PROCEEDING

1ST EARTH SCIENCE INTERNATIONAL SEMINAR
YOGYAKARTA, 29TH - 30TH NOVEMBER 2012

Theme :

"INCREASING ROLE OF EARTH SCIENCE AND TECHNOLOGY TO SUPPORTING ACCELERATION OF MINERAL AND ENERGY RESOURCES CONSERVATION"

Editors :

1. Dr. Ir. Sudarmoyo, SE., MS.
2. Dr. Ir. Y. Sumantri, MT.
3. Dr. Ir. Jatmiko Setiawan, MT
4. Nurkhamim, ST, MT
5. Ika Wahyuning W., S.Si., M. Eng.
6. Edgie Yuda Kaesti, ST., MT.

Faculty of Mineral Technology
UPN "Veteran" Yogyakarta
2012

Foreword

The first International Earth Science Seminar 2012 of Faculty of Mineral Technology of UPN "Veteran" Yogyakarta and 5th Indonesia – Malaysia Joint Geoheritage Conference with its' theme "Increasing Role of Earth Science and Technology to Support Acceleration of Mineral and Energy Resources Concervation" is a collaboration of FTM UPN "Veteran" Yogyakarta Indonesia – UKM Malaysia, held in Yogyakarta at FTM seminar room UPN Veteran Yogyakarta 29-30th November 2012.

The Seminar exposes a discussion fair which will integrate earth science, technology and business opportunities. The exposition offer a unique opportunity for technical and business discussions amongst participants from leading oil and mineral companies, government representative and academia. It also enables a dynamic interaction between all of participants.

In addition to the above seminar, it gives me a great pleasure to introduce you the technical papers of the seminar in a format on Proceeding. We received over 60 abstracts from operating companies, service companies, government agencies, universities and students for evaluation and 48 outstanding papers have been selected for inclusion in this year's technical program. The technical committee for this seminar has strived very hard to select the best and highest quality papers that are relevant to the International Earth Science and Technology. The selected papers have special emphasis on case studies and best technology practices applied in the Earth Science technology.

In closing, I would like to recognize the great efforts, dedication and hard work of the 2012 International Earth Science Seminar committee who tirelessly worked with the authors and editors to make this year's technical program an outstanding success.

I hope you will fine the technical papers in the proceeding useful and helpful in establishing a better understanding of the Earth Science developmet.

Sudarmoyo

Chairman,

Yogyakarta 2012 International Earth Science Seminar

Gubernur
Daerah Istimewa Yogyakarta

Sambutan
SEMINAR INTERNASIONAL KEBUMIAN
"PENINGKATAN PERAN IPTEK KEBUMIAN DALAM MENDUKUNG AKSELERASI KONSERVASI SUMBER DAYA MINERAL DAN ENERGI"
Yogyakarta, 29 November 2012

Assalamu'alaikum Wr. Wb.
Salam sejahtera bagi kita semua,

Yth. Rektor Universitas Pembangunan Nasional "Veteran" Yogyakarta, Prof. Dr. H. Didit Welly Udjianto, MS. yang diwakilkan oleh Wakil Rektor III, Bapak M. Nurcholis.
Yang saya hormati saudara-saudara narasumber : Pertamina EP, Tenaga ahli SK MIGAS, Pertamina Hulu Energi, Dosen dari Universitas Kebangsaan Malaysia.

Hadirin serta peserta seminar yang berbahagia.

Marilah kita senantiasa mengucapkan syukur kehadirat Allah Subhanahu Wata'ala, atas limpahan karunia-Nya, sehingga pada hari ini kita dapat hadir dalam keadaan sehat wal'afiat.

Pertama-tama, saya mengucapkan selamat datang di Yogyakarta kepada seluruh peserta seminar. Jika ini merupakan kunjungan saudara untuk pertama kalinya di kota kami, seperti inilah Yogyakarta. Kota ini seperti memiliki dua wajah, di satu sisi adalah simbol tua yang berbalutkan nilai-nilai tradisi leluhur kerajaan Jawa, di satu sisi lainnya merupakan wajah gemerlap modernitas. Yogyakarta memiliki sumber daya alam yang terbatas. Karena itu, sebagai pedorong pertumbuhan dan kemajuan daerah, kami fokuskan pada tiga bidang yaitu : pendidikan, pariwisata dan budaya.

Adapun filosofi pembangunan di Daerah Istimewa Yogyakarta, diambil dari filosofi Jawa yaitu Hamemayu Hayuning Bawono. Filosofi ini menekankan adanya keselarasan antara manusia dengan manusia, manusia dengan alam, serta manusia dengan Tuhan. Ternyata, apa yang diajarkan nenek moyang kami, memiliki persamaan dengan tiga pilar pembangunan keberlanjutan, yaitu menguntungkan secara ekonomi (*economically viable*), diterima secara sosial (*social acceptable),* dan ramah lingkungan (*environmentally sound*). Dengan adanya keselarasan antara manusia dan alam, pembangunan dapat terus berjalan tanpa mengurangi kemampuan alam dalam menyediakan segala sumber dayanya untuk generasi sekarang dan yang akan datang.

Hadirin yang saya hormati,

Sumber daya mineral dan energi, mempunyai peranan yang sangat penting dan menjadi kebutuhan dasar dalam pembangunan ekonomi yang berkelanjutan. Oleh karena itu, keduanya harus digunakan secara hemat, rasional dan bijaksana agar kebutuhan energi pada masa sekarang dan masa yang akan datang dapat terpenuhi.

Konservasi energi sangat penting, mengingat cadangan energi semakin menipis, sementara itu penggunaan energi di semua sektor masih sangat boros. Jika tidak dilakukan langkah-langkah konservasi, tentunya kita akan menghadapi krisis energi. Selain itu, kegiatan konservasi energi sejalan dengan kebijakan energi bersih. Sebab, dengan melakukan konservasi energi, laju konsumsi energi dapat ditekan sehingga mengurangi emisi gas rumah kaca yang menyebabkan pemanasan global dan perubahan iklim. Begitu pula dengan sumber daya mineral, baik logam maupun nonlogam, harus dipergunakan dengan tepat dan cermat.

Efisiensi adalah salah satu langkah dalam pelaksanaan konservasi energi, sebab cadangan energi fosil yang merupakan salah satu sumber daya mineral nonlogam, jumlahnya terbatas dan sifatnya tak terbarukan. Dengan mengurangi penggunaan energi fosil, tentunya lingkungan kita juga semakin sehat karena polusi dan emisi gas rumah kaca bisa ditekan. Industri barang dan jasa akan lebih produktif dan kompetitif jika biaya pemakaian energi dapat diminimalkan. Begitu pula dengan penghematan energi di sektor rumah tangga, akan memungkinkan alokasi dana untuk kebutuhan rumah tangga lainnya.

Paradigma pengelolaan energi pun harus diubah dari yang dulunya adalah *Energy Supply Side Management* menjadi *Energy Demand Side Management*. Dengan adanya paradigma baru tersebut, konsekuensinya kita harus mendorong penyediaan dan pemanfaatan energi terbarukan demi terjaminnya pembangunan berkelanjutan serta untuk meningkatkan ketahanan energi. Di sisi lain, energi fosil digunakan sebagai penyeimbang semata, bukan sebagai penyedia energi utama.

Hadirin yang saya hormati,

Untuk itulah peranan ilmu pengetahuan dan teknologi kebumian tentu sangat diperlukan dalam mendukung akselerasi konservasi sumber daya mineral dan energi tersebut. Tentunya saya sangat berharap saudara-saudara disini yang memiliki disiplin ilmu kebumian, dapat menyumbangkan berbagai ide inovatif dan kreatifnya pada seminar bertaraf internasional ini.

Demikian kiranya beberapa hal yang bisa saya sampaikan. Akhirnya, dengan mengucapkan *Bismillahirahmanirrahim*, Seminar Internasional Kebumian dengan tema "Peningkatan Peran Iptek Kebumian Dalam Mendukung Akselerasi Konservasi Sumber Daya Mineral dan Energi", saya nyatakan dibuka secara resmi.

Sekian dan terima kasih atas perhatiannya.

Wassalamu'alaikum Wr. Wb.

Yogyakarta, 29 November 2012
GUBERNUR
DAERAH ISTIMEWA YOGYAKARTA

HAMENGKU BUWONO X

CONTENS

Part-1
Engineering and Geoscience

Part-2

Geoheritage

The Evolution Pattern of Turritelline Shell Morphology in Java; Relationship with Geochronological Aspects

Hita Pandita[1)], Yahdi Zaim [2)], Aswan[2)], Yan Rizal[2)]

1) Student of PhD Program, Institute of Technology Bandung. Dept of Geological Engineering, STTNAS, Yogyakarta, E-mail: hita.pandita@yahoo.com

2) Department of Geology, Institute of Technology Bandung.

Abstract

The paleontology study of occurrence of Turritelline fossil in Java is very interesting to do. The interesting thing Turritelline fossils are often found in locations discovery of fossil mollusks. However, so far not many studies that discuss the relationship of appearance Turritelline with the various aspects of geology. One of such interest is studying the relationship between morphological evolutions with geochronology aspects. This study aimed to determine Turritelline base on morphological observations and to find out the relationship with geological development especially of chronological conditions. Stratigraphic analysis and sampling have done at ten location of field survey. The site location was based on the type location of Mollusk biostratigraphy unit. Eight species of Turritelline have been identified from ten locations. All these species show different patterns of shell morphology. The progression of morphology from old to young tends to two patterns. The first pattern towards are more rounded morphology and second pattern of more angular morphology. These results are also proving that the fossil Turritelline can also be used to determine the age of rocks.

***Keywords**: Shell, Turritelline, Java, Mollusk, Paleontology*

Abstrak

Kajian mengenai kemunculan fosil Turritelline di jawa sangat menarik untuk dilakukan. Hal ini disebabkan fosil Turritelline banyak diketemukan di hamper semua lokasi penemuan fosil moluska. Namun begitu tidak banyak penelitian mengenai hubungan kemunculan fosil Turritelline tersebut dengan berbagai aspek geologinya. Salah satu kajian yang perlu dilakukan adalah melihat hubungan antara evolusi morfologi dengan aspek geokronologinya. Penelitian ini ditujukan untuk mengidentifikasi Turritelline berdasarkan aspek morfologinya untuk melihat hubungannya dengan kondisi geologinya khususnya geokronologi. Analisis stratigrafi dan pengambilan sampel dilakukan pada sepuluh lokasi pada penyelidikan lapangan.Penyelidikan dilakukan pada lokasi tipe dari satuan Biostratigrafi Moluska. Delapan spesies dari kelompok Turritelline sudah diidentifikasi dari kesepuluh lokasi tersebut. Keseluruhan spesies memperlihatkan pola morfologi yang berbeda. Berdasarkan perkembangan pola morfologi dari tua kemuda memperlihatkan dua pola berbeda. Pola pertama memiliki morfologi yang membundar sedangkan pola kedua menyudut. Hasil penelitian menunjukkan juga fosil Turritelline dapat dijadikan indicator penentuan umur batuan.

Kata kunci: *Shell*, Turritelline, Jawa, Molluska, Paleontologi

Introduction

Mollusk fossils are very abundant in Java, but the study of theses fossils are rare. Intensive research took place in the early 19th century by experts from the Netherlands and the United Kingdom. One of the highlights of these studies was the discovery of fossils Turritelline in almost all types of locations discovered fossil molluscs (Martin, 1883-1887; Martin, 1919; Oostingh, 1938). Recent studies of Turritelline attempt made by some researchers as Shuto (1974), and Aswan (1997). Both researchers developed a method of identifying the Turritelline. Shuto (1974) tried to apply the methods of identification of Merriam (1941) and Kotaka (1959) with some modifications to the Java Turritellidae. Aswan (1997) tried to connect the biometric aspects of Turritella with the depositional environment. These studies have

demonstrated the use of fossil Turritelline in the field of geology.

This study aimed to determine the relationship of morphological development Turritelline with the geological aspects. However, this study is limited to the geochronological aspects.

METHOD

Research methods based on field investigations, stratigraphic analysis, and identification Turritelline fossil. The study was conducted at ten locations across West Java, Central Java and East Java (Figure 1). The Stratigraphic sinthesis includes analysis of the stratigraphic position based on field samples and from previous research. Terminology of morphology based on Merriam (1941) and Kotaka (1959).

STRATIGRAPHY

The material was observed coming from ten locations. In West Java location in Bojong (BOJ), Bayah (BYH), Cijarian (CJR), Cilanang (CLN), Citalahab (THB), Meningten (MNT), and Pasir Ipis (PSI). In the area of Central Java is on Bumiayu (BMA) and Sangiran (SGN). One location in East Java is Kabuh (KBH). All these samples represent the notches and different stratigraphic positions. Stratigraphic correlation and basin position of the sample can be seen in Figure 2.

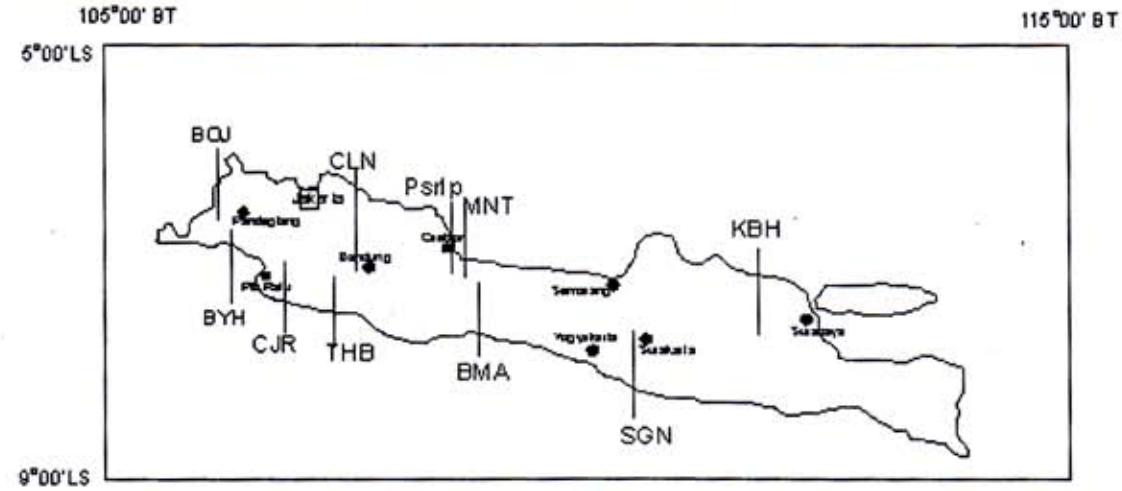

Figure 1. Sampling sites of fossil molluscs family of Turritellidae in West Java. Description of location, BOJ: Bojong; BYH: Bayah; CJR: Cijarian; THB: Citalahab Nyalindung; CLN: Cilanang; Psrlp: Pasir Ipis; MNT: Menengten (Losari); BMA:Bumiayu; SGN : Sangiran; KBH: Kabuh

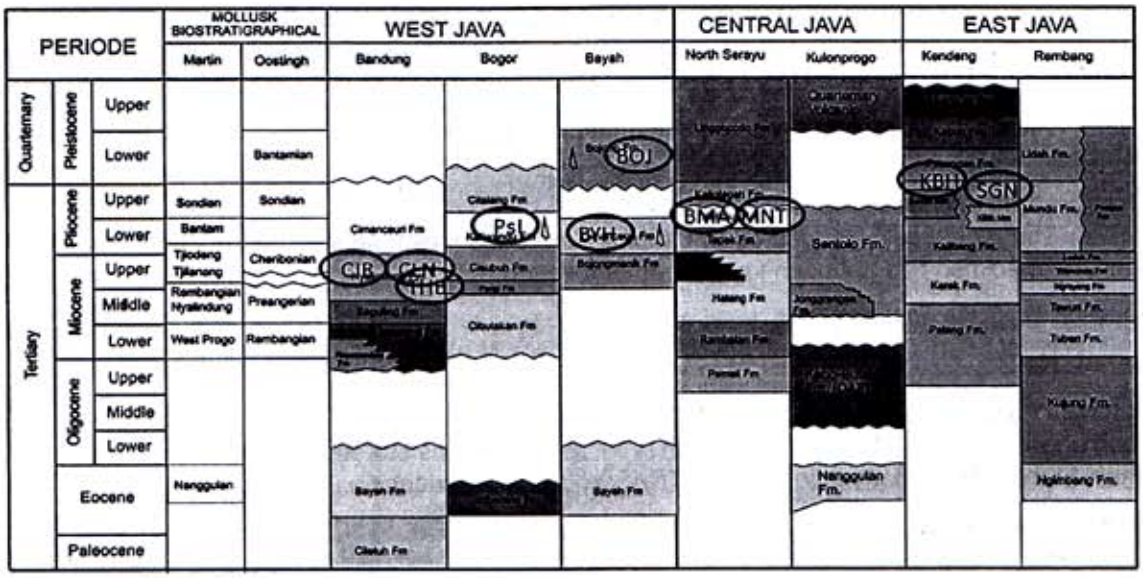

Figure 2. Regional Stratigraphy correlation of site location compile from Martodjojo (2003), Koesmono, et al. (1999), Rahardjo, et al. (1995), Pringgoprawiro (1983) and this research.

SYSTEMATIC PALEONTOLOGY

Turritelline terminology first introduced by Allmon (1996) to classify a number of species in the genus Turritella Lamarck, 1799, but not all species in the genus can be entered into the Turritelline. The development of the systematic position of this term remains unclear, so it still needs to be reexamined.

Class : Gastropoda Cuvier, 1797

Subclass : Prosobranchia Milne-Edwards, 1848

Order : Mesogastropoda Thiele, 1925

Superfamily : Cerithiacea Fleming, 1822

Family : Turritellidae Loven, 1847

Sub family: Turritellinae Woodward, 1851

Genus : Turritella Lamarck, 1799

Species: Turritella sp.

Plate 1. No 1

Material : Syntype.□Shell preservation is not complete, protoconch is loose. The whorl preserved about 12 to 14. Total specimen is 22, 9 specimens stored in NMSN Tokyo, Japan and 13 others in the paleontology laboratory STTNAS Yogyakarta Indonesia. Code number MNT-13.

Morphologic Descriptive

In the early development of the shell has form multicostate form, which is formed from the first whorl after the protoconch to the 7th or 8th whorls. The five primary spirals formed from the first whorl, with growth to the anterior form of adapical. Initial form liability whorls tend to convex, turn into strong keeled starting at 9th whorl. Keel was formed by the 2nd primary spiral from anterior sutures. Keel position is about one-third from anterior suture. Lateral aspect of growth line is anti spiral shape with single sinus.

Remarks and Discussion

There is one species that is somewhat similar to this specimen. Turritella simplex can be said to resemble this specimen, but both can be distinguished clearly in the emergence of the primary spiral

rib. In this specimen the number of primary spiral rib is 5 pieces and can still be observed in the anterior part, whereas T. simplex only has 4 primary spirals and two disappeared in the anterior (Jenkins, 1863 and Martin, 1879).

Type Locality: Cisanggarong River at Menengten valley near Waled village, Ceribon, West Java, Indonesia.

Stratigraphic and Geographic Distribution

The type locality is located at Kalibiuk Formation which sedimented at Upper Pliocene. Until now this specimen has not been found in other locations.

Species: Turritella acuticingulata Jenkins, 1863

Plate 1. No 2

Material : Paratype. Shell preservation is not complete, protoconch is loose. The number of preserve whorl about 8 to 9 whorls. Total specimen is 31, 22 specimens stored in NMSN Tokyo, Japan and 9 others in the paleontology laboratory STTNAS Yogyakarta Indonesia. Code number CLN01-B.

Morphologic Descriptive

Early development of whorl is showing multicostate form origin by 6 primary spirals. Whorl profile is convex. At the primary spiral whorl of adult is adapical grow, but it turned into cingulate shape. The primary spiral number 2 and 3 from the anterior expressed more strongly than the other. Position cingulate form located on the middle of the whorl. These changes began to occur on the 7th whorl. Angled point occurred by 2nd primary spiral from the anterior. The lateral growth line is curve with a single sinus, basal sinus is absent. Aperture may squarish round.

Type Locality: River bed of Cilanang at Mount Halu West of Bandung, West Java, Indonesia.

Stratigraphic and Geographic Distribution

The type locality is located at Cimandiri Formation which sedimented at Middle Miocene. Martin (1919) suggested this unit into Nyalindung stage estimated Middle Miocene, while Oostingh (1938) refer to as Preangerian stage who is also the Middle Miocene.

Remarks and Discussion

The naming of this species into the debate, Jenkins (1863) mentions this specimen the first time as a new species Turritella acuticingulata, but Martin (1879) had referred as Turritella acuticarinata Dunker 1847.

Actually, the specimens were observed by Martin and Dunker different. Specimens were observed Dunker from Lebak district, while the observed Martin came from the Mount Halu Cilanang River, west of Bandung. Description of the Dunker explain the observed specimens had 4 spiral rib, the bottom is weak, second very strong, strong third, and last weak. Martin's description shows that the specimens were observed to have two very strong keels, and a weak one under his keel, and possibly 3 or more very fine striae at above keels. Although the type location of Jenkins specimens is still ambiguous, the specimens are relatively similar to specimens from Martin.

Referring to the results of previous descriptions of the three authors and the observations of samples taken in the Cilanang River, the specimen is more accurately described as Turritella acuticingulata Jenkins (1864).

Species: Turritella simplex Jenkins, 1863

Plate 1. No 3

Material : Paratype. Shell preservation is not complete, protoconch is loose. The number of preserve whorl about 8 to 9 whorls. Total specimen is 33, 24 specimens stored in NMSN Tokyo, Japan and 9 others in the paleontology laboratory STTNAS Yogyakarta Indonesia Code number CLN01-A.

Morphologic Descriptive

Shell grew rapidly, an early form tends multicostate with edges of whorl is convex. The very fine primary

spiral amounted to 5 or 6 pieces formed in the initial whorl. Suture is channelized at juvenile part, change to subcarinate at adult whorls. A sharp keel formed from whorl 4 or 5 to anterior shell, which was formed by the 2nd primary spiral from anterior suture. Position of keel is about one-third form anterior to posterior suture. Lateral growth line is low curve with a sinus and basal sinus absent. The aperture is round-squared.

Type Locality: River bed of Cilanang at Mount Halu West of Bandung, West Java, Indonesia.

Stratigraphic and Geographic Distribution

The type locality is located at Cimandiri Formation which sedimented at Middle Miocene. Martin (1919) suggested this unit into Nyalindung stage estimated Middle Miocene, while Oostingh (1938) refer to as Preangerian stage which is also the Middle Miocene.

Remarks and Discussion

This species is still doubtful because there are similarities with some other species. Turritella angulata is ones species which very close with this specimen, but Vredenburg (1928) treated them conspecifically giving stress to the morphological variability of population of these specimens.

Shuto (1974) change these specimens to Zaria angulata. He suggested that the difference between Turritella angulata and T. simplex is not too significant, and both were found in the same location. Even so Shuto still doubt this specimen included in the genus Zaria, because the pattern of growth lines that appear slightly different from the pattern of Zaria.

Type specimen of T. angulata founded at Gaj Formation in India is consist one keel and more than six spiral according to Vredenburg (1928). Growth line is ophistocline. Gaj specimen is quite similar with ones specimen which Martin (1879) decided as T. angulata, but it's different with another specimen from Tjilanang Beds. Martin argues there are three different forms at the sample collection of mollusks from Jenkins, and he decided three species like T. angulata, T. simplex and T. acuticarinata. Martin also doubts the ones specimen was T. angulata, because the condition of the specimen was not intact.

Samples from the Cilanang River stored in NMNS and STTNAS can be classified in two forms. Based on observations of morphology, the sample CLN01-A is very similar and not distinguished from T. simplex by Martin (1879) and Jenkins (1863) descriptions.

Species: Turritella terebra Lamarck, 1799

Plate 1. No 4

Material : Paratype. Fossil preservation is incomplete, the protoconch and the last whorl are missing. Specimens are stored in NMSN, Tokyo and Paleontology Laboratory STTNAS, Yogyakarta, Indonesia. Sample code is SGN-1.

Morphologic Descriptive

In the early growth has the form subrounded whorl. There are 6 or 7 primary spiral ribs that form the structure multicostate at the beginning of its growth. In the adult whorl forms turned into four carinate formed by a spiral number 1, 2, 3 and 4 of the anterior sutures. Primary spiral number 2 is slightly stronger than number 3. Whorls are relative convex shape of the posterior sutures to the point angulate. The suture is channelized. Lateral growth line curve with a single sinus, at the bottom the basal sinus is not formed.

Type Locality: This specimen was found in the area Kabuh, in the Pucangan Formation.

Stratigraphic and Geographic Distribution

Type location of this species is included in Pucangan Formation. The previous author entered Pucangan Formation into Early Pleistocene age.

Species: Turritella talahabensis Martin, 1905

Plate 1. No 5

Material : Paratype. Incomplete fossil preservations, the protoconch and the last whorl are missing.

Specimens are stored in NMSN, Tokyo and Paleontology Laboratory STTNAS, Yogyakarta, Indonesia. Sample code is THB-8.

Morphologic Descriptive

Whorl tend to form sub-rounded in the early growth teleconch. In the adult whorl turn into angled which is located in the primary spiral to two of the anterior sutures. There are 7 primary spiral, one is below and 5 above the point angulaton. Fine secondary spiral develops between the primary spirals. At the young whorl sutures evolved form of channelized, but turned into a sub-carinate at the adult whorl. Lateral growth line forms a single sinus in the primary spiral into 3 of the anterior sutures. At the bottom of the basal whorl sinuses are not formed. Apeture rounded with the inner lip is not twisted.

Type Locality:

The specimen found at the top of Citalahab River in the Nyalindung area Sukabumi regency, West Java. The rock containing these specimens founded at avalanches from the surrounding hillsides.

Stratigraphic and Geographic Distribution

Type location included in Nyalindung Formation. Results of analysis of Nannoplankton show Middle-Upper Miocene age, and this is the same as some previous authors. The distribution of T. terebra talahabensis only found in the river Citalahab.

Remarks and Discussion

Species: Turritella djadjariensis Martin, 1905

Plate 1. No 6

Material : Lectotype. The number of specimens from location PasirIpis there are 13 and 11 of Bumiayu. Specimens stored in NMSN, Tokyo-Japan, and Laboratory of Paleontology, STTNAS Yogyakarta-Indonesia. Samples give code PI and BMA-1. In general protoconch is not found, but the early stages of teleconch can be observed.

Morphologic Descriptive

In general protoconch is not found, but the early stages of teleconch can be observed. At the beginning of growth teleconch peripherals tend to subrounded, have multicostate spiral pattern. In the adult whorl spiral pattern turned into a form bicarinate. Bicarinate form was prepared by the two primary spirals and three of the anterior sutures. Forms bicarinate began on 9th whorl. The total there are 6 primary spiral, one below and three above carinate. Lateral growth line is forming a sinus and the basal anterior sinuses are not formed.

Type Locality: These specimens were obtained in the Pasir Ipis, southeast of Cirebon. It is also found in Bumiayu. Sangiran, Sragen, Central Java.

Stratigraphic and Geographic Distribution

The specimen was found in the area of Formation Kalibiuk avalanches in the area PasirIpis. Formation is estimated to Middle Pliocene. Same species may also be found in the area Kalibeng Sangiran Formation of Middle to Upper Pliocene.

Genera: Zaria Grey, 1847

Species: Zaria bantamensis Martin, 1905

Plate 1.No 7

Material : Paratype.□Shell preservation is not complete, protoconch is loose. The number of preserve whorl about 8 to 9 whorls. Specimens are stored in NMSN, Tokyo and Paleontology Laboratory STTNAS, Yogyakarta, Indonesia. Samples code number BYH-1, BOJ-1, BOJ-2 and□BOJ-3.

Morphologic Descriptive

Shell length over 80 mm, with convex whorl. At the beginning of shell growth, which appears four primary spiral multicostate structures. Fines secondary spiral grow between primary spirals. Sutures in

the first form of channelized and transformed into subcarinate the whorl to 8 or 9. Three keels formed from whorl to 8 or 9 which were prepared by the primary spiral into 1, 2 and 3 of the anterior sutures. Position keel meet half of the whorl on the anterior part. Lateral growth line curved to form a single sinus, the basal sinus is also formed at the bottom of the whorl. Aperture round- oval shaped.

Type Locality: Specimens obtained from different locations. Samples numbered BOJ-1, BOJ-2 and BOJ-3 obtained from the Bojong, Pandeglang district, Banten Province. Samples were coded BYH-1 and BYH-2 found in the area Bayah, Banten Province.

Stratigraphic and Geographic Distribution

Sampling sites represent two different stratigraphic positions. Samples from the area Bayah found at Bojongmanik Formation based on analysis of the Regional Geological Map predicted Early Pliocene (Sujatmiko and Santosa, 1992). While samples taken from areas Bojong derived from Bojong Formation estimated Plio-Pleistocene.

Species: Zaria javana Martin, 1882

Plate 1. No 8

Material : Lectotype. Shell preservation is not complete, protoconch is loose. The number of preserve whorl about 9 to 11 whorls. Total specimen is 27, stored in NMSN Tokyo, Japan□Code number CJR03A.

Morphologic Descriptive

In the early observation of the sample CJR03 shows varied forms. However, after scrutiny, it can be separated into two groups based on the development of spiral and whorl shape it, which is then given a code CJR03A and CJR03B

Shell including small to medium sized. In the early rounds made up four primary spirals appears at the beginning teloconch. Whorl shape tends tricostate formed by spiral into 1, 2 and 3 are sorted from the anterior, with a spiral rib to 2 expressed slightly stronger than the other two. A fine spiral located under the posterior sutures as a spiral 4. Sutures at the beginning teleconch shaped channelled.

Start whorl to 7 there is a change of sutures and pheriperal form. Forms bicarinate appear in the center of the whorl that is formed by a spiral rib of the anterior second and third. Relative changes to subcarinate sutures.

Lateral growth line strongly curved with a single sinus, and basal sinuses also appeared at the bottom. Aperture somewhat elliptical until rounded.

Type Locality: Specimens derived from Cijarian River in Sukabumi, about 10 km from Pelabuhan Ratu. Location discovery is included in the top Nyalindung Formation.

Stratigraphic and Geographic Distribution

The type locality is located at Cimandiri Formation which sedimented at Middle Miocene. Martin (1919) suggested this unit into Nyalindung stage estimated Middle Miocene, while Oostingh (1938) refer to as Preangerian stage which is also the Middle Miocene.

Remarks and Discussion

This specimen is very similar to T. javana that the first description by Martin (1883). The location of the two specimens is also similar. It could be argued that the specimen is typical for T. javana. Referring to the classification Turritellidae from Merriam (1941), Marwick (1956) and Shuto (1969), the species is more appropriately incorporated into the genus Zaria. This is shown by a strong curvature in the lateral growth line and the emergence basal sinus in the anterior part of the shell.

Morphological Characters

The eight species Turritelline taken from ten sites showed different patterns of morphology (Table 1). There are two key parameters in determining the species according to Merriam (1941); they are the growth of primary spiral rib, growth line pattern and secondary (whorl profile, suture, etc.)

Table 1. Summary of morphological observations of the specimen

Spesies	Protoconch	Teleconch		Suture		Spiral rib	Growth Line	Whorl Form		Aperture	Lokasi
		Early	Adult	Early	Adult			Early	Adult		
T. talahabensis	np	np	multicostate	np	sub carinate	7	Turritella type	np	sub angular	elongate	THB
T. acuticingulata	np	multicostate	cingulate	channelize	sub carinate	6	Turritella type	sub rounded	sub angular	rounded	CLN
T. simplex	np	smooth	monocarinate	sub carinate	sub carinate	5 or 6	Turritella type	convex	angular	sub rounded	CLN
T. terebra	np	multicostate	multicostate	channelize	channelize	6 or 7	Turritella type	sub rounded	sub rounded	sub rounded	KBH, SGN
Turritella sp	np	multicostate	monocarinate	channelize	sub carinate	5	Turritella type	concave	convex	rounded	MNT
T. djadjariensis	np	multicostate	bicarinate	sub carinate	sub carinate	6	Turritella type	sub rounded	angular	rounded	Psl, BMA
Z. javana	np	tricostate	bicarinate	channelize	sub carinate	4	Zaria type	sub rounded	sub rounded	sub rounded - elongate	CJR
Z. bantamensis	np	multicostate	multicostate	channelize	sub carinate	4	Zaria type	sub rounded	sub rounded	rounded	BOJ, BYH

The pattern of whorl profile can be grouped into two, there are angular and rounded pattern on the whorl. The angular pattern represented by T. talahabensis, T. simplex, T. acuticingulata, T. djadjariensis and Turritella sp .. While the rounded pattern shown by Z. bantamensis, Z. javana, and T. terebra.

Based on the sculpture pattern of the adult teleconch three species have a multicostate pattern, there are T. talahabensis, T. terebra and Z. bantamensis. Two species have bicarinate pattern, there are Z. javana and T. djadjariensis. Monocarinate pattern appears in T. simplex and Turritella sp. One species T. acuticingulata has cingulate pattern.

The number of primary spiral rib showed significant differences of the eight species. Based on this Z. javana and Z. bantamensis are in the same group by the number of spiral 4 pieces. T. talahabensis and T. terebra have a closer relationship with the number of spiral rib 6-7 pieces. Four other species are predicted to be closely related to the number of spiral rib 5-6 pieces, namely: T. acuticingulata, T. simplex, T. djadjariensis and Turritella sp.

Morphological Evolution

Based on the study of the stratigraphic position of the sites, they have different of geochronological ranges (Fig. 3). The most shows obvious evolution pattern is the profile of whorl.

Angular profile shaped whorl preceded the appearance of T. talahabensis is angled responsibility to the early Middle Miocene, with an expression of the form multicostate spiral rib. At the late of Middle Miocene angular patterns divided into monocarinate on T. simplex and cingulate in T. acuticingulata. The monocarinate pattern was surviving until the Pliocene, but in the Middle to Upper Pliocene simultaneously appear very strong expression of his keel marked appearance of Turritella sp. The pattern of cingulate is also transformed into bicarinate and it marked by the appearance of T. djadjariensis in the Upper Miocene to Pliocene.

The rounded profile whorl preceded the appearance of Z. javana at the Upper Miocene and the rib expressions were bicarinate form. In the Early Pliocene multicostate appears to be characterized by two species, namely Z. bantamensis and T. terebra. The difference of two species lies in the number of primary spiral rib (table. 1).

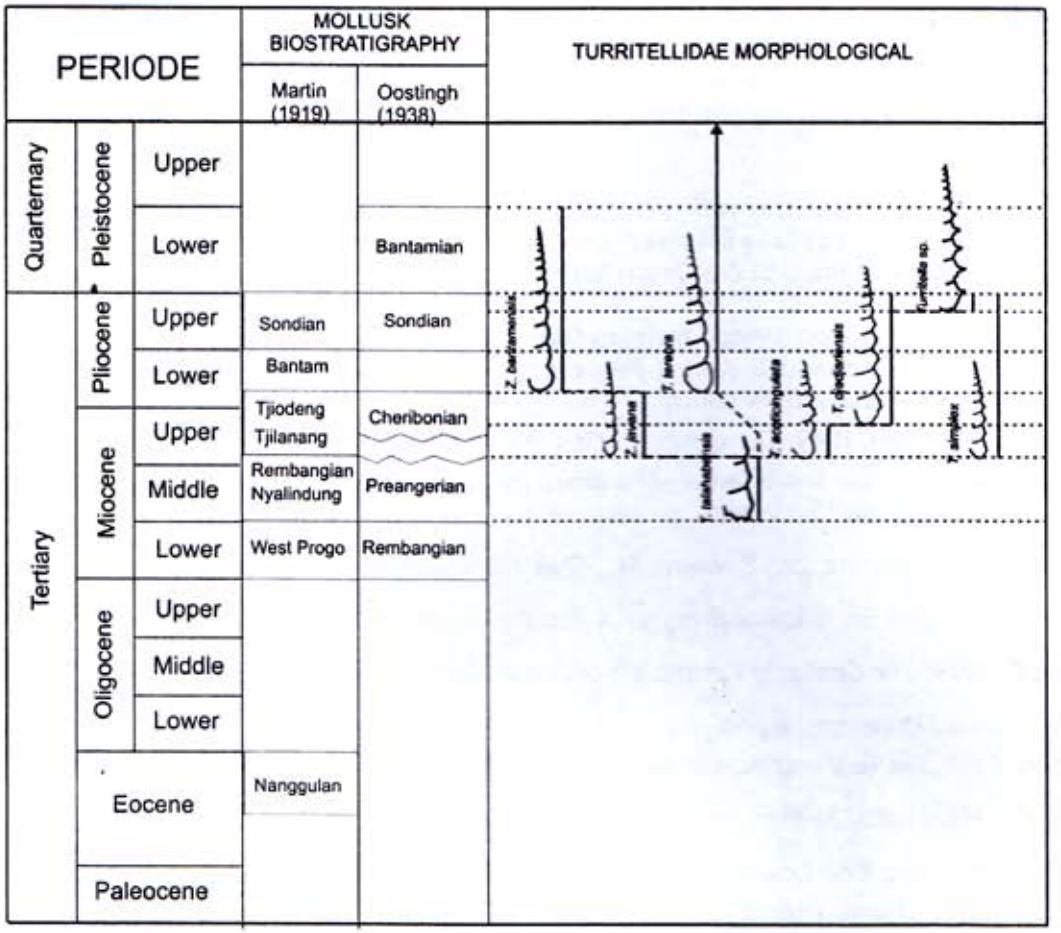

Figure 3. The Relationship Between The Evolution Patterns Of Turritelline Morphology With Geochronology In Java

Discussion

Based on the patterns of morphological evolution, it can be estimated of the evolutionary line of the eighth species. If the prime rib and the development of spiral growth pattern line became the main factor in determining the kinship patterns, we can conclude the following three evolutionary paths (Fig. 3).

The first evolutionary path was from T. talahabensis which then turned into Z. javana and T. terebra. Next stage Z. javana evolved to Z. bantamensis. The similarity lies in the three species that form the pattern of spiral rib multicostate, although Z. javana is bicarinate but the number of spiral rib and some other aspects of close to Z. bantamensis, so it goes in this pathway.

The second evolutionary path was from T. acuticingulata which then turned into a T. djadjariensis and Turritella sp. All three of these species possess the archetypal expression of their spiral rib are bicarinate. In Turritella sp. even seem to have a single keel, but there is a spiral rib below the keel which is also expressed strong despite weaker than the keel (Fig. 3).

The third evolutionary path marked only by the appearance of T. simplex, which appears at the end of the Middle Miocene to Lower Pliocene.

Conclusion

Turritelline were found in the Tertiary rocks in Java proved to have a pattern of evolution consisting of rounded and angular shape of whorl. Each pattern suggests different evolutionary trend. Three evolutionary pathways can be seen from the results of this study. The appearance of specific species at a certain time make Turritelline could be used to determine the age of rocks.

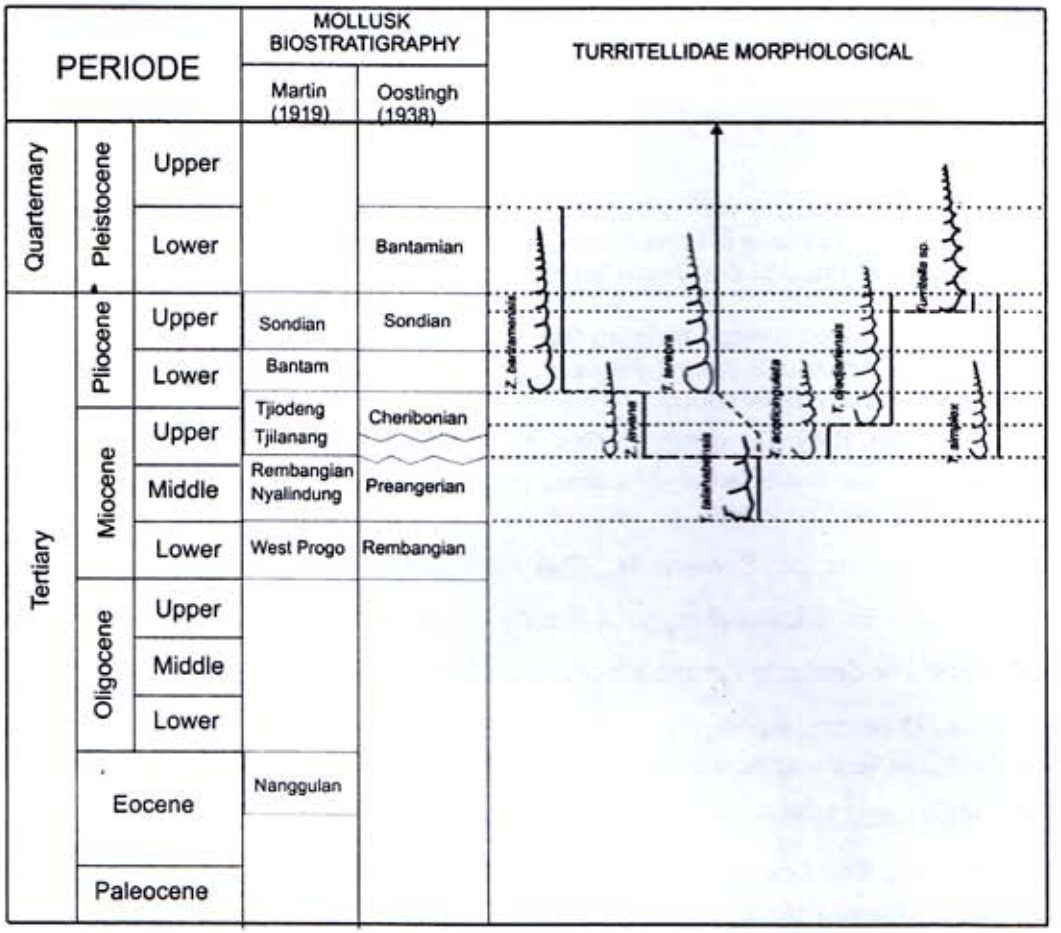

Figure 3. The Relationship Between The Evolution Patterns Of Turritelline Morphology With Geochronology In Java

Discussion

Based on the patterns of morphological evolution, it can be estimated of the evolutionary line of the eighth species. If the prime rib and the development of spiral growth pattern line became the main factor in determining the kinship patterns, we can conclude the following three evolutionary paths (Fig. 3).

The first evolutionary path was from T. talahabensis which then turned into Z. javana and T. terebra. Next stage Z. javana evolved to Z. bantamensis. The similarity lies in the three species that form the pattern of spiral rib multicostate, although Z. javana is bicarinate but the number of spiral rib and some other aspects of close to Z. bantamensis, so it goes in this pathway.

The second evolutionary path was from T. acuticingulata which then turned into a T. djadjariensis and Turritella sp. All three of these species possess the archetypal expression of their spiral rib are bicarinate. In Turritella sp. even seem to have a single keel, but there is a spiral rib below the keel which is also expressed strong despite weaker than the keel (Fig. 3).

The third evolutionary path marked only by the appearance of T. simplex, which appears at the end of the Middle Miocene to Lower Pliocene.

Conclusion

Turritelline were found in the Tertiary rocks in Java proved to have a pattern of evolution consisting of rounded and angular shape of whorl. Each pattern suggests different evolutionary trend. Three evolutionary pathways can be seen from the results of this study. The appearance of specific species at a certain time make Turritelline could be used to determine the age of rocks.

Acknowledgments

Special thanks for Dr. Tomoki Kase and Dr. Yukito Kurihara (National Museum of Nature and Science, Tokyo) whose helped sample collected during field works. Great thanks for Ministry of Education which give fund passing on doctoral research funding.

References

Allmon, W. D. 1996. *Evolution and systematics of Cenozoic American Turritellidae (Gastropoda)*. I. Paleocene and Eocene species related to "Turritella mortoni Conrad" and "Turritella humerosa Conrad" from the U.S. Gulf and Atlantic Coastal Plains. Palaeontographica Americana, 59:1–134.

Aswan, 1997, P*enggunaan Metode Biometri Dalam Menentukan Evolusi Fosil Moluska Turritella Dari Beberapa Tempat di P. Jawa & Penerapannya Dalam Biostratigrafi*, Thesis Magister, Program Pasca Sarjana, ITB, Bandung

Bemmelen, R.W. Van, 1949. *The Geology of Indonesia*. The Hague, Martinus Nijhoff, vol. IA.

Jenkins, H. M., 1863, *On Some Tertiary Mollusca from Mount Sela in the Island of Java*, Proc. Geological Society, pp 45-73. London.

Koesmono, M., Kusnama, dan Suwarna, N., 1996, *Geological Map of Sindangbarang and Bandarwaru Sheet*, 2nd Ed, Geological research And Development, Bandung.

Kotaka, T., 1959, *The Cenozoic Turritellidae of Japan*, Science Report, 2nd Ser, vol. 31, no. 2, pp 1-135, Tohuku University, Japan.

Martin, K, 1879, *Die Tertiärschichten auf Java*. E. J., Brill, Leiden, 164 p. (Original not seen).

Martin, K., 1883-1889, *Tiefbohrungen Auf Java*, Samlungen des Geologischen Reichs Museums in Leiden, E.J. Brill, Leiden.

Martin, K., 1919, *Unsere Paleozoologische Kenntnis von Java, mit einleitende Bemerkungen über die Geologi der Insel*, 158 pp., 4 pls. E.J. Brill, Leiden.

Martodjojo (2003), *Evolusi Cekungan Bogor*, Penerbit ITB Bandung

Marwick, J. 1957. *Generic revision of the Turritellidae*. Proceedings of the Malacological Society of London, 32:144–166.

Merriam, C. W., 1941, *Fossil Turritellas From The Pacific Coast Region of North America*, Univ. California Publ, Bull, Dept. Geol. Science, vol. 26, no. 1.

Oostingh, C. H., 1938, *Mollusken als Gidsfossielen voor Het Neogeen in Nederlandsch-Indie*, Handelingen van het achste Nederlandsch-Indisch Natuurwetenschap-pelijk Congres gehouden te, Soerabaja van 20-23 Juli 1938, pp. 508-516.

Pringgoprawiro, H., 1983. *Biostratigraphy and palaeogeography of northern East Java - a new perspective*. Unpublished Phd Thesis, ITB Bandung.

Rahardjo, W., Sukandarrumidi, dan Rosidi, H.M.D., 1995, *Geological Map of The Yogyakarta Sheet*, Java, Geological Research And Development Centre, Bandung.

Shuto, T, 1969, N*eogene Gastropods from Panay*, The Philippines, Mem. Fac. Sci., Kyushu Univ., Ser. D, Vol. 19, No. 1, pp. 1-250, pls, 1-24.

Shuto, T., 1974, *Notes on Indonesian Tertiary and Quarternary Gastropods Mainly described by the Late* professor K. Martin, I. Turritellidae and Mathildidae, Geology and Paleontology of Southeast Asia, vol XIV, pp. 135-160, University of Tokyo Press.

Vredenburg E. W., 1928 *Description of Mollusca from the Post-Eocene Tertiary Formation of North Western India*: Gastropoda (In Part) and Lamellibranchiata. Geol. Surv. India Memoirs 50 351–506.

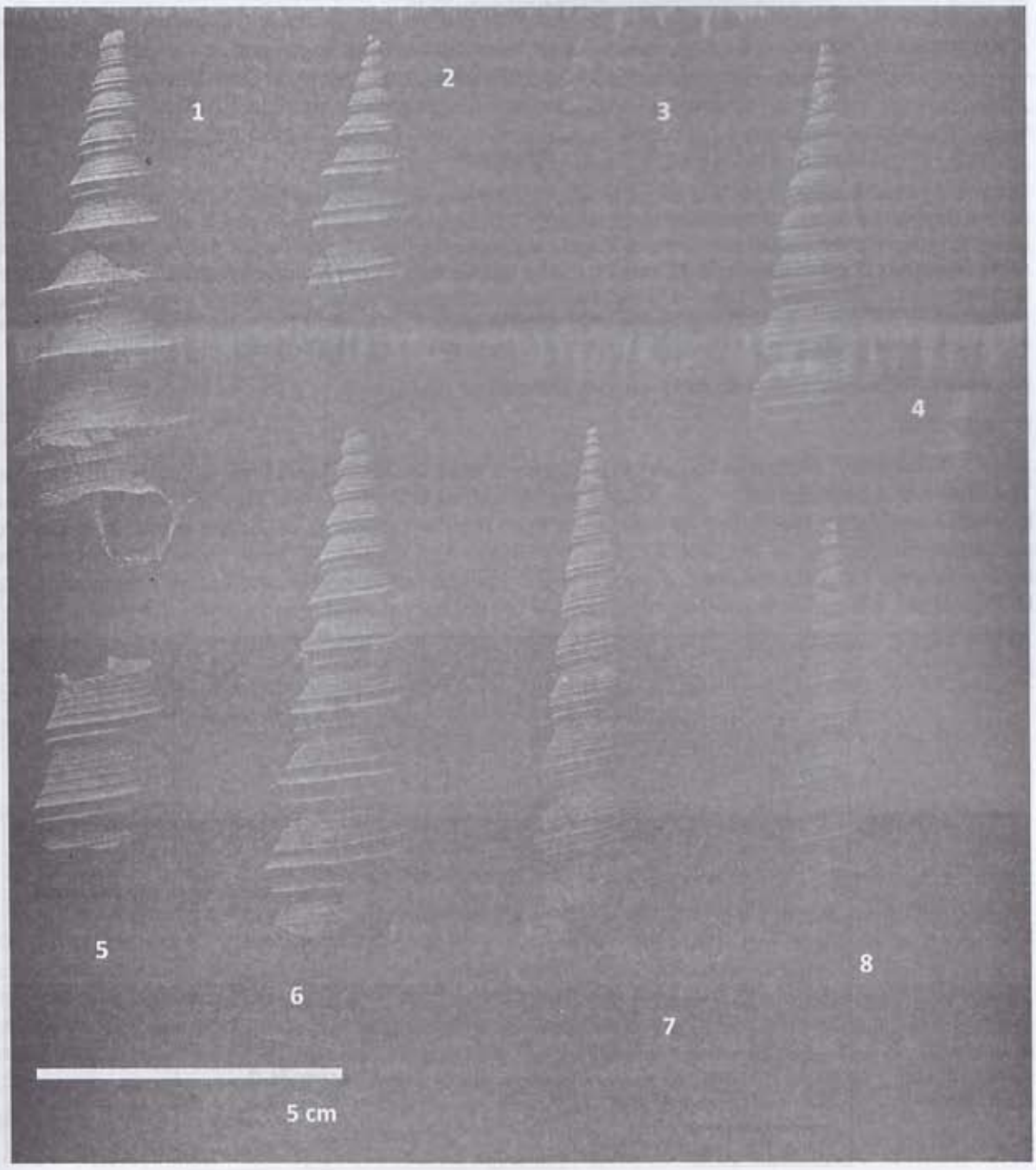

Plate 1: 1) *Turritella* sp., 2) *Turritella acuticingulata*, 3) *Turritella simplex*, 4) *Turritella terebra*, 5) *Turritella talahabensis*, 6) *Turritella djadjariensis*, 7) *Zaria bantamensis*, 8) *Zaria javana*.