

Foraminiferal Biostratigraphy of the Hnget-taung Formation, Goyangyi Kyun and Migyaunggaung Kyun, Ngayokeykaung Area, Ngaputaw Township, Ayeyarwady Region

Khin Mar Than^{1#}, May Si Tun², Kyu Kyu Win³, Kaung Sithu⁴

Abstract

Nga Yoke Kaung Area (Goyangyi Kyun & Migyaunggaung Kyun) is constituted the southwestern coastal region of Rakhine Yoma and Bengal Sea lies in the west. Regionally the study area located extremely southwest corner of the Ayeyawady Delta Basin. Shales are observed in the basal part of the Migyaunggaung, there are light grey to dark grey, moderately hard, thinly laminated, slightly carbonaceous, fossiliferous and intercalated with marl beds. There are a total of (36) foraminiferal species under (18) genera belonging to (14) families have been recorded from the whole area, as 3 planktonic species and 33 benthonic species. Among them, abundance species are *Asterorotalia multispinosa*, *Asterorotalia trispinosa*, *Calcarina calcar* var.4&5, *Pararotalia azawaia*, and common species are *Valvulineria* sp., *Cibicides foxi* and *Quinquelocalina* sp. are observed. In the Hnget-taung Formation, the method of Taxon Rang Zone and Interval Zone is applied by Hedberg (1976). Therefore, the whole of Hnget-taung Formation has a Zone, namely, *Globoorotalia menardii* Zone because of this species is occurring in association with other *Rotalia* sp. This Zone is intermediate by a zone *Globoorotalia mayari* and *Globoorotalia acoetiansis* Zone. This covers the age of upper part of Middle Miocene to early Late Miocene, i.e. Serravallian and Lower Part of Tortonium., equivalent to nearly Neogene Zone 15-16. Hnget-taung Formation is richly fossiliferous containing *Turritella* sp., *Conus* sp., *Pecten* sp., *Ostrea* sp., and corals. *Turritella* sp. appears to be characteristic of sub-littoral (inner neritic) environments.

Keywords: Biostratigraphy, Hnget-taung Formation, early Late Miocene, Goyangyi Kyun

Introduction

General Statement of the Hnget-taung Formation

The Hnget-taung Formation has been well known as a unique stratigraphic unit because of abundant occurrence of *Amphistegina* sp., *Cycloclypeus* sp., *Rotalia* sp. from the prominent outcrops of Goyangyi Kyun, Migyaunggaung Kyun, Sabahta Kyun, Thamote Taung and Tite Chi Tauk Areas.

These areas are noted for the first geological mapping in Lower Myanmar by Blandford and Fedden in 1860. The regional mapping was, first of all, done by Theobald in 1873 in this area. In the following years up to now, a large number of elder geologists such as foreign geologists and local national geologists, visited this area from time to time. All of them are recognized with bear a large number of foraminiferas.

The foraminiferal biostratigraphy of the Hnget-taung Formation, Nga Yoke Kaung Area, Ngaputaw Township has been carried out and it based on a total of 34 limestones, and 25 shales samples collected from the Nga Yoke Kaung Area (Goyangyi Kyun, Migyaunggaung Kyun, Sabahta Kyun, Thamote Taung and Tite Chi Tauk Areas).

Location and size

Nga Yoke Kaung Area (Goyangyi Kyun and Migyaunggaung Kyun) comprises the southwestern coastal region of Rakhine Yoma and Bay of Bengal lies in the west. Regionally,

¹Demonstrator, Geology Department, Patheingyi University

²Lecturer, Geology Department, Patheingyi University

³Assistant Lecturer, Geology Department, Patheingyi University

⁴Demonstrator, Geology Department, Patheingyi University

Corresponding author: khinmarthangeol@gmail.com

the study area stressed extremely southwest corner of the Ayeyawady Delta Basin. The study area is unducted in the Southwest of Pathein, 114 kilometers (70.8 miles) far from Pathein along the Pathein - Nga Yoke Kaung motor way and its distance is about 4.8 kilometers (3 mile) west of the Nga Yoke Kaung Area (Fig. 1). It lies in one inch topographic map No. 85L/2 and 85L/6. It is bounded by the Latitude between 16° 30' to 16° 37' N and Longitude 94° 14' to 94° 22' E.

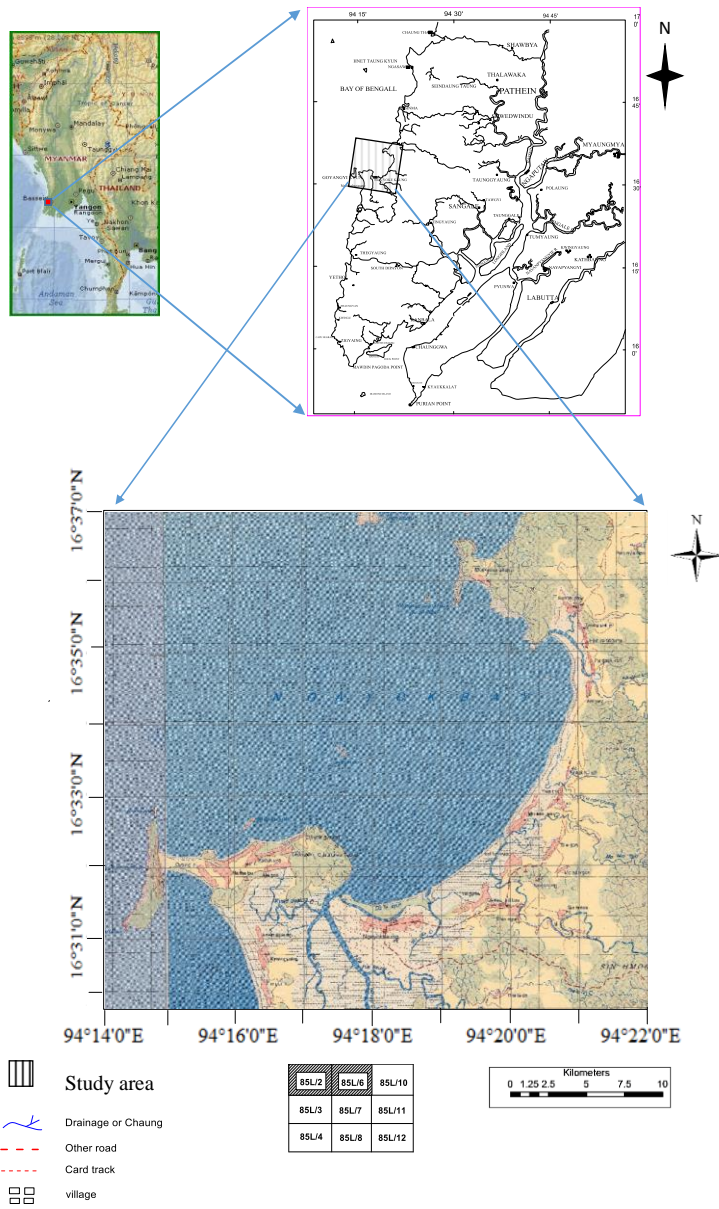


Figure (1). Location map of the study area

Methods of Study and Materials

The first phase of geological field work was carried out since the 26 September to 1st October, 2016. In addition, several reconnaissance field checking and sport sample collections were done.

In order to get more information; previous studied materials from the Southern Rakhine Yoma including Nga Yoke Kaung area was also restudied (pervious papers, books,

and reports were read carefully for the better understanding and getting wide background knowledge for the preparation of the research).

A total of (34) limestone samples and (25) shale samples collected during the field work. Block samples of about 2 x 3 x 3 of sandy limestone and limestone were taken from the outcrops. The limestones were made into thin sections. Altogether (68) thin sections were obtained from (34) limestone samples. Thin section examination and extracted fossil foraminifera were identified under a binocular microscope, using some monographs and manuals, all of which have been cited in the list of references.

A weight of ½ of shale and clay samples were collected systematically along the stratigraphic sections, properly marked and carefully packed for detailed paleontological investigation. All the clay and shale samples were processed, sorting and the extraction of microfossils

The shale samples were broken into small chips and then put into the aluminium bowls with waters. A little amount of washing soda is added to the sample in water. The shale samples were left for a day. The shales and clays were gradually disintegrated into mud solution. For the indurated shales or clays, they were first heated in an oven or over the hot plate to a temperature of about 40°C-60°C with a cover. The sample was treated with kerosene oil when it was still hot. The kerosene soaked samples was treated again with water and some detergents. The samples were slowly distinguished into mud solution. The oil emulsion together with some muddy solution washed over the brass or sieve with normal opening of mesh size 150. And then, this sample was done from all dried processed residues. Before extraction, the dried residues were sieved into mesh sizes 30, 60, and 90.respectively. The microscope examination of all fractions was very carefully done.

The treatment of material will vary much according to the usability of it. If it has been collected and prepared purely for the purpose of making a determination of age for stratigraphic correlation. If the sample has been collected for scientific study it will take a very different course. All foraminiferal specimens were picked up by means of stable hair brush and put into the sample slides. Each type species was photographed by using binocular microscope and digital camera.

The foraminiferal examination and taxonomic classification were identified by using mainly Cushman & Stainford (1945), Bermudez (1949), Le Roy (1941 & 1944) and Ruth Todd (1960). The planktonic foraminifera were classified following the works of Bolli (1957), Blow and Banner (1962), and Bolli and Saunders (1985) and finally with the work by Loeblich and Tappan (1988).

Fauna, Age and Correlation

The general consensus is that the sandy limestone unit (Hnget-taung Formation by U Tin Aung Han 1976) exposed to the near-shore and offshore islands along the western coast of southern Arekan are Miocene rather than Eocene in age. This consensus is reached on the basis of Miocene microfossils (e.g., *Cycloclypeus* sp.) and typical Miocene megafossils (e.g., *Turretella* sp., *Pecten* sp., and *Conus* sp) were collected during the trip.

The Miocene sandy limestone unit is molassic in lithologic character and is probably a fore reef facies. It has gentle westerly and northerly dips. Paw Tun (1977) assigned the age of Hnget-taung Formation to Miocene by the species. *Amphistegina* sp., and *Cycloclypeus* sp. with some megafossils of *Turretella* sp., *Pecten* sp., and *Conus* sp. (Fig. 2).



Figure (2). Showing *Conus* sp., *Pecten* sp. and *Turitella* sp. (Latitude 16° 31' 36" N, Longitude 94° 14' 78" E)

Stratigraphic correlation and conditions of deposition

Especially in the low latitude area, the planktonic foraminiferal species are used for age dating and biostratigraphic zoning and regional correlation from one continent to another. However, localized benthonic species are also used for local correlations only when from one area to the other areas are attempted within a country. The larger foraminifera are also regarded as stratigraphic index fossils, as their occurrence in the Mesozoic and Tertiary limestones are very restricted and indicative of the paleodepositional condition. Therefore, stratigraphic correlation by means of the index fossils of larger foraminiferal species and genera can be made successfully not only in local areas within a country but also from region to region.

The Age for the Hnget-taung Formation

The flooded to abundant occurrence of *Globorotalia menardii* has been recorded in the Hnget-taung Formation, especially in the Migyaunggaung area (Samples 5a – 5f). The *Globorotalia menardii* is a distinct zonal species established by Bolli (1957, 1966). The *Globorotalia menardii* Zone is definitely assigned to Neogene Zone 15, which can be recognized the lower most horizon of the Hnget-taung Formation. Besides this, the upper limit of the formation is marked by the last appearance of *Globorotalia mayari* and first appearance of *Globorotalia acostaensis*. Both the species are present in the uppermost part of Hnget-taung Formation, in association with *Globorotalia menardii* B. According to this part of formation, that it defined as the *Globorotalia acostaensis* zone, which coincides with the Neogene zone 16 of Boli (1970). Therefore, the age of Hnget-taung Formation ranges from Neogene Zone 15 to Neogene Zone 16 which is placed to upper part of Middle Miocene to early Late Miocene. According to chronological determination by Berggren and others (1985), the Hnget-taung Formation is assigned to upper part of Middle Miocene to early Late Miocene, i.e., Serravallian and Lower Part of Tortonium.

Correlation

The Kathabaung Formation of Lower Myanmar contains a few fossils of *Globorotalia mayeri* and *Globorotalia menardii*. This formation is made up of alternating series of clay, shales and sandstones with limestone lenses. The fauna of the Kathabaung Formation can be correlated with the Hnget-taung Formation (Table 1).

The Myan Aung Well No.1 is located generally the northern most part of the Ayeyarwady Delta Subbasin. The Obogon Formation is made up mainly of light gray, soft, poorly sorted; carbonaceous sandstone alternated with some shale and silt. The fauna consist of *Rotalia koeboeensis*, *Rotalia annectens*, *Cibicides koeboeensis* and *Bolivina* 1. The

general aspect of Obogon fauna of Myan Aung Well No.1 is very similar to those of Hnget-taung fauna of Goyangyi Kyun area.

In Trinidad, the Miocene Cipero Formation has been divided into (9) zone: (1) *Catapsydrax dissimilis* zone (2) *Catapsydrax stainforthi* zone (3) *Globigerinatella insueta* zone (4) *Globorotalia fohsi barisanensis* zone (5) *Globorotalia fohsi* zone (6) *Globorotalia fohsi lobata* zone (7) *Globorotalia fohsi robusta* zone (8) *Globorotalia mayeri* zone and (9) ***Globorotalia menardii*** zone. The ***Globorotalia menardii*** zone contains. All these species are recorded in the Hnget-taung Formation. Therefore, the fauna of Hnget-taung Formation can be correlated with the ***Globorotalia menardii*** zone of Miocene Cipero Formation of Trinidad.

The Lower Palembang Formation of Sumatra, Indonesia, contains the following benthonic species: -

Cibicides koeboeensis

Cibicides foxi

Bolivina sumatrensis

Rotalia indica

All these species are recorded in the Hnget-taung Formation. Therefore the fauna of Hnget-taung Formation can be correlated with those of the Middle Palembang Formation of Sumatra.

In the distribution of foraminifera in the section of Tjijarian formation, Java, LeRoy (1944) described the occurrence of ***Cibicides wuellerstorfi*** and ***Globorotalia menardii*** where it occurred.

In the Hnget-taung Formation, the occurrence of the above species has been recorded. So, the correlation of the fauna of Hnget-taung Formation with those of Middle Miocene section of Tjijarian of Java is quite feasible.

Table (1). Showing the correlation of the fauna of the Hnget-taung Formation with those of Miocene Formations of Foreign Countries

GEOLOGICAL AGE	BLOW (1969) ZONES	TRINIDAD BOLLI (1957)	INDONESIA			MYANMAR AYEYARWADY DELTA BASIN		PRESENT WORK KHIN MAR THAN (2017)
			SUMATRA LE ROY (1941,1944)	JAVA BOLLI (1996)		CHIT SAING (2003)	MAY SI TUN (2005)	
				MIDDLE PALEMBANO FORMATION	KELIBENG & REMBANG BEDS			
MIDDLE TO LATE MIOCENE	N 16	CIPERO FORMATION	MIDDLE PALEMBANO FORMATION	KELIBENG & REMBANG BEDS	1699 meters	OBOGON FORMATION	KATHABAUNG FORMATION	HNGET-TAUNG FORMATION
	N 15				1705 meters			

Conditions of Deposition

A reconstruction of the paleo-environments of deposits has been inferred and based on area wise observations recorded from the lithological characters, sedimentary features and macro-faunal contents.

During the Late Miocene, the sea regressed again and calcareous muddy limestone was deposited with intercalations of highly bioturbated calcareous sandstone and packstone/boundstone beds at Nga Yoke Kaung and Migyaunggaung areas as a barrier reef near the shore.

The Hnget-taung Formation is characterized by rich of foraminiferal which is made up of (33) benthonic species together with (3) planktonic species. The faunal assemblage of *Elphidium advena*, *Asterorotalia trispinosa*, *Rotalia koeboeensis*, *Rotalia annectens* are found in the shallow marine, especially (Near shore) environment and Late Miocene in age.

Classification of benthonic marine environments in terms of depth and positions of critical oceanographic boundaries of transitional zones in the modern world ocean. Note that water depths are given in meters. This classification is a modification of that presented by Hedgpeth (1957): from Ingle (1975a). Hnget-taung Formation is richly fossiliferous containing *Turritella* sp., *Conus* sp., *Pecten* sp., *Ostrea* sp., and corals. *Turritella* sp. appears to be characteristic of sub-littoral (inner neritic) environments. The conditions have also been warm enough for the development of corals.

The environmental condition of the lower part of the formation is very shallow marine (littoral) in origin as suggested by the development of cross-bedding, ripple marks, and the occurrence of *Turritella* sp. and *Pecten* sp., has been usually used as an indicator of brackish water environment. The development of clay-pebble conglomerates, concretionary sandstones and fossiliferous gritty sandstones suggest an unstable condition indicating a near shore area.

Faunal Reference List

A list of references of genera and species of the foraminifera studied during this work is given below (Table 2 & Table 3). The original and sometimes one or more subsequent references are given for each of the species. The primary objective of this list is to facilitate references to original sources and to systematic treatises. An assemblage of foraminiferal species in the study area is as follows.

Benthonic Species

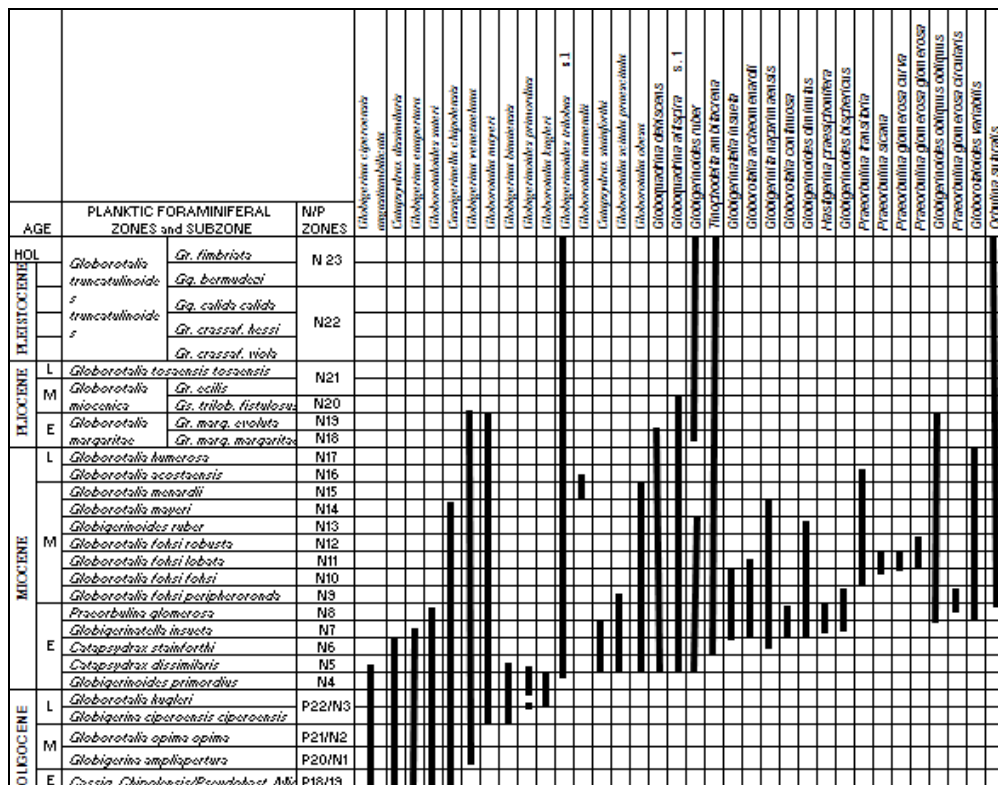
1. *Rotalia annecten*
2. *Elphidium crispum*
3. *Rotalia sumatrana*
4. *Spiroloculina dentata*
5. *Cibicides wuellerstorfi*
6. *Bolivina sumatrensis*
7. *Asterorotalia multispinosa*
8. *Elphidium advenum*
9. *Cibicides koeboeensis*
10. *Cibicides foxi*
11. *Quinqueloculina seminulum*
12. *Streblus beccarri* var. 1
13. *Reussella simplex*,
14. *Valvulineria demonti*

15. *Asterorotalia trispinosa*
16. *Calcarina calcar* var 2
17. *Rotalia calcar*
18. *Rotalia ozawai*
19. *Quinqueloculina* sp.2
20. *Calcarina calcar* var 4&5
21. *Elphidium incertum*
22. *Bolivina bilaensis*
23. *Rotalia murrayi*
24. *Planorbilina acervalis*
25. *Textularia candeiana*
26. *Rotalia beccarii* (linne) var.2 ssw
27. *Nodosaria* sp.
28. *Spiroloculina* sp.
29. *Cymbaloporetta squamosa*
30. *Spiroloculina exima*
31. *Pararotalia ozawi*
32. *Quinqueloculina lamaricicna*
33. *Milionella* sp.1

Planktonic Species

1. *Globorotalia menadii*
2. *Globorotalia mayeri*
3. *Globorotalia menadii* B

Table (2). Showing the stratigraphic range of planktonic species within Neogene Zone 15 and Neogene Zone 16 Bolli and Saunders: (1985) Oligocene to Holocene low latitude planktic foraminifera



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PLATE. I. EXPLANATION

1. *Rotalia annecten*
2. *Elphidium crispum*
3. *Rotalia sumatrana*
4. *Spiroloculina dentate*
5. *Cibicides wuellerstorfi*
6. *Bolivina sumatrensis*
7. *Asterorotalia multispinosa*
8. *Elphidium advenum*
9. *Cibicides koeboeensis*
10. *Globorotalia mayeri*
11. *Cibicides foxi*
12. *Quinqueloculina seminulum*
13. *Globorotalia menardii*
14. *Streblus beccarii* var.1
15. *Reussella simplex*,
16. *Valvulineria demonti*
17. *Asterorotalia trispinosa*
18. *Calcarina calcar* var 2
19. *Rotalia calcar*
20. *Rotalia ozawai*

PLATE. II. EXPLANATION

1. *Quinqueloculina* sp.2
2. *Calcarina calcar* var 4&5
3. *Globolotalia menardii* B
4. *Elphidium incertum*
5. *Bolivina bilaensis*
6. *Rotalia murrayi*
7. *Planorbulilina acervalis*
8. *Textularia candeiana*
9. *Rotalia beccarii* (linne) var.2 ssw
10. *Nodosaria* sp.
11. *Spiroloculina* sp.
12. *Cymbaloporetta squamosa*
13. *Spiroloculina exima*
14. *Pararotalia ozawi*
15. *Quinqueloculina lamaricicna*
16. *Milionella* sp.1

PLATE I

PLATE II

