

Research Article

Middle Permian (Murgabian) Foraminifers Faunas of the Thitsipin Formation, Western Part of the Southern Shan State, Myanmar

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Abstract

The Thitsipin Formation exposed at the Pegin Pagoda Hill, Ywa-ngan Township, southern Shan State, Myanmar, represents an important Middle Permian (Murgabian) carbonate sequence within the Shan Plateau. This study presents detailed lithologic, stratigraphic, and paleontological analyses of the limestone unit, focusing on the taxonomy and biostratigraphic implications of its foraminiferal assemblages. Fieldwork involved measurement of stratigraphic sections, fossil sampling, and petrographic examination of 30 thin sections. The lithology is characterized by alternating dark grey, fossiliferous lime-mudstone and crinoidal grainstone interbedded with purplish calcareous shale, forming a 78-meter-thick sequence. Four foraminiferal genera *Lunucammina* sp., *Nodosaria* sp., *Pachyphloia* sp., and *Multidiscus padangensis* were identified. Among these, *Pachyphloia* sp. and *Multidiscus padangensis* are indicative of the Middle Permian (Murgabian) age. The basal portion of the Thitsipin Formation unconformably overlies the Silurian Linwe Formation and yields abundant bryozoans, crinoids, and gastropods, suggesting a shallow marine depositional environment with moderate energy conditions. The discovery of *Multidiscus padangensis* allows biostratigraphic correlation with coeval units such as the Htam Sang Limestone in Hopong Township. The results confirm the Middle Permian age of the Thitsipin Limestone and refine the regional stratigraphic framework of the southern Shan State. Furthermore, the study provides essential paleontological evidence for understanding the evolution of Permian carbonate platforms in Myanmar and offers a valuable reference for future regional correlations and educational purposes in stratigraphy and paleontology.

Keywords

Thitsipin Formation, Foraminifera, Middle Permian, Murgabian, Shan State, Myanmar, Stratigraphy, Paleontology.

1. Introduction

The research area is situated in the northwestern part of the Pindaya Range, Ywa-ngan Township, southern Shan State. Detailed sedimentary and palaeontology investigation were carried out from the limestone of Thitsipin Formation at the Pegin Pagoda Hill as shown in [Figure 1](#), which is located four

and a half miles NE of Ye-U and on one-inch topographic map sheet no. 93 C/12. The unit was firstly defined as a basal bed of the Permian Thitsipin Limestone Formation by Garson *et.al* 1976 and Thura Oo *et.al* 2002. Important investigators among

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others who contributed lithostratigraphic and biostratigraphic aspects of the Pegin area were [2, 3, 5, 11, 20, 32, 33].

The Pegin area is the interesting place for the stratigraphy, sedimentology and paleontology point of view. The fossils gastropods, bryozoans, algae, foraminifera, and crinoids are fairly abundant. At the present research area, Thitsipin Formation unconformably overlies the Linwe Formation at Pegin Monastery [7]. Limestones of the Thitsipin Formation consist of well-bedded, dark grey, crinoidal and fossiliferous limestone. About four meters from the base, the wavy bedded limestones occur as intercalated nature with purplish calcareous shale. Their trending indicates NNW-SSE in direction and eastward dipping. The purposes of present investigation are firstly to carry out the taxonomic assessment of foraminifera; secondly to synthesize the stratigraphic status of the Thitsipin Formation exposed at the Pegin Pagoda Hill on account of the foraminifera fossils; the last purpose is to make the supplement of studios fields for undergraduate students.

2. Regional Geologic Setting

The study region lies in the western part of the Eastern Highlands that is a distinct geotectonic domain [14]. To the west, it is separated from the Central Basin by the Shan Scarp. To the east, the Shan Massif is bordered by the Mekong River. The northern boundary of the Shan Massif is bounded with NNE striking belt of ultrabasic and basic intrusive extending from north of Mogok. Towards south, the Shan Massif decreases in width and extends for a considerable part into north-west Thailand. Large areas of the Shan Plateau are covered by thick carbonate sequences of Ordovician, Silurian, Devonian, and Permian-early Mesozoic age. The Pegin area (Pegin Pagoda Hill) and its environ as shown in Figure 2, lying in the northwestern part of the Pindaya range, southern Shan State. The area is covered by the thick Paleozoic sequence composed of the Pindaya Group and Mibayataung Group [27], and part of the "Plateau Limestone Group". The Pindaya Group consists of siliceous siltstones with minor number of limestones of Early Ordovician (Lokepyin Formation). It is overlain by the burrowed limestones with silt patches and laminations of Middle Ordovician (Darriwilian) (Wunbye Formation) which is succeeded conformably by fossiliferous, siliceous, and micaceous siltstones, claystones with minor amount of limestone lenses of Late Ordovician (Katian/Caradocian) (Nan-on Formation) and purplish siltstones, mudstone and shale unit of Latest Ordovician (Hirnantian) (Tanshauk Member). The Ordovician sequences are overlain conformably by the interbedded to mixed clastic-carbonate (mostly of nodular limestone with intercalations of some graptolite-bearing shales) sequence of Silurian-Early Devonian (Silurian-Lochkovian) (Linwe Formation, included in the Mibayataung Group). So far, no undoubted Devonian units attaining dacryoconarid tenticulites, such as *Nowakia* and *Styliolina* which are common in the Zebingyi Formation of Early Devonian, Pragian [9, 10] or brachiopod, *Atrypa racticularis*, rugose corals, *Calceola sandalina* and *Phillipsastrea hlawaii*, common in the Padaukpin Limestone of Middle Devonian, Eifelian [1, 8, 28] have been recognized in this area. The most widely distributed carbonate rock unit in this region is the Plateau Limestone Group of Permian-Triassic age. The nature of contact between the Silurian and overlying the Thitsipin Formation of Pegin Pagoda Hill seems to be a structural, rather than stratigraphic or unconformable as described in Permian of Myanmar [31]. There may also be no break in sedimentation or sign of unconformity between the mixed clastic-carbonate unit of the Thitsipin Formation and mostly calcitic, coralline, fusuline limestone with partial dolomites of Early to Middle Permian Thitsipin Limestone Formation [19], which is gradationally passed upward by mostly unfossiliferous dolomitic limestone and dolomites of the Late Permian to Early Triassic Nwabangyi Dolomite Formation.

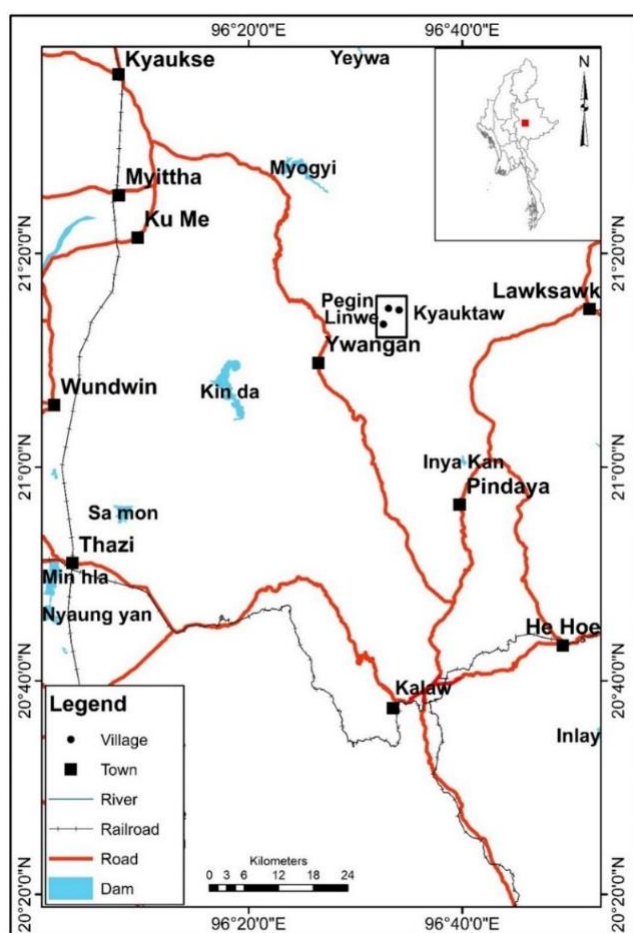


Figure 1. Locality map of the Pegin Pagoda Hill, Pegin Village, Ywa-ngan Township, Southern Shan State.

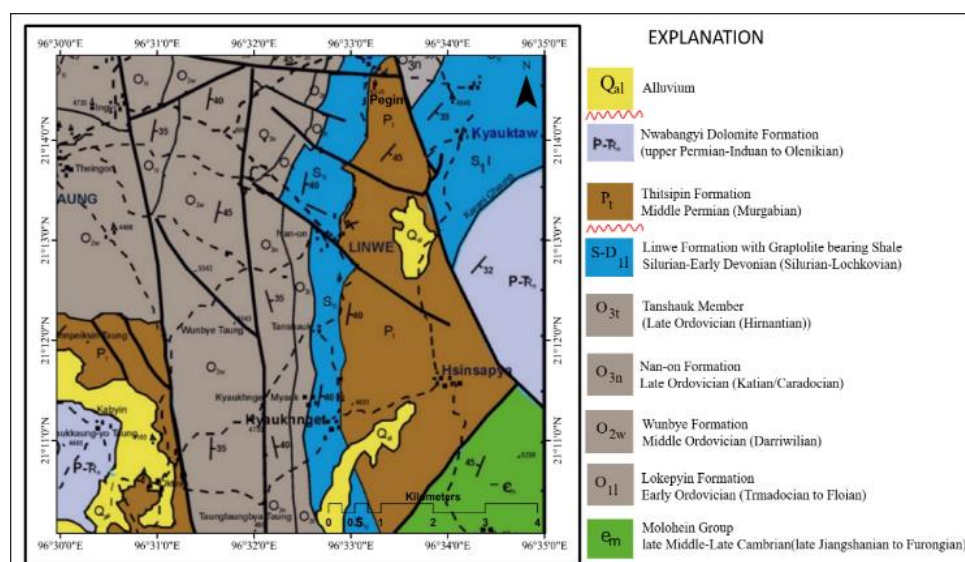


Figure 2. Geological map of Pegin Pagoda Hill and its environ, Ywa-ngan Township, Southern Shan State [6].

3. Materials and Methods

Materials of the present research are carried out from the well exposed limestone of the Thitsipin Formation at the Pegin Pagoda Hill which is located at about one and a half miles NNE of Linwe village in Ywa-ngan Township. The present study was carried out with the following procedures in method of study. Firstly, review of previous works on the Permo-Triassic Plateau Limestone was done to synthesize general geology, stratigraphy and paleontologic accounts of the Plateau Limestone. Secondly, during April holiday of the year 2022, field investigation was arranged to the study area and it took about one week. In the field, detailed stratigraphic section measurement was carried out along chosen section line by using tape and compass method to observe detailed lithologic, to record the distribution of fossils and to collect samples. The field equipment used were Brunton Compass, geological hammer, 15x hand lens, and measuring meter-tape. Lithologic boundaries, fossil localities and various types of structural data were plotted as traverse line on the scale of 1 cm to 5 m, in order to determine the succession and structural setting of the rocks of traverse line. During the field, over 23 samples were collected to study taxonomic aspects of foraminifers and associated faunas in the laboratory. In the lab, rock samples collected were washed by pure water. The washed samples were sawed to get at least three pieces of chips for each sample. The chips were systematically labeled and stored with respective samples. The chips were then etched with dilute hydrochloric acid solution (about 7-9%HCL). This etching removes the sawed-powders and scratches, and improves the outlines of fossils appeared on the chips. The lithologic descriptions taken during the field investigation were made on the basis of these etched rock chips. The etched chips were examined with 15x hand lens to mark

target area that contain proper sections of foraminifers. The chips were then cut again to trim out target area for making thin-sections. About 30 thin-sections were made to study taxonomy of foraminifers. The thin-section were examined under binocular petrographic microscope (Olympus-CH). Characteristic and representative fossils occurring in thin-sections were taken photomicrographs. And then Taxonomic data of foraminifers and associated fossils for each sample were plotted on stratigraphic columnar section with respect to the collected sample horizons. The foraminifers terminology and supergeneric classification follows that of [25].

Repository: All the collected rock-samples and thin sections are housed in the Banmaw University Geology Museum Fossils and are prefixed by BGMF.

4. Results

4.1. Lithologic Characteristics

The base of the unit is dominated by medium-bedded lime-mudstone intercalated with purple colored thin shale layers (3 to 23 cm) in thickness [Figure 3a](#). The shale unit is remarkably rich in bryozoa together with small number of tiny brachiopods. The crinoidal lime-grainstone layer is distinctly occurred at 1 m from the base of the section [Figure 3b](#). In this part, most fossils found are fragmentary, complete fossils are rare or absent. The unit becomes arenaceous at the height between 1.5 to 3 m. There are some thin-bedded dark gray lime-mudstones, there lithology is not much changed except fossils become more complete than in the lower, containing large cystoid plates, crinoid stems and unidentifiable shells of brachiopods, gastropods and fragments of bryozoa are scattered on the bedding surface. The unit is more ferruginous giving reddish brown in colored of the outcrop. Foraminifers microfossils especially Middle Permian foraminifers were collected

form these portions.

In the middle part (6 m), bedding thicker, medium-bedded lime-mudstone with prominent cross-stratification, more fossils fragments appear in the fossiliferous horizon (about 1 m in thickness) composed of complete and fragments of brachiopods, fenestrate bryozoa, low-spined gastropod and crinoid stem, a small number of chert nodules and stromatoporoids. Purplish siltstone interbedded natures are occasionally present [Figure 3c & 3d](#). The fossils mainly of brachiopods and gastropods are larger in the upper part of the middle portion. Purplish or dark gray or dark gray lime mudstones and siltstone

containing a number of gastropod shells still remain.

In the upper part, 9 m above base of the section, the fossil fragments of the above assemblage bearing grainstone occur sporadically. Purer carbonate ratio and less of shale or silt at this horizon. Medium to thickly bedded outcrops are characteristically distinguishable from the upper part of this unit to the poorly bedded to massive outcrops of the Permian Thitsipin Formation [Figure 3e & 3f](#). From the biostratigraphic point of view, no fusuline biozone has been so far determined due to the lack of any fusuline taxon at the lower and Middle parts of the measured section.

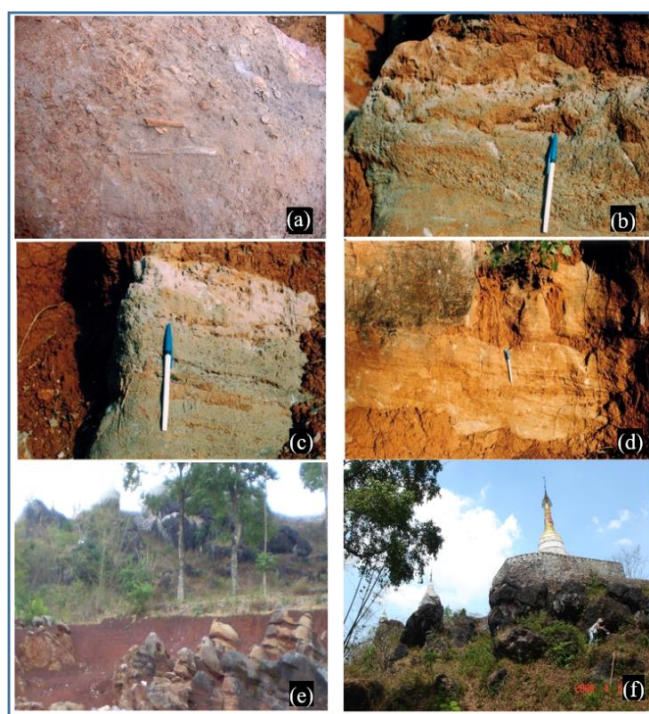


Figure 3. Photograph showing lithological characters of the Middle Permian Thitsipin Formation, Pegin pagoda hill, Pegin village, Ywangan township, Shan State (south). (a-f) (a) purple coloured thin shale layers in basal part of the Pegin Formation; (b) crinoidal lime-grainstone layer in the basal part of the Thitsipin Formation; (c) fossils fragment bearing layer of the Middle part of the Thitsipin Formation; (d) Lime-mudstone with prominent cross-stratification; (e-f) thick bedded to massive outcrop overlying the mixed clastic and carbonate units of the Thitsipin Formation.

4.2. Faunal Characteristics

In this section, authors are advised to provide a thorough analysis of the results and make comparisons with The Pegin section is situated at the Pegin Pagoda, Pegin village. Section measurement was carried out between the grid points M093749 and M095750. The total stratigraphic thickness is about 78 m [Figure 4](#). At the base of the section, a nearly ten-meter-thick sequence of well-bedded, dark grey, crinoidal limestone and micritic limestone is well exposed. It is interesting to note that a four-meter-thick interval of wavy bedded, dark gray limestone with purple calcareous shale intercala-

tions, is well exposed at the base of Pegin Pagoda. In this interval, *Multidiscus padangensis* of the Middle Permian foraminifers are discovered in a dark gray, micritic limestone. Fossils are locally fairly common. No fusuline fossil has been noticed at the Pegin Section that is composed mainly of microbioclastic packstone, microbioclastic grainstone, wackestone and minor peloidal packstone and lime mudstone. Partially silicified specimens of *M. padangensis* commonly occurs in argillaceous microbioclastic wackestone in association with smaller foraminifers (such as *Pachyphloia* sp. and *Tetrataxis* sp.), sponge spicules, bryozoans and gastropod coils at the lower part of the section. Large crinoid stems and bryozoans are abundant, especially in the basal portion of the measured section.

Simplified columnar section at Pegin Monastery showing sample collecting horizon with collected fossils is shown in Figure 4. It is here noteworthy that an early Middle Permian smaller foraminifer, *Multidiscus padengensis*, is characteristically present in the argillaceous limestone facies of the lowest part of the section that unconformably overlies the Linwe Formation of Silurian age. It can be correlated with the Htam Sang Limestone of Hopong Township, southern Shan State [4, 31].

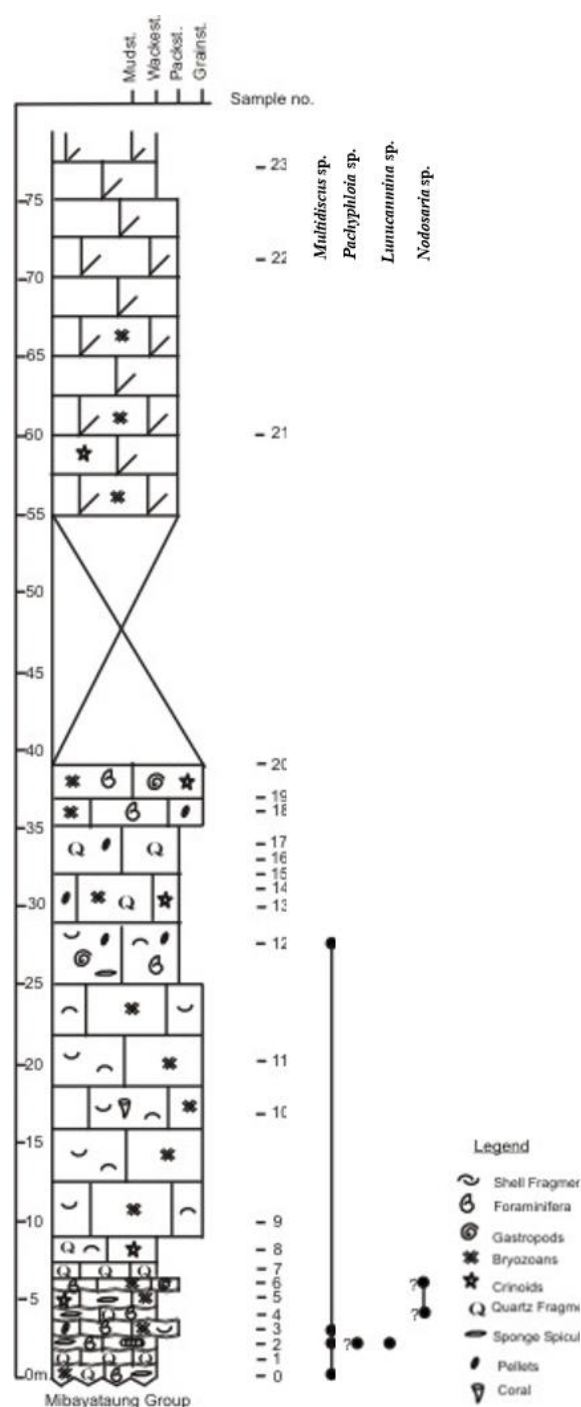


Figure 4. Columnar section at Pegin Monastery between the grid points M093749 and M095750 (one-inch topographic map no. 93/C12); showing sample collecting horizons with collected fossils.

Systematic Paleontology

Superfamily ENDOTHYRACEA Bardy, 1884

Family NODOSINELLIDAE Rhumbler, 1895 [29]

Subfamily NODOSINELLINAE Rhumbler, 1895 [29]

Genus Lunucammia Spandel, 1898 [30] Figure 5a-5b

Type species., *Lunucammia devonica* Lepina, 1950 (P-213, PL-223, Fig-6) from Russian platform, USSR.

Diagnosis., Test elongate, narrow to broadly flaring and subtriangular in outline, compressed, ovate to reniform in section, commonly with a median longitudinal depression that in slightly tangential longitudinal sections may give the appearance of two opposed and not alternating rows of chambers, globular proloculus followed by gradually widening, low, uniserial and rectilinear chambers, slightly to distinctly arched at the midline of flat sides, sutures medially arched, depressed, wall calcareous with microgranular inner layer and radially striate or fibrous outer layer, surface smooth to longitudinally striate, aperture terminal, rounded to ovate.

Lunucammia sp.

Material., Only two longitudinal section (BGMF- 5003 and 5004)

Description., The test is elongate and subangular in outline. This species occurs and appears an ovate to reniform. It is commonly occurred with a medium longitudinal depression. Consisting of globular proloculus. Chamber are rectilinear and not alternating rows. The present species has six chambers and it is the same as type species.

Comparison and Remarks., They are distributed extensively in Europe, Asia, Australia, and North America. There is no literatures available on the genus Lunucammica of the neighboring regions. Thus, this comparison of the species is only made between the present form and the Germany species [23].

Geological range., Upper Devonian - Upper Permian

Occurrence., This species is found in the basal part of the Thitsipin Formation, Pegin Pagod Hill, Ywa ngan Township.

Super family NODOSARIOIDEA Ehrenberg, 1838

Family NODOSARIOIDAE Ehrenberg, 1838 [15]

Genus Nodosaria Lamarck, 1816 [21] Figure 5c

Type species., *Nodosaria doliiformis* Eichenberg, 1933 [16] (p. 7, pl. 7, Figure 6)

Nodosaria doliiformis Eichenberg; 1962 Tappan, (p. 173, pl. 45)

Diagnosis., Test free, narrow, rectilinear, with straight sides; 4-7 cylindrical chambers gradually increasing in size as they are added, later chambers higher than broad; suture distinct and slightly depressed; wall calcareous and hyaline; aperture terminal and rounded.

Material., One frontal axial section (BGMF-5002)

Description., Similar in outline to other species by having the chambers disassociated from the original test due to the fragile stolon connecting the chambers.

Occurrence.; Fairly occurs in the argillaceous microbioclastic wackestone at the base of Thitsipin Formation, Pegin Pagoda Hill, Ywa ngan Township.

Geological Range; Permian to Recent, cosmopolite.

Superfamily GEINITZINIACEA Bozorgnia, 1973 [12]

Family GEINITZINIDAE Bozorgnia, 1973 [12]

Genus *Pachyphloia* Lange, 1925 [Figure 5d](#)

Type species., *Pachyphloia ovata* Lange, 1925 [22]; Gallo-way, 1933 [18] (*1205), (p. 172)

Pachyphloia Lange, 1925; (*1788), (p. 230)

Parapermodiscus Miklukho-Maklay, 1953; (*2117), p. 129

Parapermodiscus gefoensis Miklukho-Maklay, 1953 OD

Diagnosis., Test elongate, compressed, ovate in outline, fusiform to sinuate in horizontal section, consisting of a rectilinear series of very broad, low, strongly overlapping chambers; wall calcareous, two layered, with very thin dark inner layer and thicker hyaline outer layer of radial structure, lamellar thickening especially prominent at the flattened sides; aperture terminal, rounded, bordered by radial grooves.

Material., One axial section (BGMF-5005)

Description., Test is elongate and compressed. The number of chambers is 6-8. Uniserially arranged chambers are strongly arched. A well-developed lamellar thickening can be observed in the lateral longitudinal sections.

Occurrence; Rarely occurs in microbioclastic wackestone in association with *Multidiscus padangensis* at the lower part of Thitsipin Formation, Pegin Pagoda Hill, Ywa ngan Township.

Geological Range; Middle Permian to Recent, cosmopolite.

Superfamily CORNUSPIROIDAE Sochulze, 1854

Family NEODISCIDAE Lin, 1984 [24]

Genus *Multidiscus* Miklukho-Maklay, 1953

Type species: *Multidiscus padangensis* (Lange) M. Permian, Guguk Bulat, Sumatra, East Indies.

Multidiscus padangensis Lange, 1925 [Figure 5e-j](#)

Materials: Three axial sections: (BGMF-5006, 5007, 5008)

Three subaxial section: (BUMF-5009, 5010, 5011).

Description: The spherical proloculus is followed by planispirally coiled undivided tubular second chamber. The coiling is involute but the last whorl coils evolutely. Test large, entirely planispiral involute. Buttresses and oval shaped to semi-circular section of the whorl.

Discussion: According to the original description, the genus *Multidiscus* is characterized by a large test, with planispiral coiling of the entire test or with some fluctuation of the axis of coiling, and with significant lateral thickenings [13, 26]. The genus *Neohemigordius* [34] is characterized by a large test, with an axis of coiling of the first whorl displaced with respect to the next ones that are planispirally coiled, and with developed lateral thickenings. Thus, *Neohemigordius* has morphological features which match the description of the genus *Multidiscus* and is a junior synonym of the latter genus, in agreement with the opinion of [17].

Occurrence: Fairly occurs in microbioclastic wackestone in association with *Pachyphloia* sp. and *Lunucamina* sp. at the lower part of the Thitsipin Formation, Pegin Pagoda Hill, Ywa ngan Township.

Geological Range; Middle Permian (Murgabian)

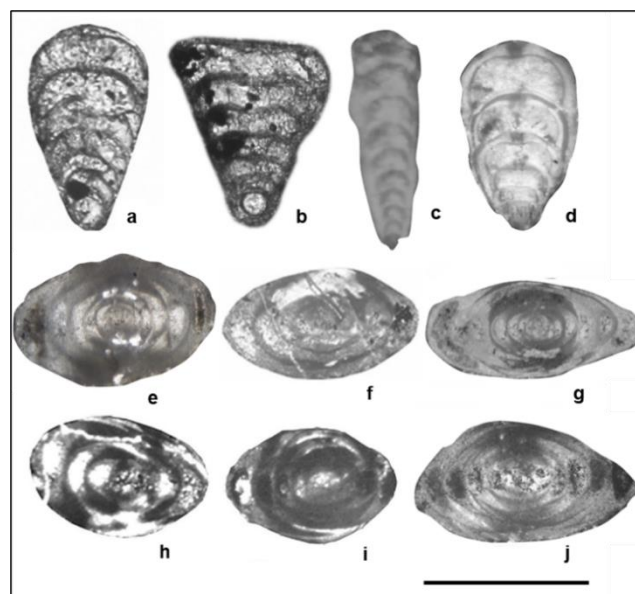


Figure 5. a-b (BGMF-5003, 5004) *Lunucamina* sp. showing Test elongate, narrow to broadly flaring and subtriangular in outline, collected from the base of the Pegin Formation. c-(BGMF-5002) *Nodosaria* sp. showing rectilinear test with cylindrical chamber, collected from the argillaceous microbioclastic wackestone at the base of Thitsipin Formation. d- (BGMF-5005) *Pachyphloia* sp. showing ovate outline test, collected at lower part of the Thitsipin Formation. e-g axial section (BGMF-5006, 5007, 5008); h-j subaxial section (BGMF-5006, 5007, 5008) of *Multidiscus padangensis* showing discoidal to subspherical, planispiral, slightly evolute, polar ends unbilicated to rounded, spirotheca relatively thick, collected from the lower portion of the middle part of the Pegin Formation (scale bar = 0.5 mm).

5. Conclusions

The present study of the Thitsipin Formation at Pegin Pagoda Hill, southern Shan State, has provided new insight into the taxonomy and stratigraphic significance of its foraminiferal assemblages. Four genera (*Nodosaria* sp., *Lunucamina* sp., *Pachyphloia* sp., and *Multidiscus padangensis*) were identified from thin-section analyses. Among them, *Pachyphloia* sp. and *Multidiscus padangensis* are characteristic of the Middle Permian (Murgabian) and confirm that the Thitsipin Limestone in the study area is of Middle Permian age. The lithological succession from basal calcareous shale and wackestone to crinoidal grainstone demonstrates a fossiliferous carbonate sequence with significant biostratigraphic value. These results not only refine the stratigraphic framework of the southern Shan State but also provide a useful reference for regional correlations with other Permian carbonate successions in Myanmar and beyond. Furthermore, the findings contribute to the academic foundation for undergraduate training and open new perspectives for future paleontological and stratigraphic research in the Shan Plateau.

Abbreviations

BGMF Banmaw Geology Museum Fossils

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Author Contributions

Aung Myo Zaw is the sole author. The author read and approved the final manuscript.

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Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Biography



Aung Myo Zaw is a Associate Professor at Dagon University, Geology Department. He completed his PhD in Geology from Yangon University in 2019, and his Master of Sciences in Geology from the same institution in 2009. Recognized for his exceptional contributions, Dr. Aung Myo Zaw has

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Research Field

Aung Myo Zaw: Stratigraphy and Paleontology of Permian Strata