Granulometric Models of *Zaria bantamensis* Beds at Bojong and Bayah Area, in Banten Province

Hita Pandita
Department of Geology, Institut Teknologi Nasional Yogyakarta
Jalan Babarsari No.1 Depok, Sleman, D.I.Yogyakarta, Indonesia
hita@sttnas.ac.id

Abstrak

Penelitian tentang fosil moluska di Indonesia sudah sering dilakukan. Sejauh ini penelitian lebih tertuju pada penamaan-penamaan spesies baru. Masih sedikit penelitian yang mengarah pada hubungan keterdapatan fosil moluska dengan lingkungannya. Kajian kali ini ditujukan untuk mengetahui hubungan kemunculan fosil moluska dari genus Zaria dengan mekanisme sedimentasi yang terjadi. Yang diharapkan dapat memberikan gambaran atau model lingkungan dari Zaria. Metode yang digunakan berupa penyelidikan lapangan, penyelidikan laboratorium dan identifikasi karakter morfologi Zaria. Penyelidikan dilakukan terhadap dua lokasi penemuan fosil Zaria bantamensis di daerah Bayah dan Bojong. Hasil penelitian menunjukkan bahwa Zaria bantamensis muncul pada batuan yang berkarakter sortasi jelek, dengan ukuran butir pasir sedang sampai halus. Berdasarkan kurva Visher menujukkan mekanisme sedimentasi didominasi mekanisme saltasi dari sampel Bojong dan suspensi pada sampel Bayah. Hasil penelitian juga menunjukkan ada kemungkinan hubungan antara panjang cangkang dengan kondisi mekanisme sedimentasi.

***Kata kunci** : Zaria, granulometeri, biometri, environment, sedimentasi*

Abstract

Several research on mollusk fossils have beendone in Indonesia. So far research was focused in the identification of species. Although thestudy ofrelationshipsbetween mollusks fossilsand their environment is important, only a few studies have been carried out it in Indonesia. The present study is aimed to reveal the relationships of genus Zaria appearance and sedimentation mechanism and expected to provide an overview of environmental model of Zaria. The methods used are field surveys, laboratory analysis and identification of morphological character of Zaria. Field surveys were conducted in two sites of discovery of Zaria bantamensis fossil in Bayah and Bojong areas. Laboratory work composes of granulometricand statistical analysis of biometric Zaria.The results showed that Zaria bantamensis appeareancewas associated with the rocks of poor sorting characteristics, with medium to fine sand grain sizes. Based on Visher curve the sedimentation mechanism of Bojong samples was dominated by saltation and in Bayah samples was thesuspensions. The results also indicate a possible relationship between shell length and sedimentation mechanism conditions.

***Keywords** : Zaria, granulometeri, biometri, environment, sedimentasi.*

1. Introduction

The appearance in the rock of *Zaria* which is one of the genus of Turritellidae is very interesting to study. *Turritella* has been intensively studied particularly about the relationship of its appearance with the sedimentary environment. It does not rule out that Zaria also has the same character.

The studies of the relationship between Turritella and their environment have been done by some palentologists. Allmon and Knight [1] studied the relationship of Turritella assemblage with carbonate deposition. Pandita et al. [8] tried to study the relationship between biometric of Turritella in rekation with geological aspects. An interesting discussion was also on the relationship of Turritella assemblage with paleoecology and paleoenvironment [2]. The study of the relationship between mollusk fossil and the model of ancient current deposition will be interested.

Understanding of the depositional current model can be approximated by granulometry method [4]. The study of granulometry was developed by several researchers. Visher [14] studied the pattern of granulometry in sedimentation in several rivers in America. The results show different characters in each environment. The relationship between granulometry and the settling environment was also studied by several other researchers [10] [9].

Received March 13, 2019; Revised May 14, 2019; Accepted May 24, 2019

Zaria bantamensis found in two location types in Bayah and Bojong have different length size [8]. *Z. bantamensis* from Bojong area is found to be longer than that of Bayah. Therefore it is interesting to know the relationship between sedimentation process and the size of the shell of *Z. bantamensis*.

2. Objectives

The purpose of this study is to analyze the granulometryof *Zaria bantamensis* fossil at two sites of discovery in Banten. The ultimate goal is to know the relationship between the grain size of sediment and the presence of *Zaria* fossils. The study also attempted to find out the extent of grain size effect of sediment to the size of the shell.

3. Methods

Methods of research conducted include field investigation and laboratory analysis. Field investigations were done in two locations, namely Bayah (BYH) and Bojong (BOJ) areas. Both locations are located in the province of Banten (Fig. 1) Laboratory investigations were performed in granulometric test and paleontological identification.

The granulometry test uses a standard sized sieve tool with filter numbers 20, 40, 60, 100, 200 and Pan. While the number of samples tested are each weighing 200 gr. This sieve method is in accordance with that proposed by Ingram [5] and has been widely used in previous studies [4]. For grain sizes that pass mesh 200 are tested again with the suspension method.

Observations and identification of *Zaria bantamensis* fossils were also performed, including morphological and biometric aspects. The identification parameters uses the references of Pandita, et al. [8] and Merriam [6].

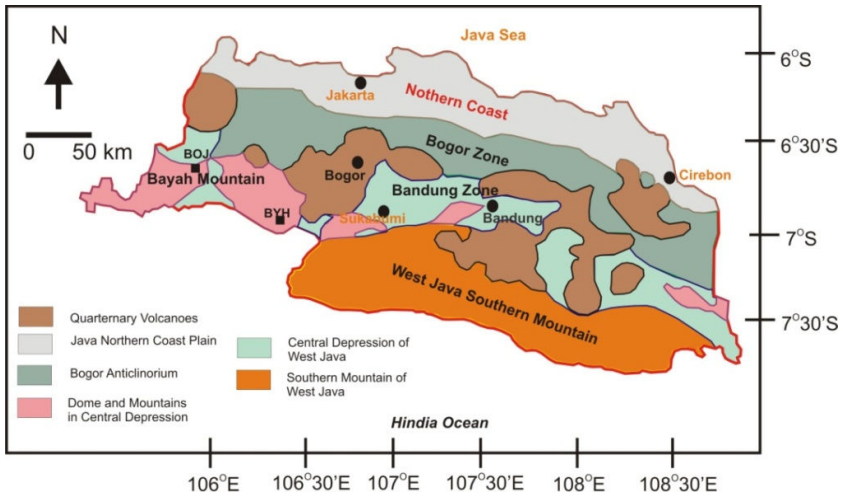

Figure 1. West Java physiography (redrawn from van Bemmellen, 1949) and the study area at Bojong (BOJ) and Bayah (BYH).

4. General Geology

4.1 Bayah (BYH) and Lithology

Bayah location is located in the area of Cimancak, Bayah District, and in the west of the district city of Bayah,with the coordinatesof 06O54'09.2"S and 106O14'48.5"E. The site is located in the cliffs of Cimadur River that flows to the east. There are two sampling sites, namely BYH01 and BYH01B.

The study area belongs to the West Java Depression Zone at Bayah Mountain Sub-zone [13], and at the southern part of Bayah Mountains. The bed of the rock dips to the southeast. This sub zone is controlled by north-south trending fault patterns, and the west-east-trending folding axis.

The lithology in the site location consists of calcareous limestone with calcite nodule at bottom part, and sandy shale with mollusk fossils in the middle. The mollusk fossil are *Zaria* and *Arca*. Few planktonik foraminifera are also found at the middle part (BYH01).

The thickness of the outcrop at this location is approximately 5.5 m. Oostingh [7] suggested this outcrop is included in the Sondian stage of upper Pliocene and is referred to as Tjimanceuri layers. Name of Cimanceuri Formation has been used in these rock units by Baumann, et al. [3], and placed this formation into the Upper Miocene - Pliocene. Sudjatmiko and Santosa [12] separated the existing rock units into two formations, namely the Bojongmanik Formation and Cimanceuri Formation, where Bojongmanik Formation occupies the upper Miocene - Lower Pliocene, whilst Cimanceuri Formation of Middle Pliocene. Unfortunately, the characteristics of both rock formations are difficult to distinguish in the field, because the relatively similar rock variations of carbonate and limestones (Figure 2).

The lithology in this area consists of calcareous sandstone at the bottom part with calcite nodules. Then above of it sandstones containing molluscs fossil (BYH01) *Zaria* and *Arca* are encountered The BYH01 layer also contains a few planktonic foraminifera. Then above BYH01 coquina layer with a thickness of 20 cm is found. At the top carbonate sandstone with laminate structure of small grain size of silt to silt is found (Figure 2).

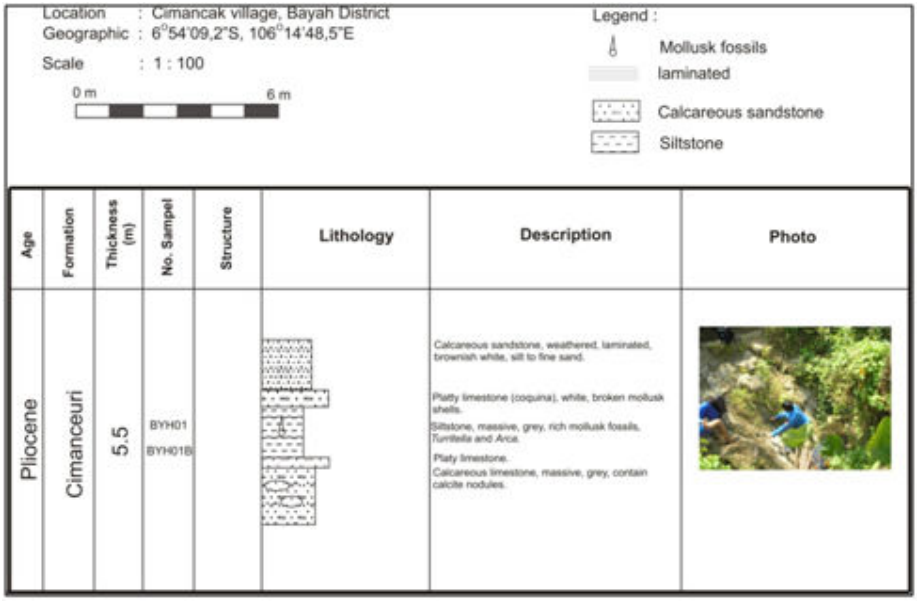

Figure 2. Outcrop profile of Bayah site

4.2 Bojong (BOJ) and Lithology

Bojong location is located in the Kadupandak Village, Bojong District, in the southwest of the city of Bojong District. Geographically it locates at 06O29'09 "S and 106O58'04.1" E. The position of the location is at the base and the east bank of Cilemer River.The study area belongs to the border of Bayah Sub Zone of the Central Depression Zone of West Java [13]. The slope of the rock layer at the site is less than 5O to the south.

The thickness of the outcrop is about 4 m, some are below of river. Oostingh [7] suggested that the outcrop was included to the Bantamian stage as Bojong Layer. The Bantamian stage is estimated to be of Pleistocene age. The Bojong Formation was then used for the rock units at this location, and placed its age as Pleistocene based on the foraminifera content [11]. The bottom part of the outcrop consists of calcareous claystone. The overlying calcareous claystone consists of laminated calcareous sandstone. The upper part of the outcrop at this location consists of calcarenite containing mollusk fossil (Figure 3).

The formation of calcareous claystone and calcareous sandstone at the bottom also exhibit the laminated structure indicating the presence of traction currents at the sedimentation process.

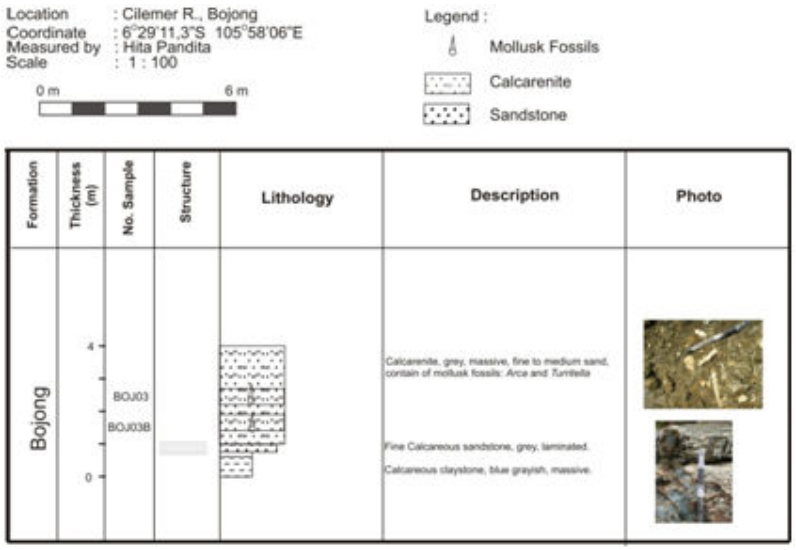

Figure 3. Outcrop profile of Bojong site

5. Analysis

5.1 Cumulative Diagram

Four samples were taken from the field on a layer containing *Zariabantamensis* fossils. Two samples come from Bojong with BOJ03 and BOJ03B codes. The others were taken from Bayah, namely BYH01 and BYH01B. The sieving and weighing show the result of cumulative percent value of each grain size (Table 1) which then included in the cumulative diagram (Figure 4). Based on he cumulative diagram, thegrain size precentil value of the four samples would be known (Table 2). The value of precentil could be determined by using the statistical analysis.

Table 1. Cumulative weight percent from Bojong and Bayah

Sample	% Weight Grain Size								
	0.25	1.23	2	2.75	3.75	4.75	5.57	6.72	6.84
BOJ03B	0.3	13.9	42.5	56.8	82.0	97.8	99.8	0.0	0.0
BOJ03	0.4	18.3	49.3	60.5	83.0	92.5	97.4	99.8	99.8
BYH01	0.2	5.9	25.5	35.9	82.2	96.0	98.9	99.9	99.9
BYH01B	2.3	8.8	31.6	53.1	87.0	95.9	98.9	98.9	0.0

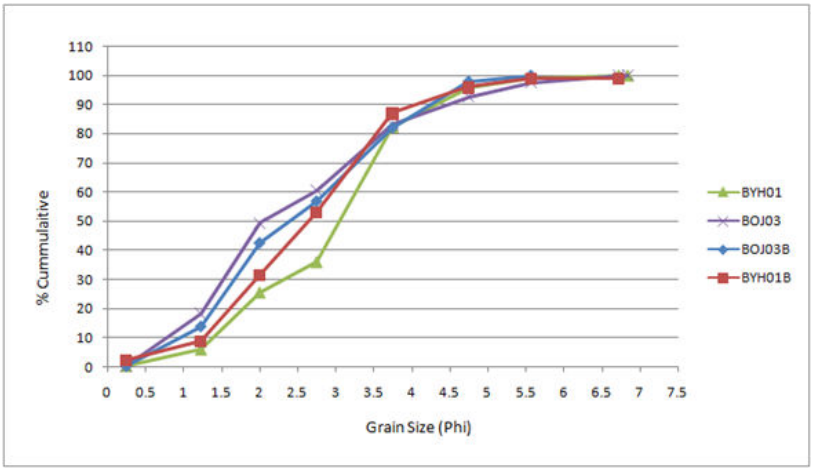

Figure 4. Cumulative curves showing trend of all the samples.

5.2 Statistical Analysis

Statistical analysis of granulometry is necessary to determine the values of grain size distributions. In this statistical analysis the searched values are: median, mean, standard deviation, skewness, and kurtosis. In the statistical analysis the formula of Boggs [4] is used. The formula is as follows:

$$M_z = \frac{\phi_{16} + \phi_{50} + \phi_{84}}{3} \quad \text{Mean} \quad (1)$$

$$\sigma = \frac{\phi_{84} - \phi_{16}}{4} + \frac{\phi_{95} - \phi_5}{6.6} \quad \text{Standard Deviation} \quad (2)$$

$$SK = \frac{\phi_{84} + \phi_{16} - 2\phi_{50}}{2(\phi_{84} - \phi_{16})} + \frac{\phi_{16} + \phi_{50} + \phi_{84}}{2(\phi_{95} - \phi_5)} \quad \text{Skewness} \quad (3)$$

$$K = \frac{(\phi_{95} - \phi_5)}{2{,}44(\phi_{75} - \phi_{25})} \quad \text{Kurtosis} \quad (4)$$

Table 2. Graphic measures from the grain size analysis of the sediment samples from Bayah and Bojong

Sample	Statistical Parameters											
	ϕ 95	ϕ 84	ϕ 75	ϕ 50	ϕ 25	ϕ 16	ϕ 5	Median	Mean	SD	SK	Kurtosis
BYH01B	4.75	3.7	3.4	2.7	1.78	1.35	0.6	2.70	2.583	1.216	(0.0805)	1.0499
BYH01	5	3.95	3.6	3.05	1.98	1.6	1.2	3.05	2.867	1.163	(0.1039)	0.9613
BOJ03	5.2	3.95	3.3	2	1.4	1.15	0.5	2.00	2.367	1.412	0.3773	1.0138
BOJ03B	5.15	3.55	3.05	1.78	1.2	0.78	0.37	1.78	2.037	1.417	0.3440	1.0589

The median value is the middle value of the grain size distribution of each sample. The results of the analysis show that from the four samples, the samples from Bojong (BOJ03 and BOJ03B) have the median values between 1 to 2 phi, while the samples from Bayah (BYH01 and BYH01B) above 2 phi. Based on the classification of grain size from Wentworth [4], the samples from Bojong show moderate sand medium values (Figure 5), while samples from Bayah attain median values of fine sand.

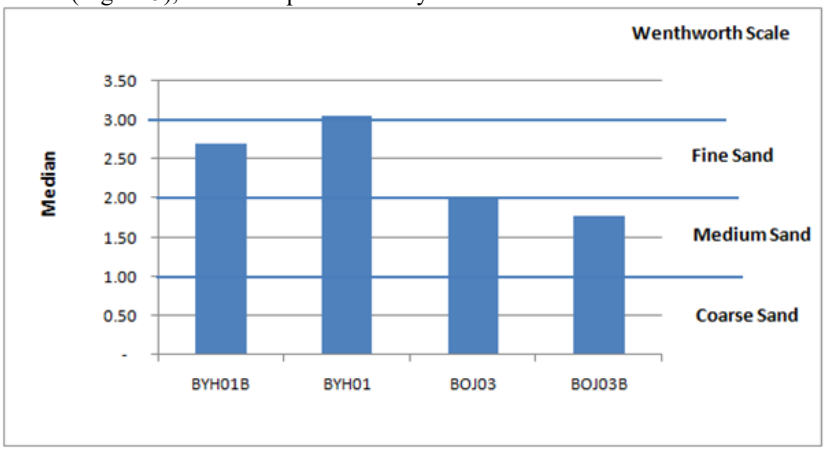

Figure 5. The median value of all four samples. Showing the median of Bayah is more fine than in Bojong

The mean value describes the average grain size of the grain size distribution of each sample. The analysis of the four samples shows only the sample of BOJ03B having the mean value being below the 2.0 phi value. The other three samples are above the 2.0 phi value. Based on the classification of grain

sizes from Wentworth [4], the samples from BOJ03B have mean value medium sand (Figure 6), while other samples have the size of fine sand.

The standard deviation value is strongly related to the sorting of rocks, ie uniformity of grain size. The results of the analyzes of all four show a standard deviation value above 1.0. Based on the sorting classification of Folk (1974 in Boggs [4]), the four samples belong to bad sorting values (Figure 7).

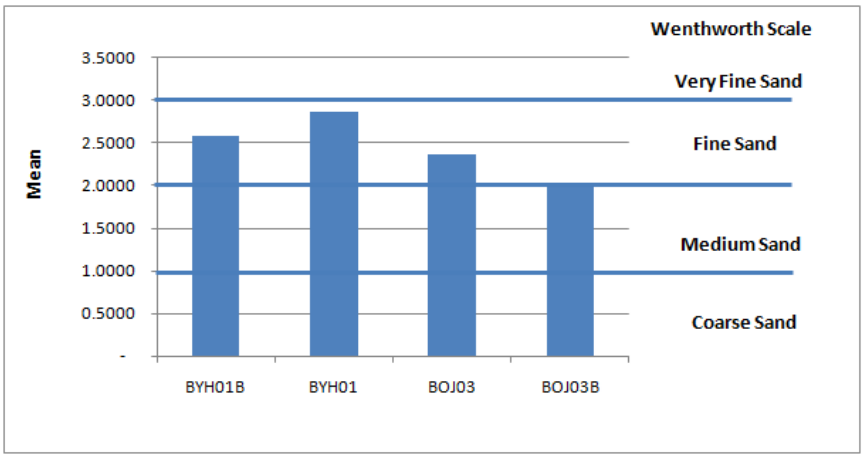

Figure 6. Mean value of grain size of all four samples

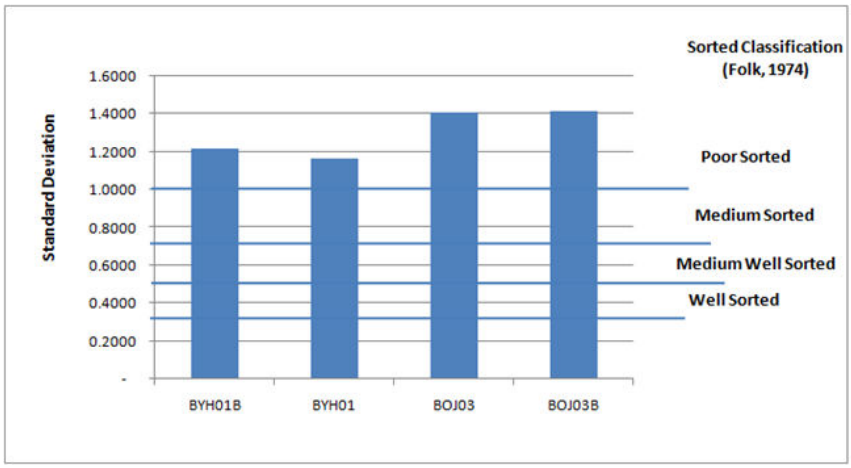

Figure7. Standard deviation from four samples, all samples are poor sorted

The skewness value is related to the tendency of the grain size distribution of rock or sediment. The analysis of the four samples showed that BYH01 and BYH01B had values between 0.1 and -0.1, while the samples from BOJ03 and BOJ03B were more than 0.3. Based on the skewness level classification of Folk (1974, in Boggs [4]), the samples from Bayah have symmetry values, while those from Bojong show very fine skewness (Figure 8).

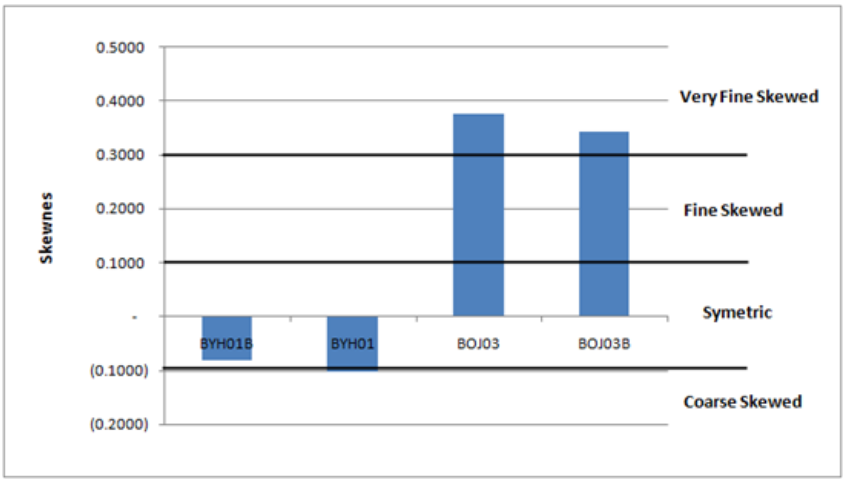

Figure 8. Skewness value from four samples, show BOJ samples are very fine and BYH symetrical skewness

5.3 Depositional Mechanism

The analysis of precipitation mechanisms is intended to identify the types of granular movement during the sedimentation process. The modeling approach uses is a model from Visher [14], namely the cumulative distribution included in the probability diagram.

The results of the analysis on all four samples showed the difference of grain size distribution between samples from Bayah and Bojong. Bojong samples of BOJ03 and BOJ03B show 50% granules of 0 to 2 phi, indicating traction currents contribution of 50% in the precipitation process (Figure 9). Based on the grain size relationship model with the settling environment of Visher [14], the possible deposition environment in Bojong is lower foreshore (Figure 9).

Different results are shown by samples from Bayah. The samples from Bayah BYH01 and BYH01B showed 20-30% granules of 0 to 2 phi, meaning the contribution of traction current in the settling process was 30% (Figure 10). Based on the grain size relationship model with the settling environment of Visher [14], the possible deposition environment in Bojong is lower foreshore.

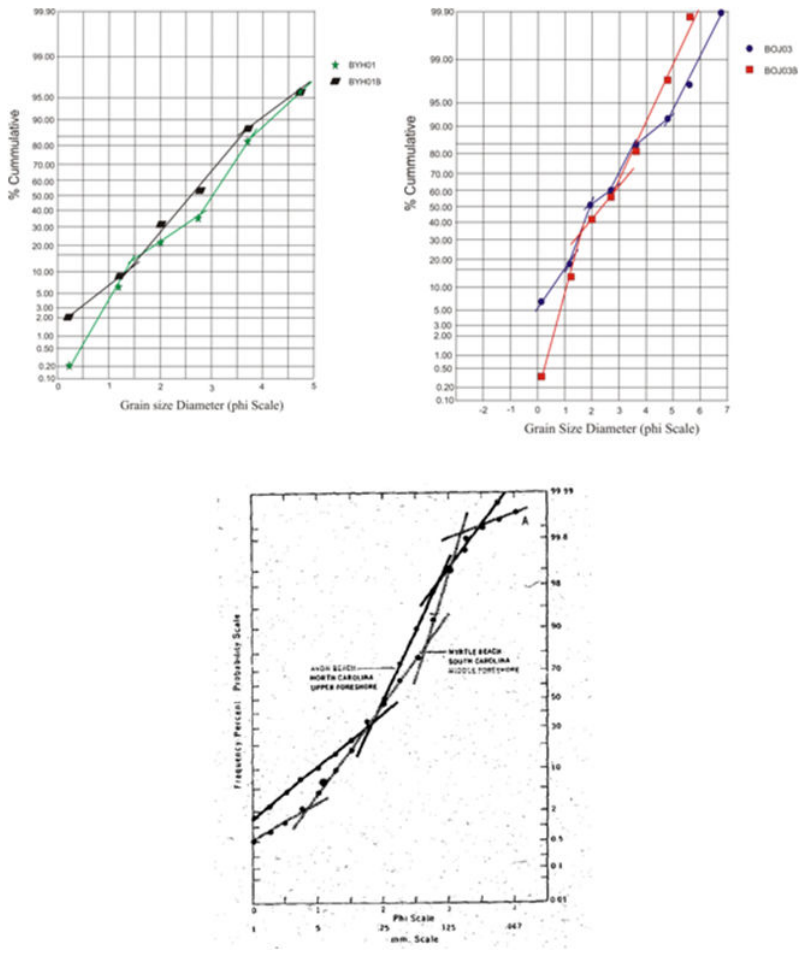

Figure 9. Lograrithmic graphic from four samples, comparation with Visher's graphic [5]

5.4 Biometric

Methods of biometric measurement on Zaria were proposed by Pandita, et al. [8] in the form of length (L), Wang, and Wsut. Wang is the maximum width of the room, while Wsut is the width at maximum on the boundary between rooms. Based on these methods there are differences in size between the population of Bayah (BYH) and Bojong (BOJ). The size comparison between the two populations can be seen in Table 3. Based on the biometric aspect, it shows that the population of Bojong is larger than Bayah (Figure 10).

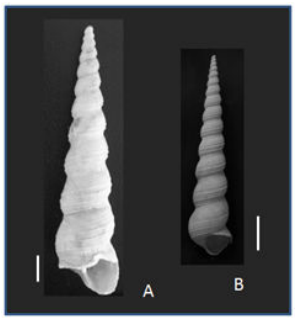

Figure 10. Comparation of *Zaria bantamensis* from BOJ03 (A) and BYH01 (B). Scale bar is 1 cm.

Table 3. Mean value of *Zaria bantamensis* biometric from Bojong and Bayah.

Samples	L	W_{ang}	W_{sut}
BYH01	71.8	18.15	13.2
BYH01B	45.45	12.58	9.39
BOJ03	99.43	22.69	16.94
BOJ03B	93.28	23.14	16.55

5.5 Discussion

In accordance with the purpose of this paper which is to examine the relationship between the sedimentation mechanism and the availability of Zaria bantamensis from both locations, the grain size identified from the mean and median values (Fig. 7 & 8), it shows that the sizesof Bojong sample are longer than Bayah (Table 3).

The relationship between the difference in the size of the shell by grain sorting also appears. In BOJ samples where sorting is worse than BYH (Figure 7) it shows larger shell size (Table 3). The same thing also can be seen in the skewness value showing the correlation of shell size with skewness value, where in Bojong samples it shows the asymmetry results contains larger shell size.

6. Conclusion

Based on the results of the analysis and discussion there are several conclusions. The first conclusion is that Bojong's location has a slightly more sedimentary energy compared to Bayah. The second conclusion may be that sedimentation energy affects the size of the Zaria shell, where the stronger the deposition energy would produce the larger shells. To confirm the effect of sedimentation energy on the size of the shell, further studies are needed.

7. Acknowledgement

This research was conducted by collaboration between National Museum of Nature and Science (NMNS), Tokyo Japan and Sekolah Tinggi Teknologi Nasional (STTNas), Yogyakarta, Indonesia. The field was funded by NMNS for 2012 while the granulometric analysis was funded by STTNas fiscal year 2014.

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