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By Hita Pandita

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Relationship of Biometrical Aspect of Turritellidae with Geochronological Aspect in West Java

Hita Pandita[1], Yahdi Zaim[2], Aswan[2], Yan Rizal[2]
[1]Department of Geology, Institute of Technology Bandung, Sekolah Tinggi Teknologi Nasional, Yogyakarta, Indonesia
[2]Department of Geology, Institute of Technology, Bandung, Indonesia
Email: hita@indo.net.id

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ABSTRACT

Mollusk paleontology research in Indonesia so far has not been widely utilized in various kinds of applications, especially in the geology. Although mollusk in Java is very rich, the study of correlation between mollusk appearances with geological condition is rare. This study aimed to determine Turritellidae base on morphological observations (qualitative) and quantitative (biometric method). The ultimate goal is to find out the relationship between of biometrical aspect of Turritellidae with geological development especially of chronological conditions. Stratigraphic analysis and sampling have done at five location of field survey. Site selection was based on the type locality of mollusk biostratigraphic unit arrange by Martin (1919) [1] and Oostingh (1938) [2]. The scattered analysis shows two large distribution of consistent groups based on shell size and geochronological aspect. Biometrical aspect of Turritellidae is reflection of the chronological aspect in West Java. Small size was appearance in Upper Miocene to Lower Pliocene and large shell in Pliocene to Pleistocene.

Keywords: Biometry; Turritellidae; West Java; Mollusk; Paleontology

1. Introduction

Paleontology research on mollusk has not really been well developed in Indonesia so far. Mollusc paleontology research have been initiated by Jenkins (1863) [3] and continued by Martin (1919) [1], Oostingh (1938) [2], and other that deal with taxonomy and biostratigraphy. Martin (1919) [1] and Oostingh (1938) [2] introduced molluscan biostratigraphy in Java based on assemblages and index fossil of mollusc. The research then continued by several researchers such as Pozzobon (1997) [4], Aswan (1997) [5], Shuto (1974) [6], Kase *et al.* (2008) [7], and others. However most of studies focused on aspects of taxonomy and less at the application of geology. Occurrences of mollusc fossils have not been optimally utilized in various of geological applications.

Therefore, an assessment of the usefulness of fossil mollusks in various aspects of geology needs to done. One aspect is important to know the relationship of shell growth Turritellidae with the geological aspects.

The aim of this study is to determine the Turritellidae approached by qualitative and quantitative methods and the ultimate goal is to find out the relationship of the occurrence of Turritellidae with geological development especially of chronological in the study area.

2. Location and Method

The study areas are located at five locations in West Java area (**Figure 1**). There are Cilanang Rivers (Mt. Halu), Cisanggarong Rivers (Menengten/Waled Village), Pasir Ipis (Cirebon), Cijarian River (Pelabuhan Ratu) and Leuwimeteng (Bojong). The selection of these areas is based on the type locality of biostratigraphic unit as compiled by Martin (1919) [1] and Oostingh (1938) [2].

During field investigations conducted rock sampling, stratigraphic profiling, and fossils sampling. Some rocks and 49 Turritellidae had been collected for five locations. Five stratigraphic profiling from five sites has been done during field study.

Laboratory analysis devided into molusks fossils identify and age determine. Mollusc identify done by morphological observation and biometrical measurement of mollusc shell. Age determine based on micropaleontology data and regional stratigraphy.

3. Stratigraphy

The five sites of study area are representative of some of

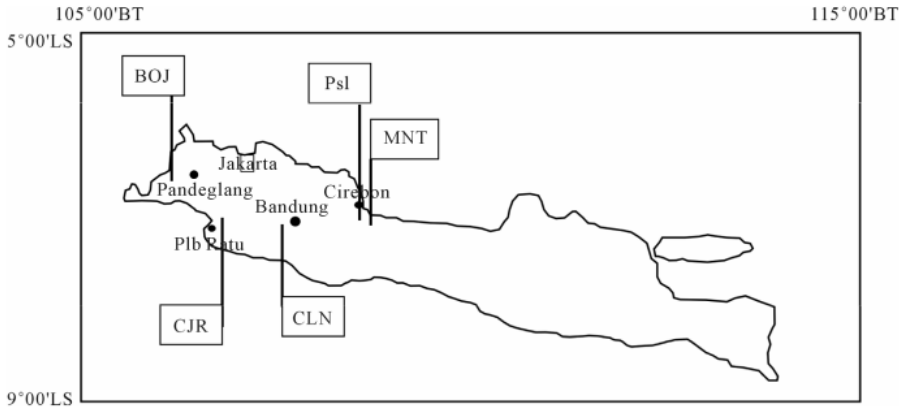

Figure 1. Sampling sites of fossil molluscs family of Turritellidae in West Java. Description of location, CLN: Cilanang; MNT: Menengten; PsI: Pasir Ipis; CJR: Cijarian; BOJ: Bojong.

the biostratigraphic units compiled by Martin (1919) [1] and Oostingh (1938) [2]. Cijarian site for the Tjiodeng stages, Cilanang site for the Tjilanang stages, Menengten and Pasir Ipis sites for Kaliwangu formation, and Bojong for the Bantamian stage (**Table 1**).

According to regional stratigraphic two location are representatif age in Upper Miocene-Lower Pliocene there are CLN01 and CJR02B. Three location are represent atif age in Pliocene-Pleistocene there are MNT13, PsI, and BOJ03.

4. Fossil Identification

Taxonomical characters of Turritellidae have been developed by several authors. Merriam (1941) [9] proposed three main parameters for identification: 1) the outer lip trace, 2) the ontogeny of primary spiral and 3) protoconch. These parameters have been accepted by some authors such as Marwick (1957) [10] and Kotaka (1959) [11] with some detail improvements. Shuto (1969) [12] has accepted also, but he added other parameters with respect to biometry.

In Turritellidae the morphological observation comprises of the number of spiral ribs, sculpture, protoconch shape and teleconch. Biometric measurement including of the number of whorls, shell length (L), maximum width of the last whorl (W_{ang}), wide sutures in the last whorl (W_{sut}), and the apex angle (α) (**Figure 2**). Additionally, in some taxa has been also measured the width of the whorl that changes the shape of the first whorl (W_n). Fifty specimens have been taken from the study area as shown in **Tables 2** to **6**. The selection of five species was based on their morphological resemblance of monocarinate. These specimens are representing five species: *Turritella* sp (MNT13), *T. bantamensis* (BOJ 3), *T. simplex* (CLN01A), *T. djadjariensis* (PsI), and *T. javana* (CJR02).

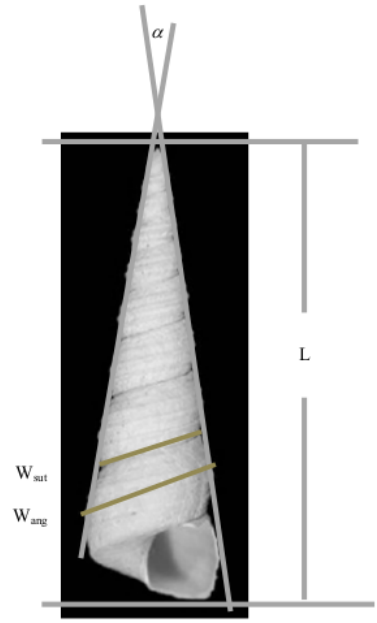

Figure 2. Parameter measured in Turritellidae shell.

5. Analysis

Biometric data of Turritellidae have been analyzed with statistical method. The analysis is carried out on four parameters: 1) the ratio of shell length with whorl number, 2) the ratio of W_{ang} with W_{sut}, 3) the ratio of shell length (L) with W_{ang}, and 4) the ratio of shell length with W_{sut}. Fixation these parameter is based on assumption that organism will always have the consistency of growth, when one parameter was going up it should be follow by the other ones. The ratio of shell length with whorl number has been proposed by Aswan (1997) [5], but the other

Table 1. Regional stratigraphy of mollusk sample sites in West Java (compilation from Martodjojo, 2003 [8], Oostingh, 1938 [2] and Martin 1919 [1]).

Periode			Mollusk Biostratigraphy		West Java		
			Martin (1919)	Oostingh (1938)	Bandung	Bogor	Bayah
Quartenary	Pleistocene	Upper		Bantamian			Bojong Fm.
		Lower				Citalang Fm.	
Tertiary	Pliocene	Upper	Sondian	Sondian	Cimanceuri Fm		Cipacar Fm
		Lower	Bantam			Kaliwangu Fm.	
	Miocene	Upper	Tjiodeng	Cheribonian	Nyalindung Fm.	Cisubuh Fm.	Bojongmanik Fm.
			Tjilanang			Parigi Fm.	
		Middle	Rembangian	Preangerian	Saguling Fm.	Cibulakan Fm.	
			Nyalindung		Jampang Fm.		Cimapag Fm.
		Lower	West Progo	Rembangian	Rajamandala Fm.		
	Oligocene	Upper					Cikotok Fm.
		Middle					
		Lower			Bayah Fm.		Bayah Fm.
	Eocene		Nanggulan			Jatibarang Fm.	
	Paleocene				Ciletuh Fm.		

ratio are proposed in this study.

Based on shell length, Kotaka (1959) [11] devided shell into two group, there are small shell if measurement less than 60 mm, and large shell if more than 60 mm. Result of the measurement from samples could be devided into two group, there are small shell represented samples code CLN-01A and CJR02B and large shell represented samples code MNT13, PsI and BOJ03.

5.1. Ratio of Shell Length (L): Whorl Number

This ratio is based on the results of measuring the shell length and the total whorl number. Aswan (1997) [5] proposed this parameter and proved that added of shell lenght is correlated with added of whorl number. In some species will show a different pattern on linear regression.

The measurement of specimens shows that MNT13 and CJR02B have a wide distribution, while the other sample have a narrow distribution. Approach with a cluster analysis it can be grouped in two clusters. Cluster A represents the shell in long less than 60 cm, included in this group are CLN01A and CJR02B (**Figure 3**). Cluster B represents longer shells size are included in this group MNT13, Pasir Ipis and BOJ03.

5.2. Ratio of Shell Length (L): W_{ang}

This parameter is based on the ratio of the shell length with a maximum wide of last whorl. Although many paleontologists have measured the shell length and maximum wide of last whorl, they never used this ratio as parameter to identify. The assumption of this parameter

Table 2. The biometric measurements of *Turritella* sp. from Meningten area.

Code	MNT 13								
Species	*Turritella* sp.								
Location	Waled Village, Cisanggarong river (Meningten Valley)								
No. Spec	$L_{(mm)}$	W_{ang}	W_{sut}	W_{w9}	α (°)	Whorl Number	W_{ang}:L	W_{sut}:L	W_{sut}:W_{ang}
1B	68.80	25.00	15.85	13.00	12.50	12	0.3633721	0.2303779	0.634
2B	73.30	28.80	16.60	14.30	11.00	12	0.3929059	0.2264666	0.5763889
3B	63.85	20.45	15.00	12.90	12.50	12	0.3202819	0.2349256	0.7334963
4B	71.90	29.40	16.50	13.35	15.00	12	0.4089013	0.2294854	0.5612245
5B	72.60	28.55	16.45	12.95	14.00	12	0.3932507	0.226584	0.5761821
6B	90.90	26.75	18.30	14.75	11.00	13	0.2942794	0.201320	0.6841121
1Y	95.70	28.30	22.50	14.00	15.00	13	0.2957158	0.235110	0.795053
2Y	85.30	32.50	19.10	15.50	13.00	13	0.3810082	0.2239156	0.5876923
3Y	97.20	30.30	20.10	16.10	13.50	12	0.3117284	0.2067901	0.6633663
4Y	64.70	22.60	15.40			10	0.3493045	0.2380216	0.6814159
5Y	89.00	27.40	18.30	12.50	12.50	14	0.3078652	0.205618	0.6678832
6Y	63.90	22.80	16.20	13.40	15.00	12	0.3568075	0.2535211	0.7105263
7Y	82.40	26.45	18.50	13.20	13.00	13	0.3209951	0.2245146	0.6994329
8Y	77.00	31.50	18.30	14.10	14.00	13	0.4090909	0.2376623	0.5809524

Table 3. The biometric measurements of *Turritella bantamensis* from Bojong area.

Code	BOJ3								
Species	*Zaria bantamensis*								
Location	Mekarjaya Village								
No. Spec	$L_{(mm)}$	W_{ang}	W_{sut}	W_{w7}	α (°)	Whorl Number	W_{ang}:L	W_{sut}:L	W_{sut}:W_{ang}
BOJ3-1B	94.60	20.50	16.00	7.75	10.00	13.00	0.216702	0.169133	0.780488
BOJ3-2B	95.00	22.30	16.95	7.00	13.00	13.00	0.234737	0.178421	0.760090
BOJ3-3B	105.00	23.40	18.00	11.90	13.00	13.50	0.222857	0.171429	0.769231
BOJ3-4B	105.80	24.95	18.25	11.35	10.00	13.50	0.235822	0.172495	0.731463
BOJ3-5B	111.20	24.00	17.70	9.40	10.00	14.00	0.215827	0.159173	0.737500
BOJ3-1Y	111.20	25.40	18.50	8.00	8.00	14.00	0.228417	0.166367	0.728346
BOj3-2Y	79.10	20.90	15.35	10.00	8.50	11.00	0.264223	0.194058	0.734450
BOJ3-3Y	114.00	26.50	18.90	10.00	9.00	12.50	0.232456	0.165789	0.713208
BOJ3-4Y	81.30	21.10	14.90	8.40	9.50	12.25	0.259533	0.183272	0.706161
BOJ3-5Y	80.80	21.80	15.10	8.90	11.00	12.00	0.269802	0.186881	0.692661
BOJ3-6B	85.00	21.00	14.75	8.35	10.00	12.00	0.247059	0.173529	0.702381

Table 4. The biometric measurements of *Turritella simplex* taken from CLN01-A.

Code	CLN01-A								
Species	*Turritella simplex*								
Location	S. Cilanang, Gn, Halu, Bandung								
No. Spec	$L_{(mm)}$	W_{ang}	W_{sut}	W_{w5}	α (°)	Whorl Number	W_{ang}:L	W_{sut}:L	W_{sut}:W_{ang}
01A/1B	40.40	15.00	10.95	5.90	21.00	9	0.371287	0.271040	0.730000
01A/2B	41.80	16.30	11.80	7.00	21.00	9	0.389952	0.282297	0.723926
01A/3B	30.55	14.95	10.30	6.50	21.00	8	0.489362	0.337152	0.688963
01A/1Y	50.25	14.40	11.20	5.50		12	0.286567	0.222886	0.777778
01A/2Y	38.50	16.00	10.50	7.60		8	0.415584	0.272727	0.656250
01A/3Y	53.80	17.60	12.00	7.00		11	0.327138	0.223048	0.681818
01A/4Y	27.70	13.40	9.70	9.20		8	0.483755	0.350181	0.723881
01A/5Y	37.80	13.70	11.00	6.70		10	0.362434	0.291005	0.802920
01A/6Y	37.40	15.75	11.30	7.10		10	0.421123	0.302139	0.717460

Table 5. The biometric measurements of *Turritella djadjariensis* taken from Pasir Ipis (PsI01).

Code	PsI01								
Species	*Turritella djadjariensis*								
Location	Pasir Ipis, Cirebon								
No. Spec	$L_{(mm)}$	W_{ang}	W_{sut}	W_{w8}	α (°)	Whorl Number	W_{ang}:L	W_{sut}:L	W_{sut}:W_{ang}
PI01/1Y	83.90	26.10	18.00	10.60		14	0.3110846	0.2145411	0.6896552
PI01/2Y	79.00	25.25	17.70	11.30		13	0.3196203	0.2240506	0.7009901
PI01/3Y	75.10	25.50	17.70	10.75		13	0.3395473	0.2356858	0.6941176
PI01/4Y	68.35	21.60	16.20	11.00		12	0.3160205	0.2370154	0.75
PI01/5Y	58.50	20.30	13.20	10.00		11	0.3470085	0.225641	0.6502463
PI01/6Y	64.80	21.00	15.10	10.00		12	0.3240741	0.233025	0.7190476
PI01/7Y	69.70	24.00	16.35	10.70		12	0.3443329	0.234577	0.68125
PI01/8Y	58.00	19.70	13.15	10.00		11	0.3396552	0.2267241	0.6675127

Table 6. The biometric measurements of *Turritella javana* taken from Cijarian (CJR02B).

Code	CJR02							
Species	*Turritella javana*							
Location	S. Cijarian, Pelabuhan Ratu							
No. Spec	$L_{(mm)}$	W_{ang}	W_{sut}	α (°)	Whorl Number	W_{ang}:L	W_{sut}:L	W_{sut}:W_{ang}
CJ02B-1B	59.60	15.75	11.40	11.00	11.00	0.264262	0.191275	0.723810
CJ02B-2B	56.85	12.60	9.20	12.00	12.00	0.221636	0.161829	0.730159
CJ02B-3B	40.75	11.90	8.75	11.50	10.00	0.292025	0.214724	0.735294
CJ02B-4B	39.65	10.75	7.55	12.50	10.00	0.271122	0.190416	0.702326
Cj02B-6B	52.30	12.30	8.85	11.00	12.00	0.235182	0.169216	0.719512
CJ02B-7B	56.60	14.60	10.55	11.50	9.00	0.257951	0.186396	0.722603
CJ02B-8B	44.80	12.50	8.60	10.00	10.00	0.279018	0.191964	0.688000

is based on the hypothesis that each additional the shell length will be followed by large changes in the last whorl. If this occurs, then each species may show a different pattern.

The results showed that MNT13 samples have a wide distribution, and the other samples showed a narrow distribution. Each species is forming an independent cluster, it is mean that each ratio of shell lenght with W_{ang} is correlated with a particular species.

Approaching with the cluster model, the data indicates the variability represented in 2 groups. Group A consists of CJR02B and CLN01A (small shell), Group B consists of Pasir Ipis, MNT13 and BOJ03 (large shells) (**Figure 4**).

5.3. Ratio of Shell Length (L): W_{sut}

This ratio is based on the shell length with the maximum width of suture at last whorl. This parameter has never been used to determine a species. Based on the nature turreted it could be estimated that each additional length of the shell will be followed by additional wide of the suture at last whorl. If this occurs, different species should be show different patterns.

Specimens from MNT13 and PsI distributed on the same area, it's possible because they are from the same formation. Based on size of shell it can be divide into two groups (**Figure 5**). Group A consists of CJR02B, and CLN01A with short-sized shells. Group B consists of Pasir Ipis, BOJ03 and MNT13 with large shells.

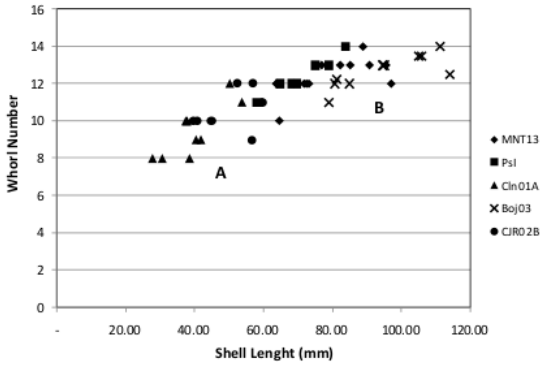

Figure 3. Distribution of ratio of shell length with whorl number, tend to be distributed.

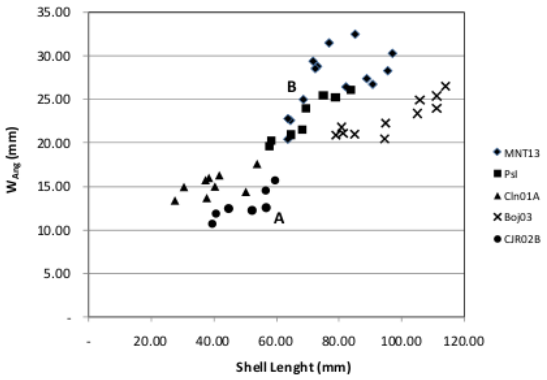

Figure 4. Distribution of the ratio of shell length with a maximum width of the last whorl (W_{ang}).

5.4. Ratio of W_{ang}:W_{sut}

This ratio is a comparison between the maximum width of last whorl with maximum wide of suture at last whorl. The nature of uniformity in the Family Turritellidae is a turreted form. Turreted form should be occured if the ratio between the suture whorl with a maximum width of the whorl is relatively consistent. The comparisons between one species and another will show a relatively equal ratio values.

The samples from MNT13 show a widened spread, while other samples show the opposite. This shows that the nature of the turreted can be seen in the ratio of W_{ang}:W_{sut}.

Approach taxa cluster analysis there are two large clusters. Cluster A consists of CJR02B and CLN01A, which is a cluster of small-sized taxa. Cluster B grouping BOJ03, PsI and MNT13, as large (**Figure 6**).

6. Discussion and Synthesis

Results of the parameters analysis show a consistent character in each population, so that each population can be synonyms as a distinct species. All parameters could be used to determinate a species.

Overall cluster analysis of all chart shows two large clusters of consistent groups (**Figure 7**). Based on geological especially at chronological studies (**Table 1**), two groups of clusters turned out to represent several things:

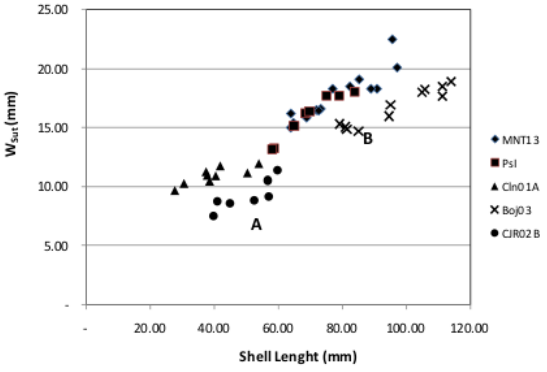

Figure 5. Distribution of ratio of shell length to width suture of the last whorl (W_{sut}) Distribution points clustered into two groups: A and B.

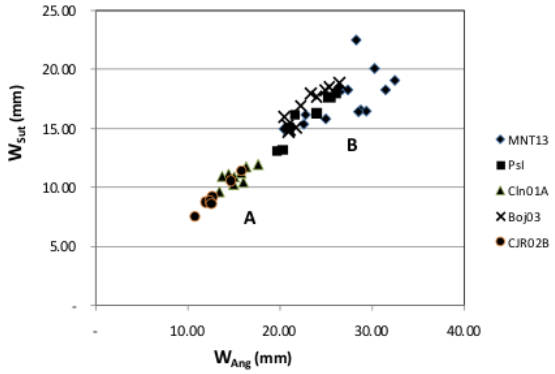

Figure 6. Distribution of ratio of the ratio of W_{ang} with W_{sut} distribution points clustered into two groups: A and B.

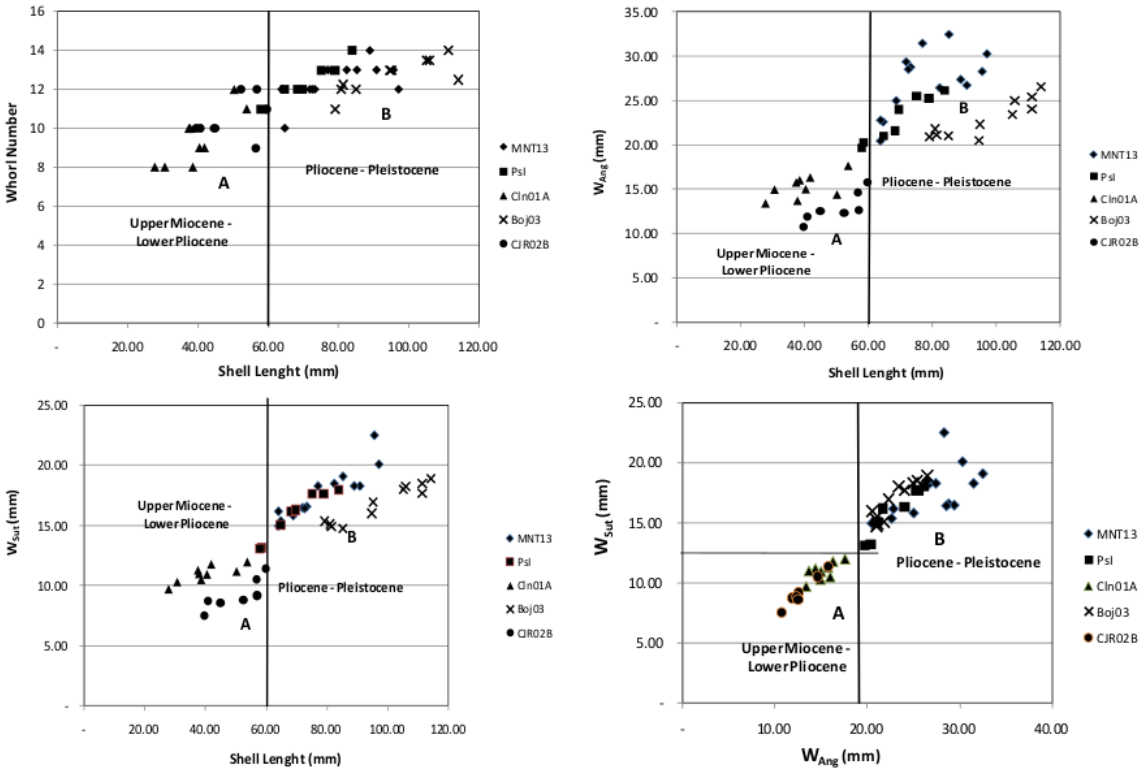

Figure 7. Distribution of each ratio associated with chronological. A is representative sample from upper Miocene to Pliocene, B is representative from Pliocene to Pleistocene.

1) Based on the aspects of stratigraphy, cluster A is representative group of Upper Miocene-Lower Pliocene. Cluster B is represents a group of Plio-Pleistocene.

2) Aspects of evolution shows that the trend toward the increas of body size at a younger age. It seens that the small size of cluster A realted to Upper Miocene-Lower Pliocene specemines. Whereas large-sized cluster B to younger specimens (Pliocene-Pleistocene).

7. Conclusions

This study shows biometrical aspects are reflection of geological condition. It has been seen that small size of individual appeared on Upper Miocene-Lower Pliocene, whereas large-sized ones appear in younger level Plio-cene-Pleistocene in age.

Thus the emergence of larger Turritellidae fossils can

be used to identify rocks from Pliocene to Pleistocene. While the small shells can be identify to older age of rocks. This research needs to be developed further, which is valid only in Java alone or also in other areas.

8. Acknowledgements

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