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A New Standard Facies Belt and Biofacies Approach Based on *Acropora* Coral in Ujunggenteng Area, West Java Province, Indonesia*

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Abstract

Acropora coral is one of coral, which found as a builder of reefal limestone. So far, the study about *Acropora* coral just stop for the study about coral shape, we call it with branching corals, and known as bafflestone facies in limestones. Studies about taphonomy and the presence of coral as a divider in the limestone facies and limestone biofacies still rarely performed. One location that shows the distribution of coral *Acropora* with good exposed along the Ujunggenteng Beach, Sukabumi, West Java, Indonesia, at coordinates 70° 21' 31.2" - 70° 22' 30" latitude and 106° 24' 12.2" - 106° 25' 30" longitude, To understand the aspects of paleontology with well, detailed mapping and supported by laboratory analysis were done. Results of morphological observation showed that the coral *Acropora* Ujunggenteng area consists of five species, namely *Acropora cervicornis*, *Acropora palifera*, *Acropora gemmifera*, *Acropora humilis*, and *Acropora palmata*. Five coral can be divided into three biofacies associations and each of that has a specific characteristics. It is namely with association *Acropora cervicornis* - *Acropora palmata* (thanatocoenose), *Acropora gemmifera* - *Acropora humilis*, and *Acropora cervicornis* - *Acropora palifera*. After analyzing biofacies, limestone standard facies belt analysis was performed. The new approach is made limestone standard facies classification in the Ujunggenteng area, which is based on depositional environment and coral taphonomy. Based on these parameters, limestone standard facies in Ujunggenteng area can be divided into three groups of limestone facies, which is proposed as Shoreface - thanatocoenose coral, Open shelf - thanatocoenose coral, and Shelf margin - biocoenose coral.

Introduction

Some previous study of limestone tried to perform a limestone classification based on lithological characteristics. Dunham (1962) made the limestone classification from lithology description; based on mud versus grain supported. All of coralline limestones classified as boundstone. In 1971, Embry and Klovan (1971) established a more detailed classification in Boundstone. This classification divided boundstone into three types: framestone ("head" coral), bindstone ("platy" coral), and bafflestone ("branching" coral) based on the shape of coral and organism. The

further interpretation was proposed by James and Borque (1992) which found the relationship between coral shape and geometry with wave energy and sedimentation.

The problem of previous classification appears since many corals with similar shape and geometry have different living environment. Species of coral is one of the important factors to interpret depositional environment of limestone as well as limestone facies. Thus, coral species and biofacies approach could be useful to solve several problems in coralline limestone from previous study. Ujunggenteng Area, West Java, Indonesia, located in 7° 21' 31.2" - 7° 22' 30" S and 106° 24' 12.2" - 106° 25' 30" E show the good distribution of coral within the continuous outcrop. Hence, this area is chosen as the research area (Figure 1).

Methods

Geological mapping along the detailed transect was performed to capture all of coral and lithology variation in the research area. Afterwards, a detailed and systematic description of coral incorporating micropaleontology analysis have been done in the laboratory to reveal coral association that used for interpreting paleobathymetry.

Result and Discussion

Coral Biofacies and Paleobathymetry

Branching coral in Ujunggenteng area is classified into *Acropora* genus. The genus *Acropora* has the characters of the family Acroporidae (synapticulotheca, simple septa and no columella or dissepiments) and could be defined by its mode of growth, in which a central or axial corallite extends and buds off subsidiary or radial corallites at branch tips (Wells, 1956; Wallace, 1978; Veron and Wallace, 1984). For detail taxonomy, species of *Acropora* genus can be divided based on growth form, size of branches diameter, and the angle between branches (Wallace and Dai, 1997; Van der Meij and Visser, 2011).

Based on field and laboratory observations, *Acropora* corals in Ujunggenteng area consist of five species: *Acropora cervicornis*, *Acropora palifera*, *Acropora gemmifera*, *Acropora humilis*, and *Acropora palmata*. The photograph of these species can be seen in Figure 2.

Supported by paleontology description, biofacies analysis was performed with coral association and coral distribution constraints. Ujunggenteng area could be distinguished into three groups of biofacies (Figure 3):

- a) *Acropora cervicornis* – *Acropora palifera* biofacies. *Acropora cervicornis* – *Acropora palifera* biofacies occupies the southern area in Ujunggenteng. The characteristics of this facies are the dominance of *Acropora cervicornis* and *Acropora palifera* with biocoenose condition. Another organism, which is found on this biofacies are *Favosites* and *Fungia* on thanathocoenose condition. Paleobathymetry analysis show *Acropora cervicornis* – *Acropora palifera* biofacies was deposited in 8 – 13 meters of water depth.

- b) *Acropora gemmifera* - *Acropora humilis* biofacies. *Acropora gemmifera* - *Acropora humilis* biofacies can be found on the middle part of Ujunggenteng area. Domination of *Acropora gemmifera* and *Acropora humilis* with biocoenose condition is the main characteristics of this biofacies. Broken mollusca and undetermined coral fragments are also found on this biofacies. Paleobathymetry analysis indicates that the facies was deposited in 3 – 8 meters of water depth.
- c) *Acropora cervicornis* – *Acropora palmata* biofacies. This biofacies occupies the northern part of Ujunggenteng area. *Acropora cervicornis* and *Acropora palmata* with thanatocoenose condition is the primary characteristic of this biofacies. All of coral were found on fragments and broken condition. Paleobathymetry analysis shows that this biofacies was deposited in 0 – 3 meters of water depth (Figure 4).

Limestone Standard Facies Belt

The result of biofacies is the main input to build the new standard facies belt. The new standard facies is proposed for the alternative and more consistence standard facies belt than the previous study. This standard facies using two parameter groups, which the first group as the depositional environment and the second group refer to coral, build up condition.

Ujunggenteng area can be divided into three groups of the standard facies belt (Figure 8):

- a) Shoreface - thanatocoenose coral. This standard facies has the bioclastic coralline limestone as the main characteristics, where broken coral fragment from *Acropora palmata* and *Acropora cervicornis* were transported from the deeper bathymetry. Another characteristic of this standard facies are monotonous coral variation within fine-grained shoreface sandstone, without presence of foraminifera fossil as the another characteristic of this facies standard (Figure 5).
- b) Open shelf - thanatocoenose coral. This standard facies consist of bioclastic coralline limestone and thanatocoenose coral. Various coral species with thanatocoenose condition such as *Acropora palmata*, *Acropora cervicornis*, *Montipora*, and *Favosites* can be found and become the primary indicator of this standard. In addition, this standard facies could be recognized by the presence of fine-grained sandstone with abundant of foraminifera (Figure 6).
- c) Shelf margin – biocoenose coral. Shelf margin – biocoenose coral standard facies consist of many species corals with the biocoenose condition. *Acropora cervicornis*, *Acropora palifera*, *Acropora humilis*, and *Acropora gemmifera* is the coral species, which can be found and become the main characteristic of this facies. The corals have association with sandstone which high contain of foraminifera fossils (Figure 7).

Conclusions

Detail taxonomy coral and biofacies approach have been employed to determine and classified the new standard facies belt for limestone. We have demonstrated the applicability of our idea with the following results:

1. Based on morphological observation, *Acropora* species in Ujunggenteng area consists of five species, namely *Acropora cervicornis*, *Acropora palifera*, *Acropora gemmifera*, *Acropora humilis*, and *Acropora palmata*.
2. Ujunggenteng area can be distinguished into three biofacies: *Acropora cervicornis* – *Acropora palifera* biofacies, *Acropora gemmifera* – *Acropora humilis* biofacies, and *Acropora cervicornis* – *Acropora palmata* biofacies.
3. This study proposed the new standard facies belt based on environment and corals taphonomy, which is proposed as Shoreface - thanatocoenose coral, Open shelf - thanatocoenose coral, and Shelf margin - biocoenose coral.

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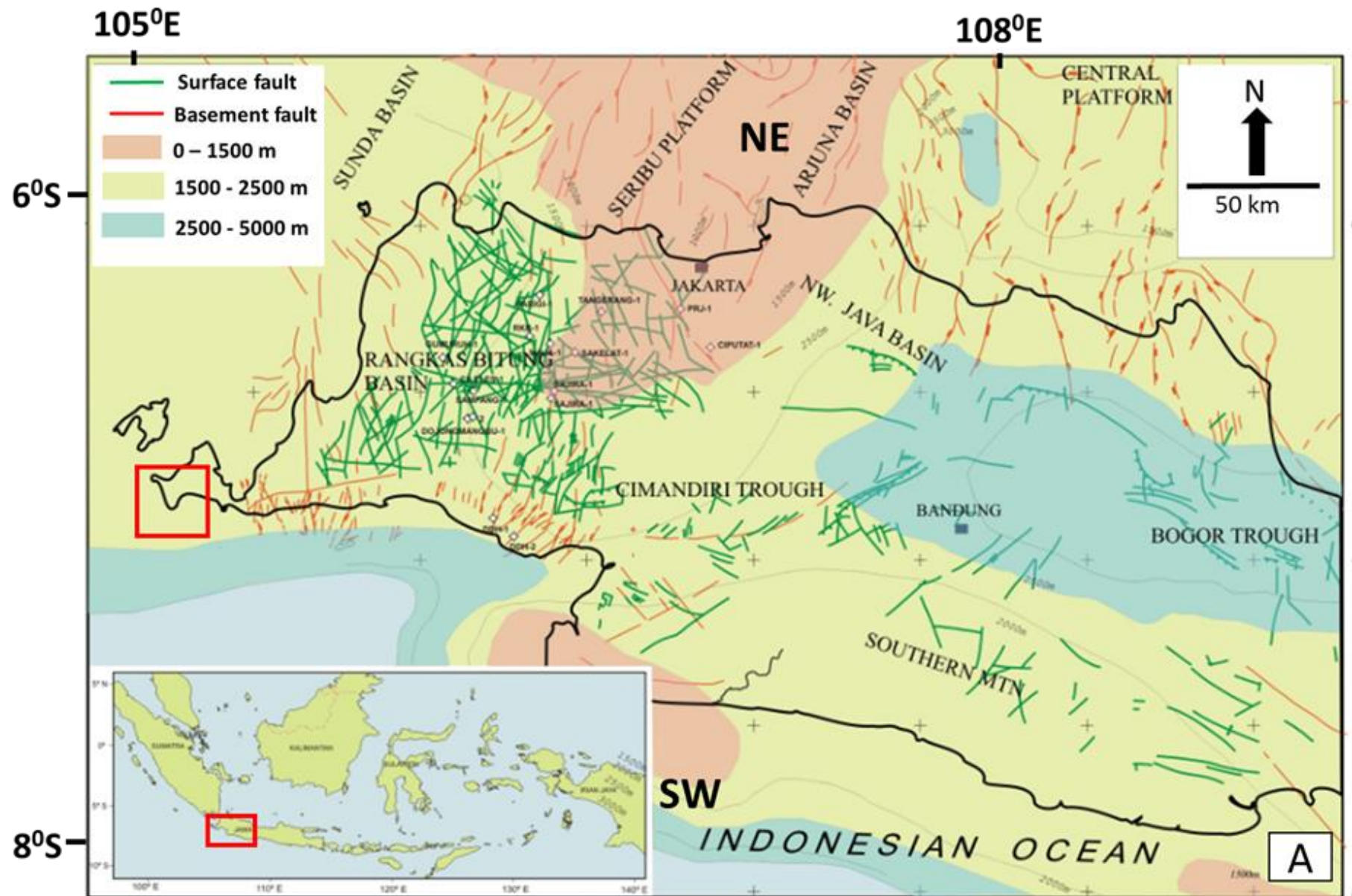


Figure 1. Location of the research area in Ujunggenteng, West Java, Indonesia (Martodjojo, 2003).

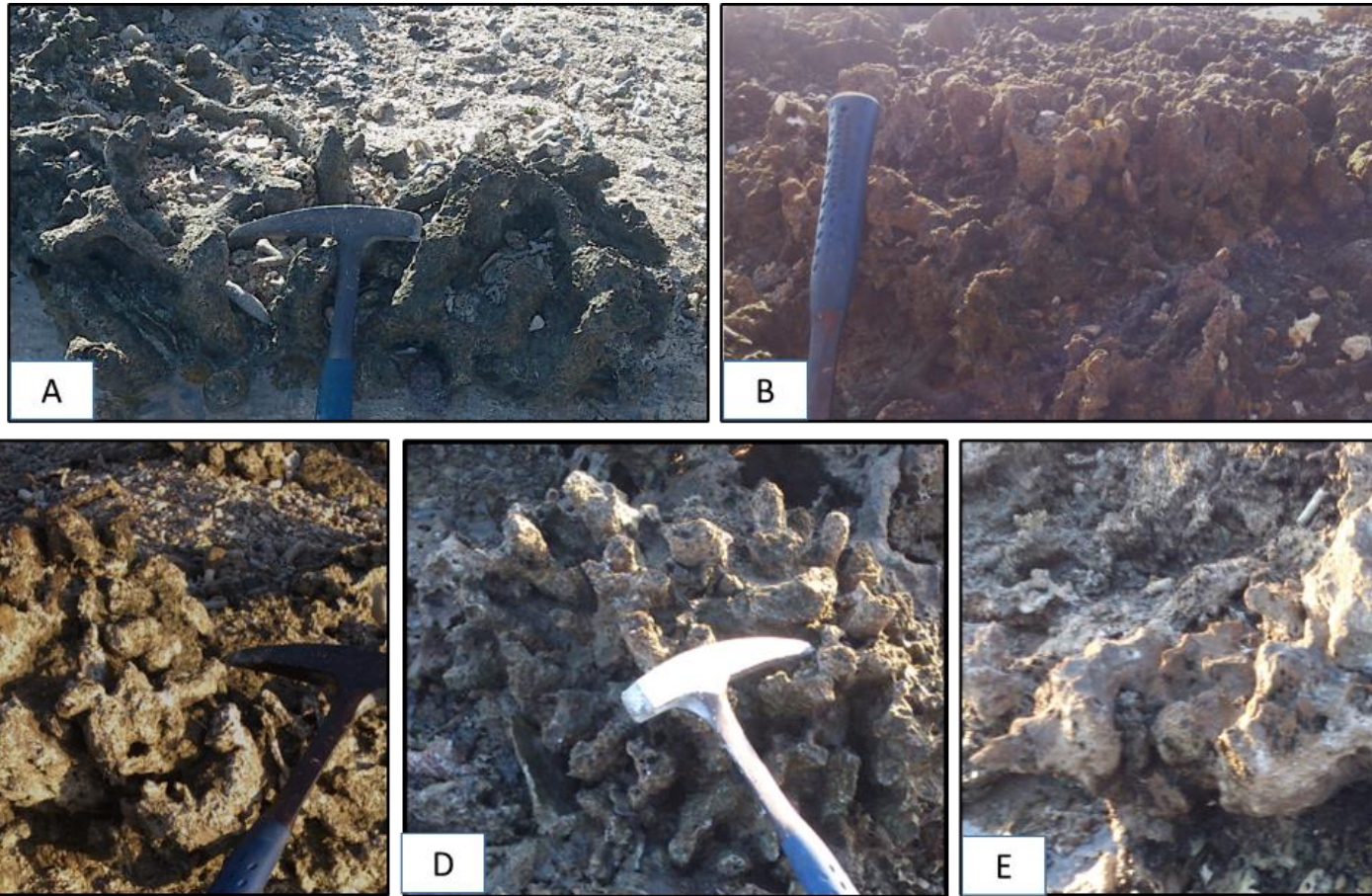


Figure 2. The five species *Acropora* in Ujunggenteng area: (A) *Acropora cervicornis*, (B) *Acropora palifera*, (C) *Acropora gemmifera*, (D) *Acropora humilis*, and (E) *Acropora palmata*.

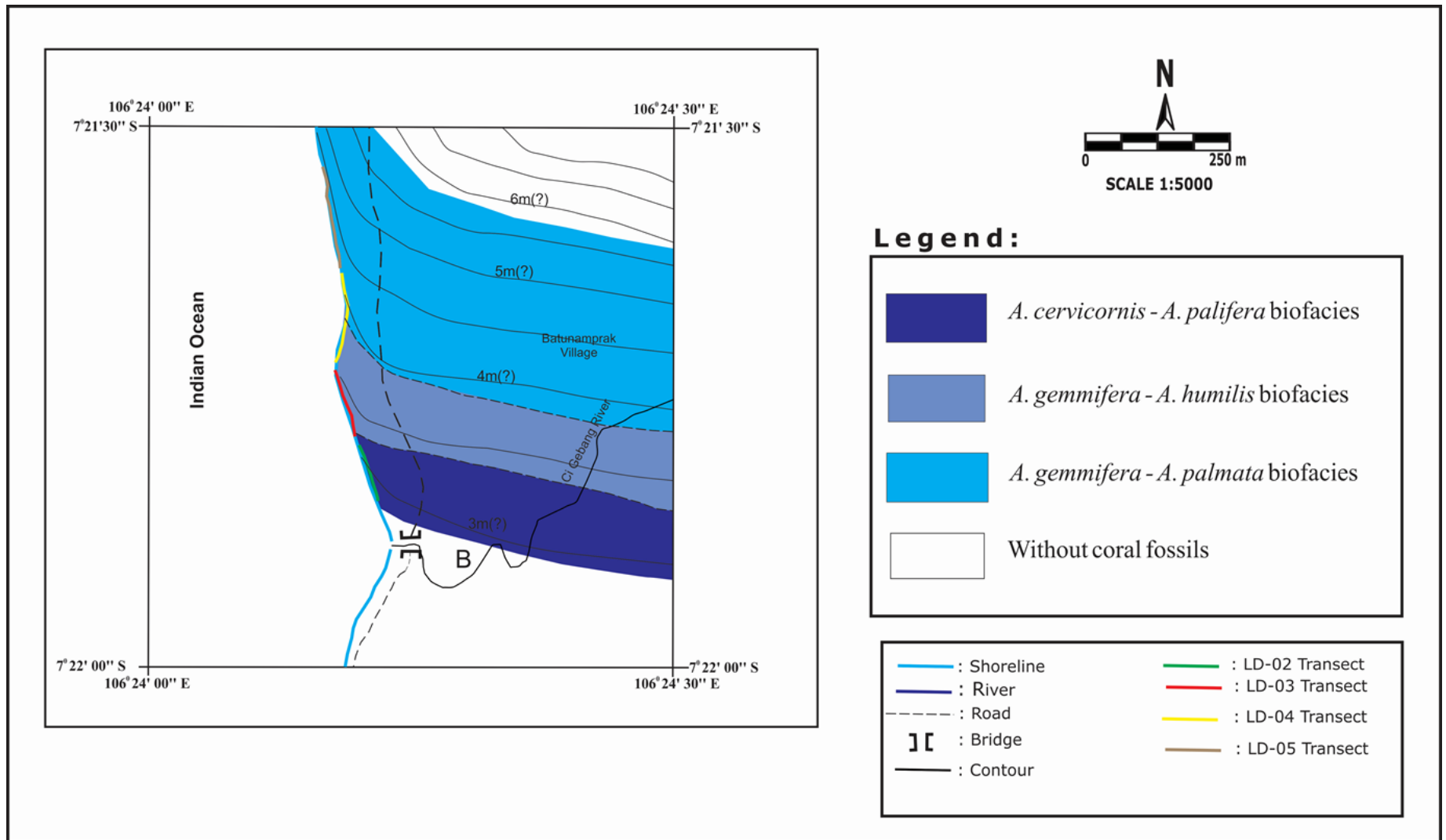


Figure 3. Biofacies map based on *Acropora* corals in Ujunggenteng area.

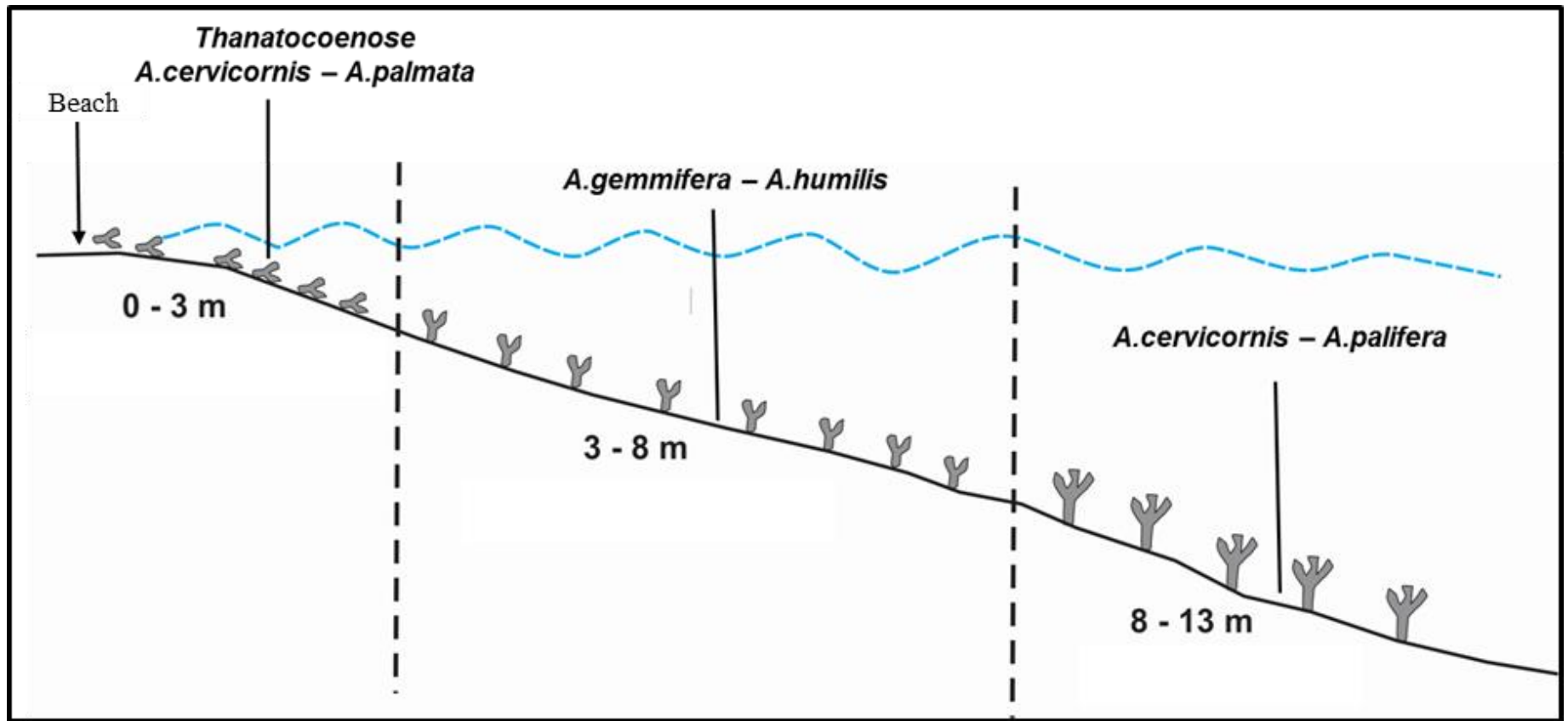


Figure 4. Paleobathymetry model of *Acropora* corals in Ujunggenteng area.

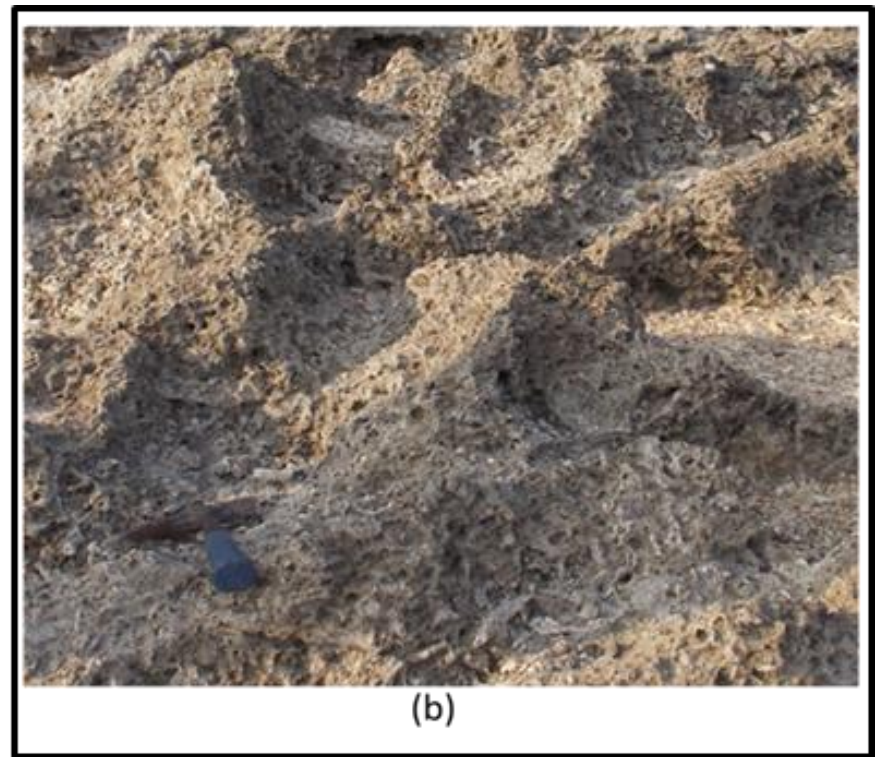
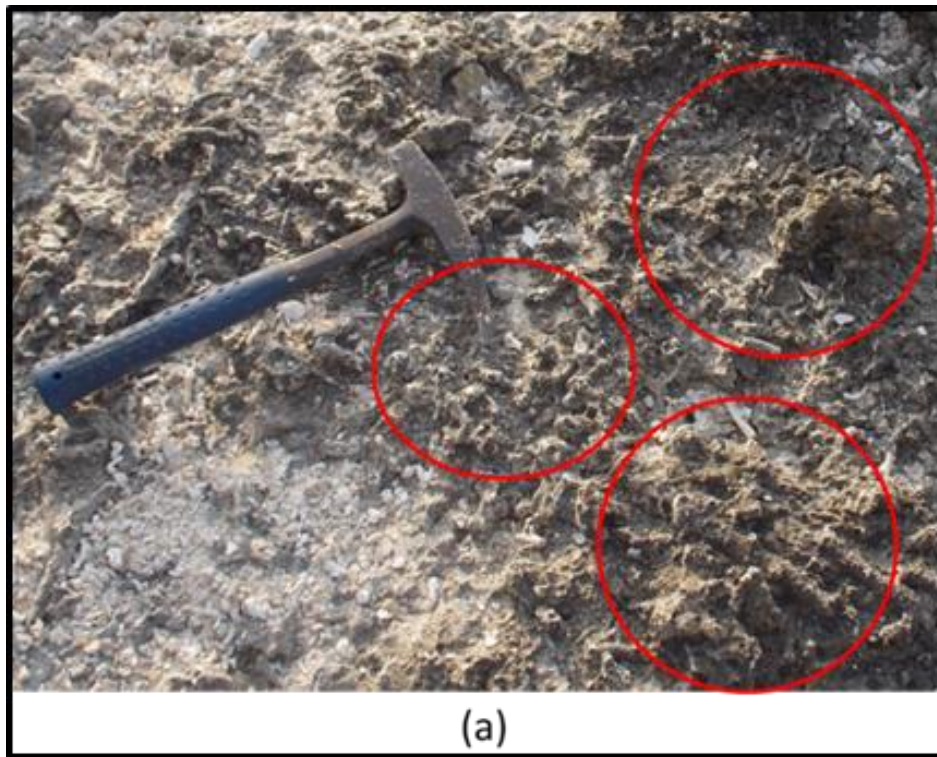


Figure 5. Shoreface - thanathocoenose coral characteristics: (a) bioclastic limestone from coral fragment. (b) Shoreface fine- grained sandstone.

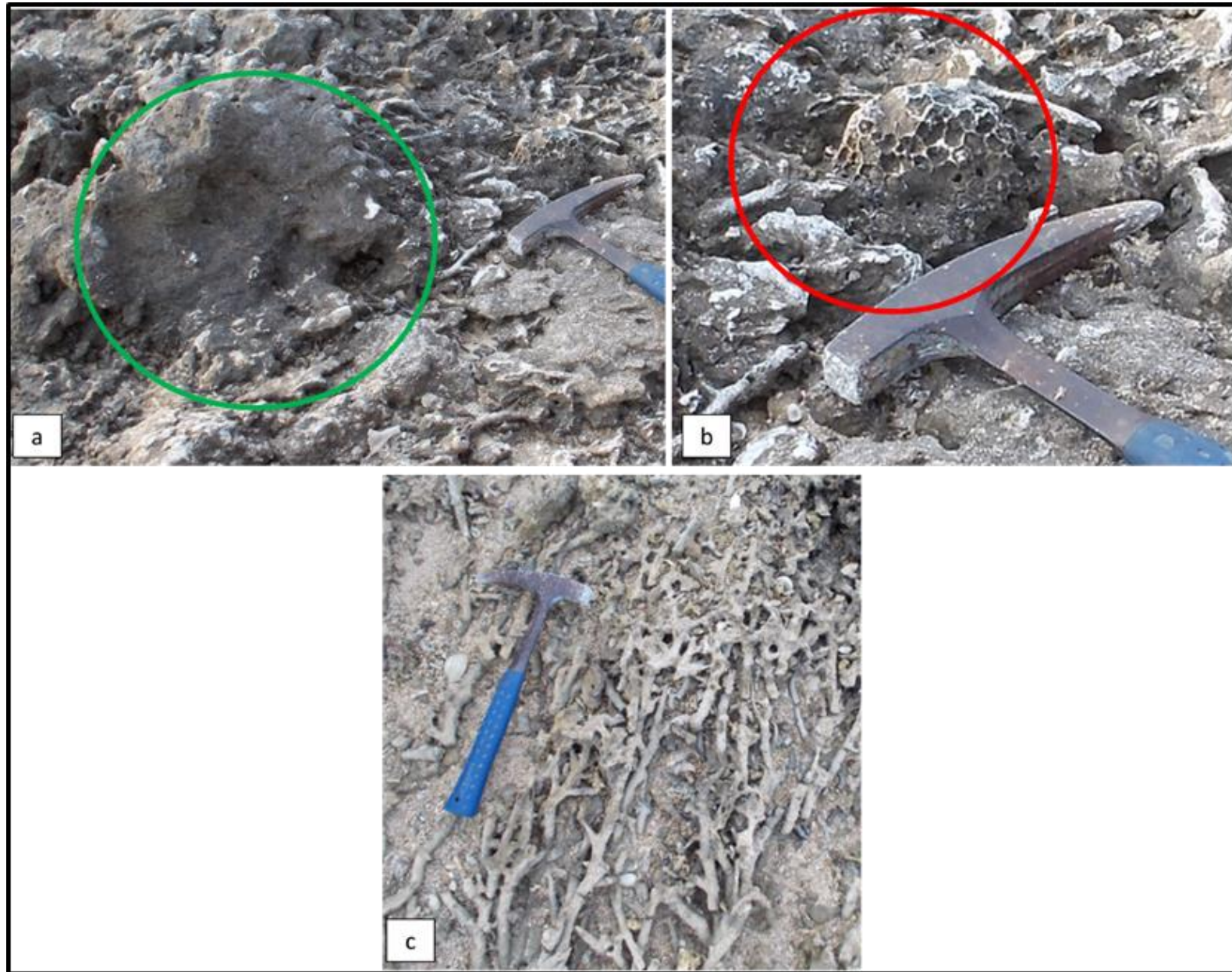


Figure 6. Open shelf - thanathocoenose coral characteristics with various corals on thanathocoenose condition: (a) *Montipora*, (b) *Favosites*, and (c) *Acropora cervicornis*.



Figure 7. Shelf margin – biocoenose coral characteristic with biocoenose coral build up.

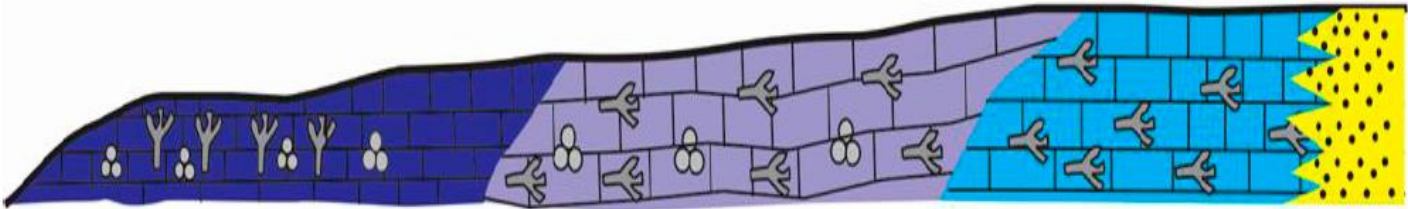
Standard Facies	(Shelf margin - biocoenose coral)	(Open shelf -thanatocoenose coral)	(Shoreface - thanatocoenose coral)
Cross section sketch			
Lithology characteristic	Coralline limestone	Limestone <i>packestone</i> – <i>grainstone</i> .	a. Bioclastic limestone <i>wackestone</i> – <i>grainstone</i> . b. Shoreface sandstone
Sedimentary structures	Build up reef	Interbedding bioclastic limestone with contain of corals fragment and mollusk.	Cross bedding on the Shoreface sandstone
Organism	<ul style="list-style-type: none"> • <i>Acropora cervicornis</i>, <i>Acropora palifera</i>, <i>Acropora humilis</i>, and <i>Acropora gemmifera</i> with <i>biocoenose</i> condition. • High contain with foraminifera fossils. 	<ul style="list-style-type: none"> • <i>Acropora palmata</i>, <i>Acropora cervicornis</i>, <i>Montipora</i>, and <i>Favosites</i> with <i>thanatocoenose</i> condition. • High contain with foraminifera fossils. 	<ul style="list-style-type: none"> • <i>Acropora cervicornis</i> and <i>Acropora palmata</i> with <i>thanatocoenose</i> condition. • Without foraminifera fossils.

Figure 8. The new limestone standard facies belt is proposed for Ujunggenteng area.