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RESEARCH ARTICLE

Depositional Environmental Changes of Cimanceuri Formation Based on Mollusk Fossil Assemblages in Bayah, Banten Province

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Abstract

Bayah is located in Lebak Regency, Banten Province. This location is chosen due to its abundant mollusk fossils which exposed along the outcrops. The aim of this research is to determine depositional environmental changes using mollusk fossil assemblages. Data obtained from a measured stratigraphic section of Cimanceuri Formation. It is dominated by very fine-fine sandstones with claystone intercalation. A total thickness of measured stratigraphic section is 4.2 meters. There are at least seventeen mollusk associations (bottom-top) consisting of 1) Ringicula arctatoides - Olivella tomlini were obtained. 2) Ringicula arctatoides - Marginella (Cryptospira) ventricosa sangiranensis. 3) Olivella tomlini, 4) Ringicula arctatoides - Olivella tomlini, 5) Ringicula arctatoides, 6) Turritella (Turritella) bantamensis - Scapharca (Scapharca) gedinganensis, 7) Polinices aurantius - Marginella (Cryptospira) ventricosa sangiranensis, 8) Scapharca (Scapharca) gedinganensis, 9) Scapharca (Scapharca) multiformis - Timoclea bataviana, 10) Turritella (Turritella) bantamensis tjicumpaiensis - Ringicula arctatoides, 11) Turritella (Turritella) bantamensis - Ringicula arctatoides, 12) Turritella (Turritella) bantamensis tjicumpaiensis - Turritella (Turritella) bantamensis, 13) Turritella (Turritella) bantamensis tjicumpaiensis - Ringicula arctatoides, 14) Turritella (Turritella) bantamensis - Architectonica sp., 15) Turritella (Turritella) bantamensis tjicumpaiensis, 16) Turritella (Turritella) bantamensis - Turritella (Turritella) bantamensis tjicumpaiensis, and 17) Turritella (Turritella) bantamensis. The condition with the most stable ecosystem is the association of Turritella (Turritella) bantamensis tjicumpaiensis - Turritella (Turritella) bantamensis (Association 12). At least there are seven depositional environmental changes that occur in this research area with two shallowing - deepening cycles : 1) open shallow marine, 2) subtidal - open shallow marine, 3) open shallow marine, 4) open shallow marine - subtidal, 5) subtidal, 6) subtidal - open shallow marine, and 7) open shallow marine.

Keywords: Mollusk, Depositional environment, Bayah, Cimanceuri Formation

1. Introduction

Mollusks are one of the phylum with a very abundant number of organisms, so it is potential to be used as an indicator to interpret the depositional environment. In addition, the environmental distribution of mollusks is wide ranging from marine to terrestrial. Bayah region has many marine sediment outcrops. Bayah region is chosen for studying due to its abundant mollusk fossils which exposed along the outcrops. In this location, foraminifera fossils that commonly used for interpretation of depositional environments is rarely found. Based on this condition we propose the mollusk fossils to be used as indicators of depositional environment interpretation.

Bayah is located in Lebak Regency, Banten Province (Fig. 1.). The details location have found in Cikumpay River with coordinates 106° 14' 18,282" BT; 6° 54' 48,963" LS and 106° 14' 18,084" BT; 6° 54' 49,987" LS and in the Cikuya River (Cikumpay's tributary) with coordinates 106° 14' 0,582" BT; 06° 55' 8,776" LS (Fig. 2 and 3)

The assembly of fossils which was found in the Cimanceuri Formation is deposited in terrestrial-fluvial to littoral. Its lithology is very fine to finegrained carbonate sandstones with claystone intercalation and contains of mollusk fossils in several places, at the top of this formation there is a coquina (Sujatmiko, et al., 1992). Mollusk and Foraminifera fossils which found in Cimanceuri Formation shows Early Pliocene (Koolhoven, 1933 in Sujatmiko, et al., 1992).

Based on Neogen Stage of Java (Oostingh, 1938 and Shuto, 1975), Cimanceuri Formation are known belong to the Sondean Stage with Turritella bantamensis tjicumpaiensis and Scapharca gedinganensis as its fossil index. These fossil index are come from Pliocene / N19-N20. (Sufiati, et al., 2014).

2. Material and Method

Twenty-two rock samples were obtained from 3 measured stratigraphic sections in Cikumpay and Cikuya Rivers (Fig. 3.). Systematically rocks sampling

are carried out with an interval of $\pm 20\mbox{ cm}$ at each layer.

Description and measurement of sediment re thickness were carried out in the field. Afterwards, the

samples then prepared. The preparation process aims to clean up the remaining sediment until the fossils ready to be identified.



Fig. 1. Research area, Bayah, Lebak Regency, Banten Province (Source: Google Maps).



Fig. 2. Sampling location map Bayah, Lebak Regency, Banten Province.



Fig. 3. The Outcrop of CKY 3 in research area.

A binocular microscope is used to identify microsized mollusks. The references to identification and determination refer to Martin (1879,1880), Oostingh (1933), Leloux (2009), and Sufiati (2012), while for the ecological determination of each species refers to Abbott (1991), Okutani (2000), Aswan (2006), and Prasetyo et al. (2012). Species that have been identified are then used for determine mollusk associations of each layer.

The mollusk association zone is used to indicate mollusk fossil assemblages that live in similar habitats associated with certain lithologies. Classification of depositional environment refers to Fan (2012) (Fig. 4.). The name of mollusk fossils association is based on insitu and abundant mollusk fossils, whether one or more species appear (Prasetyo et al., 2012). The result of these associations are used for interpretation of depositional environmental changes in Cimanceuri Formation. The mollusk fossils obtained from Bayah are stored at Bandung Geological Museum.

Shannon-Wiener's diversity index is used to identified the condition of ecosystem in research area, (Bakus, 2007):

$$H' = -\sum_{i=1}^{s} (Pi) (\log Pi)$$
(1)

where :

H' = diversity index s = number of species $\Sigma = \text{sum}$ $P' = \frac{ni}{N}$ ni = number of individuals of species iN = the total number of individuals of all species

Low diversity (H'<1) indicates that ecosystem conditions are unstable or disturbed, moderate diversity (1<H'<3) indicates a fairly stable ecosystem, and high diversity (H'>3) indicates a stable ecosystem condition (Jurnaliah, 2011). The Shannon-Wiener's diversity index is calculated using Microsoft Excel.



Fig. 4. Classification of tidal zone (Modified from Fan, 2012).

LITHOLOGY	MOLLUSK FOSSILS	INTERTIDAL	SUBTIDAL	OPEN SHALLOW MARINE		
CKY 1 L5	Marginella sp. Ringicula arctatoides Natic Olivella tominio Hinia (Telasco) sinusigera Turritella (Turritella) bantamenis ticumpoiensis Scapharca (Scapharca) gedinganensis Timoclea bataviano Timoclea bataviano Turritella cinguiljera	20 40 60 80 100 120	20 40 60 80 100 120			
CKY 1 L4	Naticarius (Naticarius) lineata Marginella (Tyytospiro) ventricoso Hiny (Telaso) sinusigero Architectonica sp. Timocica bataviano Marginella (Cryptospira) ventricoso songiranensis Scapharca (Scapharca Scapharca Tellina (Moerella) bantamensis Tellina (Moerella) dontamensis Olivella tomlini	0 10 20 30 40				
CKY 1 L3	Ringicula arctatoides Rindicula statingensis Scapharca (Scapharca) gedinganensis Tellina inflata Timoclea bataviana Marginella (Cryptospira) ventricosa sangiranensis Moerella nannodes Scapharca (Scapharca) multiformis	0 10 20 30 40 50				
CKY 1 L2						
CKY 1 L1	Olivella tamini Ringicula artatoides Turrfiella djadjarienis Nassarius bodjongensis Marginella (Cryptospira) ventricosa sangiranensis Columbella (Alio) tegalensis	0 10 20 30 40 50	0 10 20 30 40 50	0 10 20 30 40 50		

Fig. 5. Determination diagram of mollusk CKY 1.

LITHOLOGY	MOLLUSK FOSSILS	INTERTIDAL	SUBTIDAL	OPEN SHALLOW MARINE		
CKY 2 L4	Turritella sp: Arca sp: Nassa sp: Teilina sp: Canus sp: Marginella sp: Oliva sp: Natica sp: Ringicula sp: Thais sp:					
CKY 2 L3	Ringicula arctatoides Polini bucklandi Hinia (Telasco) sinusigera Timocles bataviana Scapharca (Scapharca) multiformis Marginella (Cryptospiro) ventricos so sangiranensis Turritella (Turritella) bantamensis tijcumpaiensis Nassarius bodjongensis	0 20 40 60 80 100 120	0 20 40 60 80 100 120			
CKY 2 L2						
CKY 2 L1	Hinia (Telasco) sinusigera' Natica (Natica) zebra Ringicula artictaides Tellina (Moerello) bantamensis Timoclea batraina Chlamys tjaringinensis Scapharca (Scapharca) gedinganensis Hilma nflada Marginella (Cryptospira) ventricosa sangiranensis	0 20 40 60 80 100 120 140	0 20 40 60 80 100 120 140			

Fig. 6. Diagram determination of mollusk CKY 2.

LITHOLOGY	MOLLUSK FOSSILS	INTERTIDAL	SUBTIDAL	OPEN SHALLOW MARINE
CKY 3 L6	Natica sp. Thais sp. Tellina sp. Tonna sp. Arca sp. Turritella (Turritella) bantamensis			
СКҮ 3 L5b-	Tonna lischkeana Terebra (Myurella) junghuhni Turritella (Turritella) bantamensis Vexillum (Costellaria) rajaensis Oliva tricincta	0 5 10 15 20	0 5 10 15 20	
CKY 3 L5a—	Ringicula arctatoides Architectonica sp. Tellina inflato Turritella (Turritella) bantamensis Gemmula (Gemmula) granosa woodwardi Olivella tomint Marginella (Cryptospira) ventricosa sangiranensis Turritella (Turritella) bantamensis tjicumpaiensis	5 10 15 20		
CKY 3 L4b-	Architectonica sp. Ringicula arctatoides Nassarius badjongensij Scapharca (Scapharca) multiformis Dentalium gonatodes Turritella (Turritella) bantamensis tjicumpaiensis Scapharca terhaqn Tellina (Tellina) rosaindica			
CKY 3 L4a –	Natica (Natica) gedinganensis Architectonica sp. Nucula bantamensis Inquisitor batavianus Scapharca (Scapharco) gedinganensis Turritella (Turritella) bantamensis Nucula bantamensis	0 5 10 15 20		
CKY 3 L3f -	Ringicula arctatoides Strioterebrum(Punctaterebra) cox(Armaea mitra Turritella (Turritella) bantamensis Scapharca (Scapharca) gedinganensis Corbula sp. Tellina (Moerella) bantamensis Turritella (Turritella) bantamensis tjicumpaiensis	5 10 15 20		
CKY 3 L3e-	Ringicula arctatoides Reverta ct. suicifero Turritella (Turritella) bantamensis dicumpaiensis Masarius (Alectrion) pseudomundus Marginella (Cryptospiro) ventricos sangiranensis Columbella (Akia) tegalensis Turritello (Turritello) bantamensis	5 10 15 20		
CKY 3 L3d-	Ringicula arctatoide3 Anachis (Anachis) terpsichore Architectonica sp. Marginella (Cryptospira) ventricoso sangiranensis Turritella (Turritella) bantamensis			
CKY 3 L3c-	Scapharca (Scapharca) multiformis Bicorbula tiiguhanensis Ringicula arctatoides Natica (Natica) zebra Architectonica sp. Turritella (Turritella) bantamensis	<u> </u>		
CKY 3 L3b -		3 10 13 20	0 9 10 19 20	V J 10 13 20
CKY 3 L3a –	Ringicula arctatoides Nucula bantamensis Architectonica sp. Dentailum gonatodes Turritella (Turritella) bantamensis Scapharca (Scapharca) multiformis Turritella (Turritella) bantamensis tjicumpaiensis	5 10 15 20		
CKY 3 L2 –	Clavus (Cymatosyrinx) appenoarth[Hastula (Hastula) mantjeuriensis Scapharca (Scapharca) gedinganensis Timoclea bataviana Jaquistor batavianus Scapharca (Scapharca) multiformis Turritella (Turritella) bantamensis Marginella (Cryptospira) ventricosa sangiranensis	0 5 10 15 20		
CKY 3 L1d-	Corbula taitensis Turritella (Turritella) bantamensis Marginella (Cryptospira) ventriccos sangiranensis Gemmula (Gemmula) granosa woodwardl Gemmula (Gemmula) raina (raina) Vexilium (Castellaria) rajeansis Scopharca (Scapharca) gedinganensis	5 10 15 20		
CKY 3 L1c -	Marginella (Cryptospira) ventricosa sangiranensis Dentalium gonatodes Tellina (Moerella) bantamensis Tellina sp. Ostrea sp. Polinices aurantius Egilina sp.	5 10 15 20	0 5 10 15 20	
CKY 3 L1b-	Natica fasciata Dendropoma sp. Dentalium gonatodes Timoclea bataviana Nassarius badjongensis Scapharca (Scapharca) gedinganensis Strioterebrum bomasense Scapharca (Scapharca) multiformis Turritella (Turritella) bantamensis	5 10 15 20		
CKY 3 L1a-	Architectonica sp. Ringicula arctatoides Dentalium gonatodes Hinia (Telasco) sinusigera Natica (Natica) zebra Scapharca (Scapharca) gedinganensis	5 10 15 20	0 5 10 15 20	0 5 10 15 20

Fig. 7. Diagram determination of mollusk CKY 3.

3. Result and Discussion

Based on this research, 2373 mollusk fossils were obtained from 22 samples which is taken from Cikumpay and Cikuya rivers. Its consist of 222 species (56 bivalves, 164 gastropods, and 2 scaphopods). The data of dominant mollusk fossil species in CKY 1, CKY 2, and CKY 3 showed by graphic (Fig. 5,6, and 7). The dominant mollusk fossils are used to determine depositional environmental.

Lithology and mollusk fossils association in CKY 1 and CKY 2 shows similarities so they are interpreted as the same layer. Based on the strike / dip measurements, CKY 3 is interpreted to be younger than CKY 1 and CKY 2. Total thickness of measured stratigraphic section is 4.2 meters. The lithology is dominated by very fine-fine grained calcareous sandstones with non-calcareous claystone intercalation. At the top, there is a coquina sandstone with abundant mollusk fossils (Fig. 8.).

The results of determination represents 17 mollusk associations with 10 species variations. From these associations, it can used to analyze the depositional environmental changes from old to young layers which are correlated with local sea level changes. Classification of the depositional environmental is divided into 3, namely: intertidal, subtidal, and open shallow marine. At least there are seven depositional environmental changes that occurs in this research area, there are: open shallow marine environments that change slightly to open shallow marine – subtidal environment. Furthermore, the environment will revert gradually to subtidal, then slowly deeper into open shallow marine environment.

The diversity index value of the samples which is taken from this study ranged from 1,095 - 3,182 (Table 1.). The highest diversity index value is at CKY3 L5a, while the lowest diversity index value is at CKY3 L6. This can be interpreted that the research area is a medium – high productivity area and has a fairly stable – stable ecosystem.

Based on the mollusk fossil associations, two shallowing-deepening sea level local cycle was occurred at the Cimanceuri Formation (Fig. 8). Start from association 1 (CKY1 L1), it is an open shallow marine environment characterized by association of Ringicula arctatoides - Olivella tomlini (Fig.9). In association 2 (CKY1 L3) there are still abundant Ringicula arctatoides but it is also followed by the abundance of Marginella (Cryptospira) ventricosa sangiranensis (Fig.10). These fossils has an intertidalsubtidal environment. It can be interpreted that sea level becomes shallow and returning to open shallow marine environment on the layer above it. Its showed by associations Olivella tomlini, Ringicula arctatoides -Olivella tomlini, and Ringicula arctatoides (Association 3,4,5) respectively. In association 6 (CKY3 L1b) the environment returns to shallow again. it is showed by an abundance of Turritella (Turritella) bantamensis -Scapharca (Scapharca) gedinganensis at the same time. Furthermore, in Associations 7 and 8 (CKY3 L1c & L1d) is getting shallowing until subtidal environment, which is characterized by the abundant

of *Polinices aurantius - Marginella (Cryptospira) ventricosa sangiranensis* and *Scapharca (Scapharca) gedinganensis* associations.

The environment has changed back into an open shallow marine slowly which is indicated by the abundant presence of intertidal-subtidal mollusk fossils, Scapharca (Scapharca) multiformis and the abundance of open shallow marine environment fossils, Timoclea bataviana (Association 9). Hereafter, the sea level was becomes deeper with consecutively association of Turritella (Turritella) bantamensis tjicumpaiensis – Ringicula arctatoides, Turritella (Turritella) bantamensis – Ringicula arctatoides, Turritella (Turritella) bantamensis tjicumpaiensis – (Turritella) Turritella bantamensis, Turritella (Turritella) bantamensis tjicumpaiensis – Ringicula arctatoides, Turritella (Turritella) bantamensis -Architectonica sp., Turritella (Turritella) bantamensis tjicumpaiensis, Turritella (Turritella) bantamensis -*Turritella (Turritella) bantamensis tjicumpaiensis*, and Turritella (Turritella) bantamensis (Association 10-17).

Table 1. Table Diversity index in this study

Location	Total number of individuals	Number of species	Diversity index	
CKY3 L6	22	6	1,095	
CKY3 L5b	13	8	1,567	
CKY3 L5a	74	37	3,182	
CKY3 L4b	43	28	3,144	
CKY3 L4a	29	17	2,375	
CKY3 L3f	51	29	2,957	
CKY3 L3e	45	16	2,282	
CKY3 L3d	26	16	2,548	
CKY3 L3c	25	11	1,942	
CKY3 L3a	50	31	3,07	
CKY3 L2	65	23	2,613	
CKY3 L1d	13	8	1,738	
CKY3 L1c	36	24	2,869	
CKY3 L1b	44	28	3,036	
CKY3 L1a	9	6	1,677	
CKY2 L4	15	12	2,338	
CKY2 L3	455	61	2,98	
CKY2 L1	499	57	2,847	
CKY1 L5	387	45	2,689	
CKY1 L4	138	38	2,969	
CKY1 L3	287	45	2,963	
CKY1 L1	47	19	2,392	
Total	2373			

	LIT STR	TO- ATI- PHV			LITHOLOGY					DEPOSITIONAL ENVIRONMENT																		
AGE	FORMATION	TITHOLOGY	THICKNESS (cm)	MEDIUM SAND FINE SAND VERY FINE SAND SULT SULT CLAY	Section 1	Section 2	Section 3	DESCRIPTION	MOLLUSK ASSOCIATION	INTERTIDAL	SUBTIDAL	OPEN SHALLOW MARINE																
PLIOCENE			10			L6 L5b		Coquina calcareous fine sandstone (0,125 - 0,25mm), grey, rounded, poorly sorted with Natica sp., Tonna sp., and abundant of Turritella (Turritella) bantamensis.	Turritella (Turritella) bantamensis																			
			70			L5a	-	Calcareous fine sandstone (0,125 - 0,25mm), greyish brown, rounded, moderately sorted, with Terebra (Myurella) junghuhni, Paphia sp., common of Turritella bantamensis and Turritella bantamensis tjicumpaiensis.	Turritella Turritella (Turritella) - (Turritella) bantamensis tjicumpaiensis																			
			30			L41 L4;	b	Calcareous very fine sandstone (0,0625 - 0,125mm), brown, rounded, moderately sorted, with common of <i>Turritella bantamensis tjicumpaiensis</i> , <i>Turritella</i> <i>bantamensis</i> , and <i>Architectonica</i> sp.	Turritella (Turritella) bantamensis tjicumpaiensis Turritella - Architectonica (Turritella) - Sp.																			
			140			L3f —		Turritella (Turritella) - Ringicula bantamensis - arctatoides tjicumpaiensis Turritella - Turritella																				
	EURI	TONE		140	140	140	140	140	140	140	140			L3d	CKY 3	Calcareous fine sandstone (0,125 - 0,25mm), grey, rounded, moderately sorted, with Dentalium	(Turritella) bantamensis tijicumpaiensis Turritella (Turritella) - Ringicula arctatoides											
	CIMANC	SANDS				L3c		gonatodes, Architectonica sp., common of Turritella bantamensis, Turritella bantamensis tjicumpaiensis, and Ringicula arctatoides.	bantamensis																			
						L3b L3a			Turritella (Turritella) - Ringicula bantamensis arctatoides																			
			10			L2 L1d		Calcareous fine sandstone (0,125 - 0,25mm), brown, rounded, moderately sorted, with Scapharca gedinganensis, Turritella bantamensis, common of Scapharca multiformis, Timoclea bataviana and	tjicumpaiensis Scapharca Timoclea multiformis bataviana Scapharca (Scapharca) gedinganensis		ſ	2																
			84	84	84	2 11 84	2 11 84			L1c		Calcareous fine sandstone (0,125 - 0,25mm), dark grey, rounded, moderately sorted, with Olivella tomlini, common of Polinices aurantius, Marginella ventricosa senciranensis Turitella bentamensis aundant of	Polinices aurantius Turritella Scapharca		Į													
								2 11			L1b — L1a —		Scapharca gedinganensis, Ringicula arctatoides and fragmens of other mollusk.	(Turritella) - (Scapharca) bantamensis gedinganensis Ringicula arctatoides														
			-	-	-				11 1		L5			Coquina calcareous fine sandstone (0,125 - 0,25mm), grey, rounded, poorly sorted, with Turritella bantamensis tjicumpaiensis, Architectonica sp., common of Ringicula arctatoides and Olivella tomlini.	? Ringicula Olivella arctatoides tomlini Olivella tomlini													
			23 6 24 12	CKY 1	L3	L	KY 2 *	Calcareous fine sandstone (0,125 - 0,25mm), dark grey, rounded, moderately sorted, with Architectonica sp., Hinia sinusigera, and common of Olivella tomlini.	Marginella Ringicula - (Cryptospira) arctatoides ventricosa sangiranensis																			
				23 6		Carareous very rine clay sandstone (0,0625 - 0,125mm), blackish grey, rounded, moderately sorted, common of Marginella ventricosa sangiranensis and Ringicula arctatoides. non-calcareous claystone (< 0,004 mm), greenish	Ringicula - Olivella arctatoides tomlini			Ì																		
																								grey, no mollusk. Calcareous fine sandstone (0,125 - 0,25mm), dark grey, rounded, moderately sorted, with <i>Turritella</i> <i>djadjariensis</i> , <i>Marginella ventricosa sangiranensis</i> , common of <i>Ringicula arctatoides</i> and <i>Olivella tomlini</i> and also fragmens of other mollusk.				

Figure 8. Composite stratigraphic coloumn and local sea levelchanges in research area (getting to the right \rightarrow deeper).



Fig. 9. The Examples of macro-mollusk fossils in this study (Gastropods, a: Ventral view, b:Dorsal view; Bivalvia, a:Internal view, b:Eksternal view, c: Dorsal view).



Fig. 10. The Examples of micro-mollusk fossils in research area (a: Ventral view, b: Dorsal view

In summary, the whole mollusk fossil association assemblages above are interpreted as sea level rise. Similar results also stated in several previous research: Martodjojo (2003) explained Banten in Pliocene, remains in the south where the environment is transitional environment (Cimanceuri Formation). The Bogor Basin environment in Pliocene is divided into two parts. Most of The Bogor Basin environment is terrestrial occupied by volcanic arc but Southern Mountains Region has subsidence and transgression, according to Zhong et al (2004) the history of eustatic sea level change since the Pliocene began with a rapid rise from 5.33 to 5.1 Ma. The sea level at highstand between 5.1 and 3.7 Ma, Roza et al (2015) reported fluctuations began to occur during the Middle Pliocene where sea level tended to increase (transgression) and fell back to the Late Pliocene, and Morley et al (2016) stated that major transgression occurred across the Sunda Shelf at the beginning of the Pliocene.

4. Conclusion

There are seven depositional environmental changes that occur in this study with two shallowing deepening cycles. Depositional environmental changes (bottom-top) consist of: 1) open shallow marine, 2) subtidal - open shallow marine, 3) open shallow marine, 4) open shallow marine - subtidal, 5) subtidal, 6) subtidal - open shallow marine, and 7) open shallow marine. This result similar to several previous research that stated in Pliocene sea level tended to rise. In this area 17 mollusk fossils associations were obtained, namely 1) Ringicula arctatoides - Olivella tomlini. 2) Ringicula arctatoides - Marginella (Cryptospira) ventricosa sangiranensis. 3) Olivella tomlini, 4) Ringicula arctatoides - Olivella tomlini, 5) *Ringicula arctatoides*, 6) *Turritella (Turritella)* bantamensis - Scapharca (Scapharca) gedinganensis, 7) Polinices aurantius - Marginella (Cryptospira) ventricosa sangiranensis, 8) Scapharca (Scapharca) gedinganensis, 9) Scapharca (Scapharca) multiformis -

Turritella (Turritella) Timoclea bataviana, 10) bantamensis tjicumpaiensis - Ringicula arctatoides, 11) Turritella (Turritella) bantamensis – Ringicula arctatoides, 12) Turritella (Turritella) bantamensis tjicumpaiensis - Turritella (Turritella) bantamensis , 13) Turritella (Turritella) bantamensis tiicumpaiensis -Ringicula arctatoides, 14) Turritella (Turritella) bantamensis - Architectonica sp., 15) Turritella (Turritella) bantamensis tjicumpaiensis, 16) Turritella (Turritella) bantamensis – Turritella (Turritella) bantamensis tjicumpaiensis, and 17) Turritella (Turritella) bantamensis. The most stable ecosystem condition is the association of Turritella (Turritella) bantamensis tjicumpaiensis - Turritella (Turritella) bantamensis (Association 15/CKY L5a) with the value of diversity index is 3,182.

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References

- Abbott, R.T. & Dance, S.P. 1986. Compendium of Seashells. Melbourne: American Malacologists Inc.
- Aswan, Ozawa, T., 2006. Milankovitch 41000-year cycles in lithofacies and molluscan content in the tropical Middle Miocene Nyalindung Formation, Jawa, Indonesia. Palaeogeogr. Palaeoclimatol. Palaeoecol. 235, 382–405. https://doi.org/10.1016/j.palaeo.2005.11.004
- Aswan, Sufiati, E., Rudyawan A., Kistiani D., and Thaw Zin Oo. 2018. Depositional environmental evolution of Kalibiuk formation based on paleontological molluscan Study, Cisaat River section, Bumiayu, Central Java, Indonesia. IOP Conf. Series: Earth and Environmental Science 162 (2018) 012033. DOI:10.1088/1755-1315/162/1/012033

- Bakus, G.J., 2007. Quantitative Analysis of Marine Biological Communities: Field Biology and Environment. John Wiley & Sons, Inc., Hoboken, NJ, USA. https://doi.org/10.1002/0470099186.
- Fan, D. 2012. Open-Coast Tidal Flats. Principles of Tidal Sedimentology, 187–229. Springer Science & Business Media
- Jurnaliah, L. 2011. Diversitas Foraminifera Bentonik Kecil di Daerah Perairan Semarang (Lembar 1409) Jawa Tengah (Diversity Small Benthonic Foraminifera in Semarang Sea). Bulletin of Scientific Contribution, vol.9, Desember 2011: 121-124
- Leloux, J. and Wesselingh, F. P. 2009. Types of Cenozoic Mollusca from Java in the Martin Collection of Naturalis. NNM Technical Bulletin, 11: 1-765, Leiden.
- Martin, K. 1879-1880. Die Tertia Rschicten auf Java. Nach den Entdeckungen von F. Junghuhn. Paleontologischer Geologische-Reichsmuseum, Theil Leiden ix+164+51+6.
- Martodjojo, S. 2003. Evolusi Cekungan Bogor Jawa Barat. Penerbit ITB Bandung.
- Morley, R. J., Morley, H. P. and Swiecicki, T. 2016. Mio-Pliocene Palaeogeography, Uplands and River Systems of The Sunda Region Based on Mapping Within a Framework of Vim Depositional Cycles. Proceedings, Indonesian Petroleum Association Fortieth Annual Convention & Exhibition.
- Okutani, T., 2000. Marine Mollusks in Japan. Tokyo: Tokai University Press.
- Oostingh, C. H. 1938. Mollusken Als Gidsfossielen Voor Het Neogeen in Nederlandsh Indie (Surabaya: Handelingen Van Het Achtste Nederlandsch - Indisch Natuur Wetenschappelijk Congres).
- Prasetyo U., Aswan, Zaim, Y. & Rizal, Y., 2012, Perubahan Lingkungan Pengendapan pada Beberapa Daerah di Pulau Jawa Selama Plio-Plistosen Berdasarkan Kajian Paleontologi Moluska. (Depositional Environmental Changes in Java during Plio-Pleistocene based on Paleontological Mollusk). Jurnal Teknologi Mineral (JTM), XIX, 173-180, Bandung.
- Roza, S. E. V, Abdurrokhim. 2015. Penentuan Perubahan Ketinggian Air Laut Berdasarkan Analisis Foraminifera Bentonik. Seminar Nasional ke-II Fakultas Teknik Geologi Universitas Padjadjaran
- Shuto, T., 1975. Preliminary correlation of the Neogene molluscan faunas in Southeast Asia. Contributions to the geology and palaeontology of Southeast Asia, CLV. Geology and Palaeontology of Southeast Asia, 161-173.
- Sufiati, E., Prasetyo, U., Kistiani, D., Aripin, dan Irman. 2014. Penelitian Fosil Moluska Di Kecamatan Bayah, Kabupaten Lebak, Propinsi Banten. Laporan Kegiatan Lapangan Museum Geologi Bandung, unpublished.
- Sujatmiko & Santosa S. 1992. Peta Geologi Lembar Leuwidamar, Jawa (Geological Map of Leuwidamar Quadrangle, Java). Bandung: Pusat Penelitian dan Pengembangan Geologi.
- Zhong, G., Geng, J., Wong, H. K., Ma, Z., and Wu, N. 2004. A semi-quantitative method for the reconstruction of eustatic sea level history from seismic profiles and its application to the southern South China Sea. Earth and Planetary Science Letters 223 (2004) 443- 459. doi:10.1016/j.epsl.2004.04.039



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