex was broken, and the aperture clearly can be seen.

*3.1.2 Family: Olividae*
*Species: Oliva junghuhni* (Figure 3)
Description: this gastropod is in a range of about 3.0 - 3.5 cm in length with 1.6 -1.8 cm of width, thick, heavy, with sculpture usually elongate-ovate, the spire is small. Siphonal canal curved dorsally; the parietal shield could well develop. The surface of the body whorl is smooth.

*3.1.3 Family: Potamididae*
*Species: Vicarya* sp. (Figure 3)
Description: the characteristics of the shell gastropod are about 3.95 cm length with 2.1 cm of width, thick, heavy, with sculpture usually turriform, the spire is medium. Anterior canal curved and parietal shield could not be seen clearly, with no present of callus. Varices not present. The spire of fossil is has a structure carina interspaced. The apex and aperture were broken.

*3.2 Phylum mollusks (Bivalves)*
Two types of families that were identified are Mytilidae and Ostreidae. The first family that will be discussed was Mytilidae, followed by Ostreidae.

*3.2.1 Family: Mytilidae*
*Species: Septifer* sp. (Figure 3)
Description: the bivalves are in a range of about 2.9 – 7.2 cm length with 2.8 – 3.6 cm of width. For the anterior part of bivalves such as a cardinal shelf, cardinal tooth, lateral tooth, and ligament were difficult to been identified where most of the interior has been filled or removed by sand, but all of the features can roughly be determined based on the position of the morphology as it still can be seen even though the feature could not be seen clearly. Somehow, the ligament part of bivalves clearly can be seen between these ten fossils of *Septifer* sp.

Some of the posterior parts, such as growth line, radial ribs, umbo, lunute, and ligament, can be seen clearly. For *Septifer* sp. its show that it has possessed both medium growth line and thick, strong radial ribs, this feature can be seen at the surface of the body of the valve. Next, even though this fossil is taken from one side only, the ligament, umbo, and lunute can also be seen. Unfortunately, the thickness of this species could not be taken as only has one side of the valve.

*3.2.2 Family: Ostridae*
*Species: Ostrea* sp. (Figure 3)
Description: the bivalves are in the range of about 2.6 – 11.2 cm length with 1.35 – 9.1 cm of width. For the anterior part of bivalves such as a cardinal shelf, cardinal tooth, lateral tooth, and ligament were difficult to been identified where most of the interior has been filled with sand or soil. Somehow, the ligament part of bivalves clearly can be seen between these six fossils of *Ostrea* sp.

Some of the posterior parts, such as growth line, radial ribs, umbo, lunute, and ligament can be seen clearly. For Ostrea sp. its shows that it has possessed only radial ribs; this feature can be seen at the surface of the body of the valve. Next, even though this fossil is taken from one side only, the ligament, umbo, and lunute can also be seen. Unfortunately, the thickness of this species could not be taken as only has one side of the valve.

*3.3 Phylum Cnidaria*
*3.3.1 Family: Fungiidae*
*Species: Cycloseris* sp. (Figure 3)
This Cnidaria fossil has a rounded solitary coral with concentric rings on base. All complete septal cycles can be seen clearly. Costosepta is compact with more or less regularly dentate and granulate on its sides. Columella, with rod-like shape, is visible. Alternating major and minor septa and also dissepiments facing inwards towards columella. The size of the fossil is in a range of about 2.15 – 4.0 cm in diameter.

*3.3.2 Family: Caryophyllidae*
*Species: Discocyathus sp*. (Figure 3)
This Cnidaria fossil has a calceoloid typed of the solitary corolla. These fossils possessed no dissepiments or minor septa. The calicular boss is in a rod-like shape that is visible, where septa were facing it inwards. The growth line on the fossil's corallum (whole skeleton) is visible, with no presence of traces of previous tabulae. The apical end of this fossil is broke. The size of the fossil is in a range of about approximately 4.0 - 4.8 cm in length, as the apical end is broken with 1.4 – 1.6 cm in diameter.

*3.4 Age Determination*
As the collection of macrofossils was conducted at Padanglampe, the formation that involved is Malawa Formation. Based on the microfossils assemblages, the age of Malawa Formation is at least from the Early Eocene [4][8].

Based on the biostratigraphy column of the study area (Figure 4), it shows that the early existence of gastropods is started from Late Triassic, where *Cerithium* sp. started to evolve until this present time. At the late Neogene period, the diversity of gastropods increased were some other species such as *Olividae* sp. was present. In general, *Cerithium* sp. started to exist about 221.5 million years ago, and until now, that species still evolved. For species *Cerithium salebrosum Sowerby* and *Cerithium tuberculatum*, these fossils were found about 2.85 million years until the past 0.012 years ago, while for *Cerithium zonatum*, there is no data to date about their evolution and extinction. Next, species *Oliva junghuhni* started to evolve about 48.6 million years ago, before it was extinct about 5.3 million years ago.

Next, for the age of bivalve usually started from Lower Cambrian and continues to evolve until now. From biostratigraphy in Figure 3, the first group of species is from Ostidae family, where the *Ostrea* sp. started to appear at the late of Permian about 259 million years ago until 0.012 years and the evolution of this species ongoing until now. For Mytillidae family, the *Septifer* sp. was appeared after 5 million years' appearance of *Ostrea* sp., which is about 254 million years ago until 0.012 years after Quaternary ago.

In the middle of the Jurassic period, the first Cnidaria animal appeared, which is come from species *Discocyathus* sp. where it appeared about 171.6 million years ago until 109 million years ago in the Middle Cretaceous. Next, another existence of Cnidaria fossils was about 136.4 million years ago in the Late Cretaceous, and is still evolving until now. The Cnidarian fossil that both were evolving until now is *Cycloseris* sp., and also known as mushroom coral. From both identifications of Cnidaria's fossil, it can be concluded that both fossils were presented in the Middle Cretaceous.

*3.5 Interpretation of Fossil's Depositional Environment*
Based on the fossil identification, few fossils have been identified, which come from 2 different types of phylum, with seven families. According to previous research, the *Cerithium* sp. is living under the environment of beach in the tidal area [9], the *Cerithium tuberculatum* sp. lived under lagoon and shallow subtidal environment and, *Oliva junghuhni* was lived under marine condition [8]. On the other hand, bivalves such as *Septifer* sp. and *Ostrea* sp. are lived under the condition of strong energy, where they usually attached themselves to a hard base. The other Cnidaria fossil species, such as *Discocyathus* sp. and *Caryophyllidae* sp. are a non-reef building coral, but they prefer to live in the mud [9]. The *Cycloseris* sp. can live under the reef, marine, carbonate, shallow subtidal, deep subtidal, coastal, lagoonal, and coastal offshore [8]. In this study area, the depositional environment is lacustrine or lagoon to shallow subtidal within a restricted area based on the occurrence of the fossils (Figure 3).

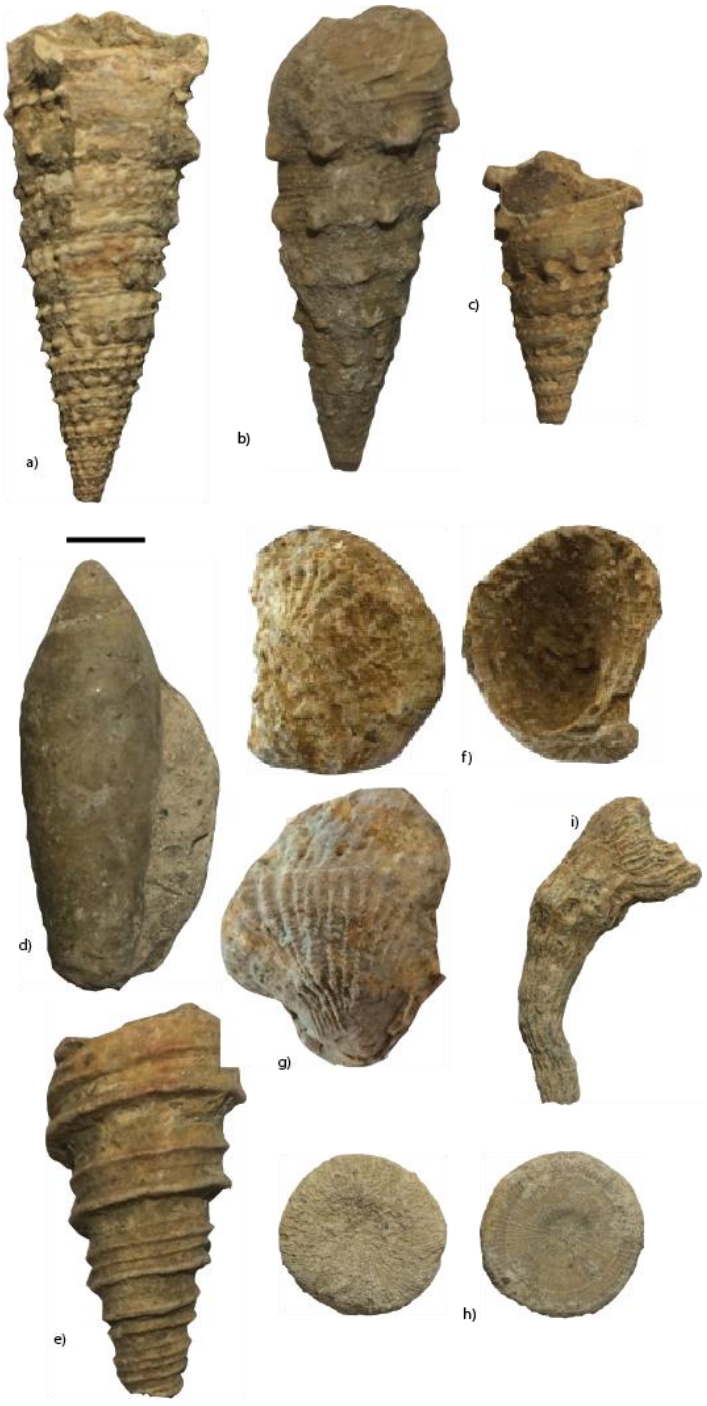


**Figure 3.** Fossils that found in the study area, which consist of Phylum Mollusks and Cnidaria; a) *Cerithium salebrosum Sowerby,* b) *Cerithium tuberculatum,* c) *Cerithium zonatum,* d) *Oliva junghuhni*, e) *Vicarya* sp., f) *Septifer* sp., g) *Ostrea* sp., h) *Cycloseris* sp. and *Discocyathus* sp.

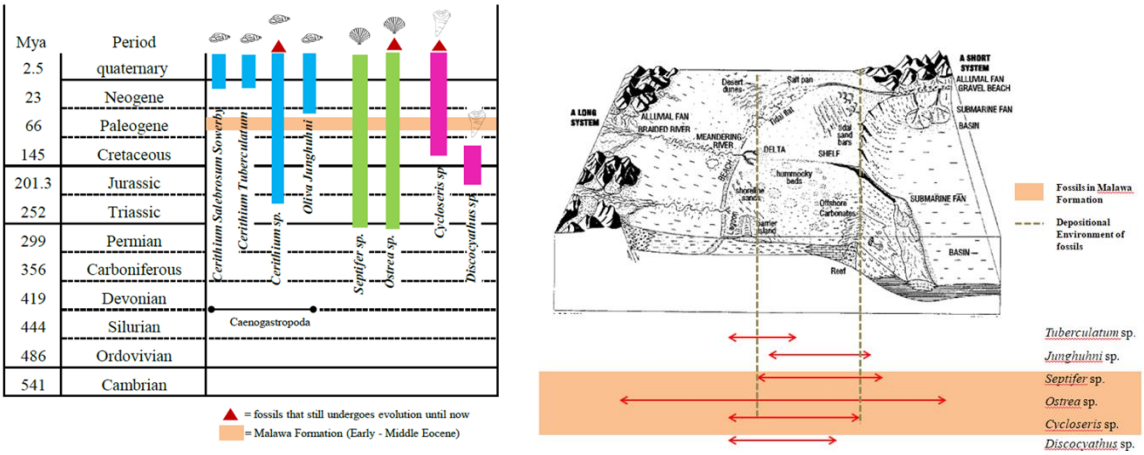


**Figure 4.** Biostratigraphy chart (left) and the depositional environments of Padanglampe (right).

## 4. Conclusion

In a nutshell, nine species that can be found at Padanglampe area is which five from gastropod's class, two from bivalve's class, and two from phylum cnidaria. Species that had been identified from gastropod's class are *Cerithium salebrosum Sowerby*, *Cerithium tuberculatum, Cerithium zonatum*, *Oliva junghuhni* and *Vicarya sp*. Species that identified for bivalve class is *Septifer* sp. and *Ostrea* sp. Lastly, species identified in Cnidaria's phylum are *Cycloseris* sp. and *Discocyathus* sp. In the middle Neogene, which is about 14.0 million years ago, all species that found already had in that place except for *Discocyathus* sp. From fossil identification, the interpretation of the age of Padanglampe is in Middle Palaeogene with the depositional environment is a shallow subtidal environment with a restricted area of lacustrine or lagoon. Fossils that presented in this time are *Cerithiium* sp., *Septifer* sp., *Ostrea* sp., and *Cycloseris* sp.

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