BRACHIOPODA FROM TAUNGNYO FORMATION, MAWLAMYINE AREA, MON STATE*

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Abstract

This paper reviews the brachiopod fossils from the Taungnyo Range, Mon State, Myanmar. I describe here, Late Devonian to Early Carboniferous brachiopods including; *Punctospirifer scabricosta, Tropidoleptus carinatus,* and *Tetracamera subcuneata* were found in the study area. According to the discovery, each species possesses different shell outline and surface morphological features. Fossil specimens are well-preserved in the mudstone and argillite (C_1t^2) unit of Taungnyo Formation. The fossil brachiopods are absence C_1t^1 and C_1t^3 units. Among them, all taxa are first described in Myanmar but previously named in the world.

Keywords: Brachiopoda, Taungnyo Formation, Taxonomic Classification, Devonian, Carboniferous, Paleoecology, Mon State

Introduction

Carboniferous to Early Permian rocks are well exposed along the Taungnyo Range. There have been a few studies, the most works have been done on the sedimentological field. Paleontological and sedimentological purpose of Taungnyo Formation described by Clegg (1953), Nyunt Htay (1979), Kyaw Min (1997), Moe Zat (2006), Nay Zar Zar Linn Aung (2006), Kyi Pyar Aung *et al.* (2014), Ye Yint Aung (2016), Moe Moe Lwin (2017), and Nandar Myint Maung *et al*. (2020). Although the detail paleontological analysis of brachiopod fossils are less detailed in this area. Therefore, the present to identify systematic paleontology of brachiopods in the Taungnyo Formation.

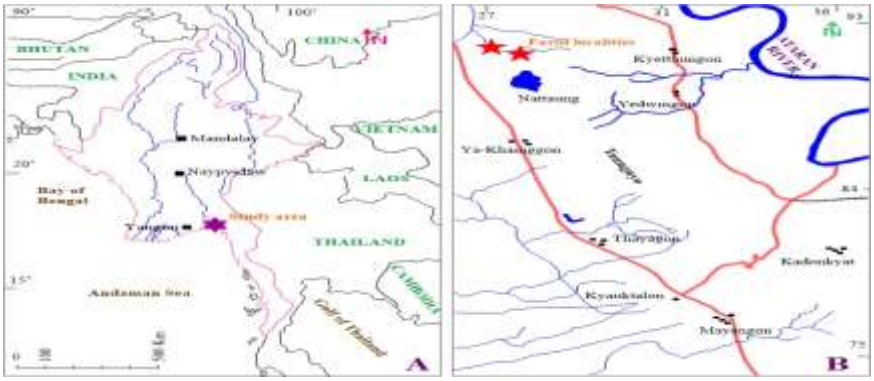

Figure 1. Location map of the study area. (A) Location of Mon State.

(B) Detailed map of the Taungnyo Range and fossil localities marked by red star.

Aims and Objectives

The aim of this paper to identify the systematic study and taxonomic classification of brachiopod faunas. The objectives of this work include to describe the various lithology, to review and update of the fossil specimens, and to determine the stratigraphic position of the study area.

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Location, Material, and Methods

The study area is located about 4.8 km from southeast of Mawlamyine Township, Mon State (Fig 1). It is also situated in the one-inch topographic map sheet no. 94H/11 and UTM map sheet no. 1697-11. I have taken 16 days long field investigation in 2016. The detailed field investigation was being done in order to know the different rock units and to collect the complete fossil specimens. The measurement of stratigraphic sections was used by the Jacob's staff methods wherever the appropriate localities. Also, the fossils were being systematically collected during the stratigraphic measurements. The fossil specimens were collected carefully packed together with tissue papers, cottons, and rubber bands. Fossils were selected and photographed with a cannon camera. The mapping was used by GIS software.

Regional Geologic Setting and Stratigraphy of the study area

The Taungnyo Range is a part of the Shan Tanintharyi Belt and trending nearly N-S structural direction. Regionally, Taungnyo Range is mainly covered by the Paleozoic strata with preserved brachiopods and other marine invertebrate faunas in this area. The regional geological map of the study area is shown in Figure 2.

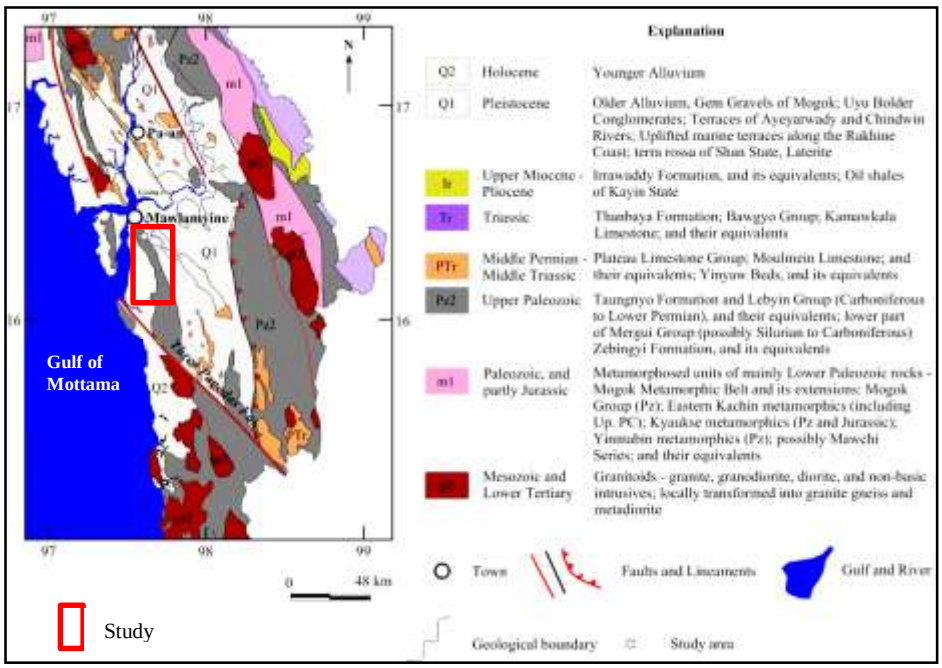

Figure 2. Regional Geological map of the study area

(cited from geological map of Myanmar, MGS, 2014)

The study area consists of clastic sedimentary rocks and limestone occurred as belts striking NW-SE direction. The Early Paleozoic rock of Taungnyo Formation and the Permian rock of Moulmein Limestone Group are widespread in the study area.

Leicester (1930) was first proposed the Taungnyo series from a rocks sequence of sandstones, quartzites, shales, and slates exposed along the Taungnyo Range. And then, the contributors include Pascoe E. H. (1959) and Brunnschweiler (1970) used the term as a Taungnyo Group. Taungnyo Formation consists of sandstones, shales, slates, siltstones, argillites, and mudstones (Figure 3). Sandstone is mostly quartzose sandstone, arenite, pebbly greywacke,

and quartzwacke (in Pascoe, 1930). Shale is pink, purple, reddish, and yellowish color. It has been subdivided into three major lithologic units; C_1t^1 unit, C_1t^2 unit, and C_1t^3 unit.

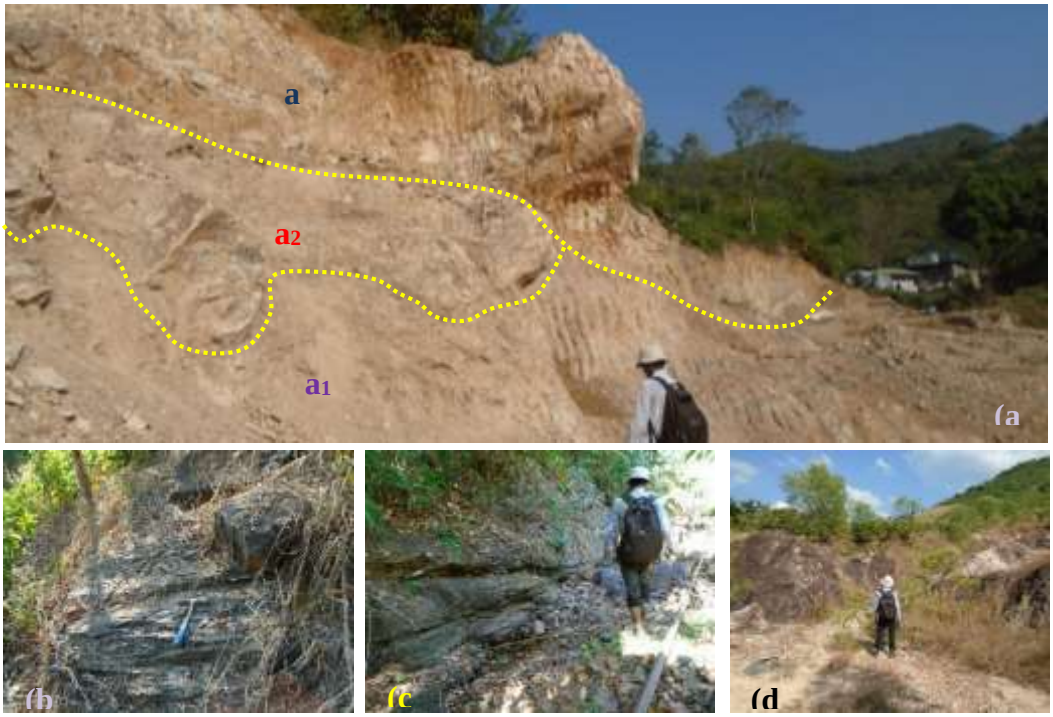

Figure 3. Rock units of Taungyo Formation; (a) C_1t^1 unit, [a_1] = Intercalated with shale and mudstone [a_2] = mudstone [a_3] = sandstone (b) Black slate of C_1t^1 unit (c) fossiliferous mudstone and argillite of C_1t^2 unit (d) thick bedded quartzo sandstone and friable sandstone of C_1t^3 unit

Brachiopods were mainly preserved fossiliferous mudstone and argillite of C_1t^2 unit of Taungnyo Formation in the study area. Some brachiopods and associated fossils occur in the Taungnyo Formation are mentioned by Kyaw Htin Khaing (2001), Zaw Win (2009), Ohmar Soe Yin *et al.* (2018), and Hai Peng Xu *et al.* (2021). The systematic work on the fossils and their collection from the following measure section Figure 4.

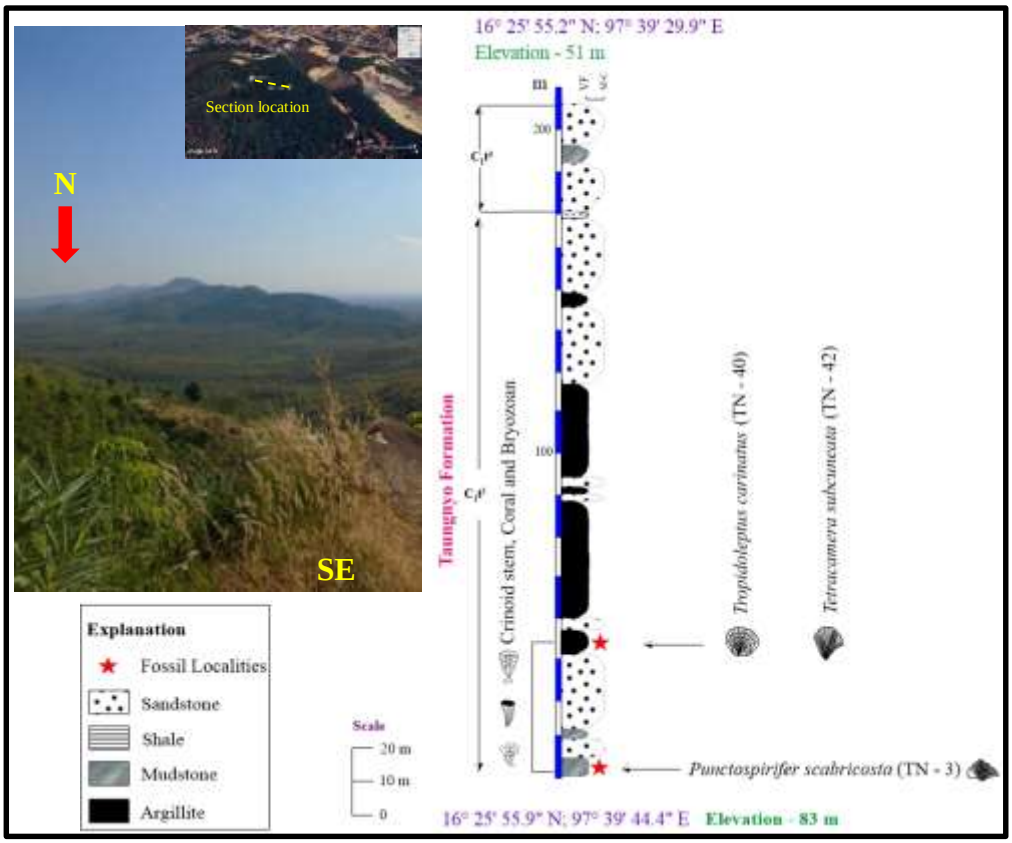

Figure 4. Stratigraphic measure section and distribution of fossil in the Taungnyo Formation

The Taungnyo Formation is overlain by Moulmein limestone (Permian age) with an unconformity. Moulmein Limestone Group is exposed as isolated hills on the alluvial plains at the eastern and western part of the Taungnyo Range. Moulmein Limestone Group is mainly composed of carbonate sedimentary rocks with a general trend of NW-SE direction.

Systematic Paleontology

Morphological terminology and classification of brachiopod follow by *Treatise on Invertebrate Paleontology* (Moore R. C., 1965**)**.

Phylum BRACHIOPODA Dumeril, 1806

Order SPIRIFERINIDA Ivanova, 1972

Suborder SPIRIFERINIDINA Ivanova, 1972

SuperFamily SPIRIFERINADEA Davidson, 1884

Family SPIRIFERINIDAE Davidson, 1884

Genus ***Punctospirifer*** North, 1920

Punctospirifer scabricosta White, 1860 (Fig 5)

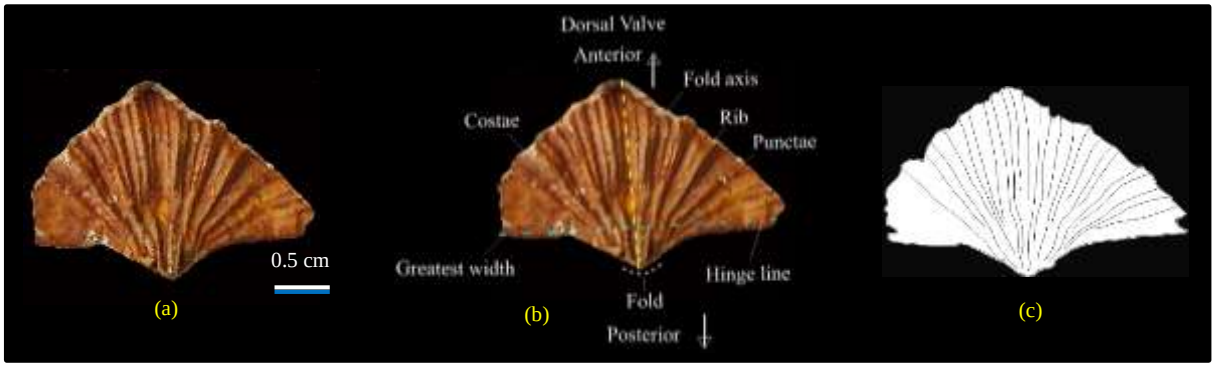

Figure 5. *Punctospirifer scabricosta* from C_1t^2 unit of Taungnyo Formation. (a) Exterior view of dorsal valve complete specimen, (b) terminology of the fossil specimen (YUDG-MlmTn 3; X 3), (c) Sketch of the shell outline

***Material*—**External shell (YUDG-MlmTn 3)

Type Locality*—*West of Shwekyatkya Monastery, ***Southeast*** of Pokukku monastery.

***Diagnosis*—**Shell small, slightly ventribiconvex, slightly wider than long, greatest width along hinge line; the outline of brachial valve sub-semicircular; ventral interarea of moderate height, to nearly orthocline; beak moderately incurved over interarea, notothyrium open, triangular; dorsal interarea not developed; fold and sulcus wide, smooth, sharply-delimited, each flank with about 4 undivided plications which decrease in size laterally; surface of both valves marked by distinct capillae and numerous, closely-spaced growth lines, giving shell a lamellose appearance; shell substance sparsely punctate; dimensions of a complete specimen: Ventral valve with short dental lamellae and median septum; dorsal valve with cardinal process of comb-like cross section and low median ridge along fold; crural plate lacking (Figure 5).

***Description*—**Shell medium sized, distinctly triangular in shape, strongly transverse, widest at hinge, strongly, sub-equally biconvex; Shell with large, densely spaced punctate. Specimens are maximum length of 10.7 mm, width 27.7 mm. Pedicle valve strongly extended laterally, characterized by strong, sub-rounded sulcus, not flaring; sulcus somewhat deeper than lateral grooves; valve with 3 or 4 sub-angular to sub-rounded, simple lateral plications; plication bounding sulcus slightly broader, higher than lateral plications, lateral extremities without plications, flat, smooth. Pedicle valve is interior with strong hinge teeth, median septum; remainder of characters of both valve interiors unknown.

***Discussion*—**This species is a common element of the *Calvustrigisruther fordi* assemblage of the eastern faces, although it is not usually found in large numbers. The Banff specimens agree in all external respects with authentic specimens from the midcontinent. Allan, Warren, and Rutherford (1932, p. 239), Brown (1952, p. 103), and Nelson (1960, Pl. 5, Figure 19) previously reported this species from the Jasper Park region.

Order TEREBRATULIDA Waagen, 1883

SuperFamily ENTELETOIDEA Waagen, 1884

Family TROPIDOLEPTIDAE Schuchert, 1896

Genus ***Tropidolep tus*** Hall, 1857

Tropidoleptus carinatus Conrad, 1839 (Figure 6)

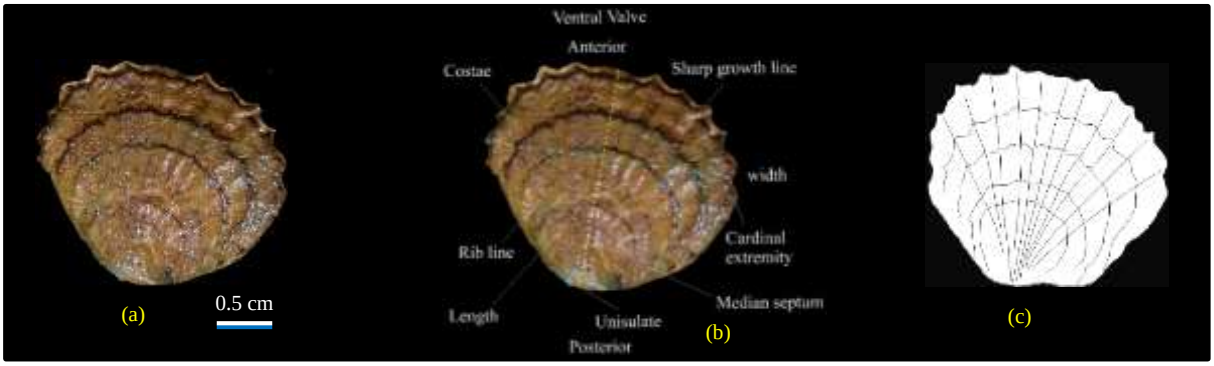

Figure 6. *Tropidoleptus carinatus* from C_1t^2 unit of Taungnyo Formation. (a) Exterior view of ventral valve complete specimen, (b) terminology of the fossil specimen (YUDG-MlmTn 3; X 2.8), (c) Sketch of the shell outline

***Material*—**Internal shell (YUDG-MlmTn 40)

Type Locality*—**Occurs in the Pokukku Chaung and near the ***Northeast of Pokukku Monastery.

***Diagnosis*—**Rounded and oval shape, curl growth line, sharp, large, depressed, non-carinate *Tropidoleptus carinatus* with low, short, and thin dorsal median septum and low rounded costae.

***Description*—**The shell is very low, planoconcave, weakly unisulcate, rather thick-walled, with cardinal extremity obtuse and never mucronate. The size is unusual and very large for the genus; the largest specimen examined attains 27.3 mm width. The shell wall is densely exopunctate. The ventral valve is transversely oval, 20.2 mm of the maximum length. The lateral margins are evenly rounded; the anterior margin is only weakly curved. The ventral valve is gently and evenly concave in a transverse profile and weakly and unevenly convex in a lateral profile, with the maximum convexity and depth in the posterior third (Figure 6).

***Discussion*—**Specimens from various stratigraphical levels may be referred to typical subspecies *T. carinatus* (Conrad, 1839). The size of the specimens does not exceed 25 mm and falls into usual size range of the type subspecies. The specimens of the Upper Pragian (sample H 1052) age have fine dorsal median septum perfectly developed already in very small individuals (pl. 5, Fig 19). Inner periphery of these small shells bears bundles of delicate radial ridges. Adult specimens are some 20 mm wide and have weakly convex ventral valve devoid of distinct carination. Specimens from stratigraphically higher beds, referred to the Upper Emsian, Emsian/Eifelian boundary interval and Eifel a have commonly smaller shells, with width about 15 mm. The ventral valve is considerably convex and, in some specimens, also distinctly carinate.

Family TETRACAMERIDAE Likharev in Rzhonsnitskaja, 1956

Genus ***Tetracamera*** Weller, 1910

Tetracamera subcuneata Hall, 1858 (Cited by Butts, 1922) (Figure 7)

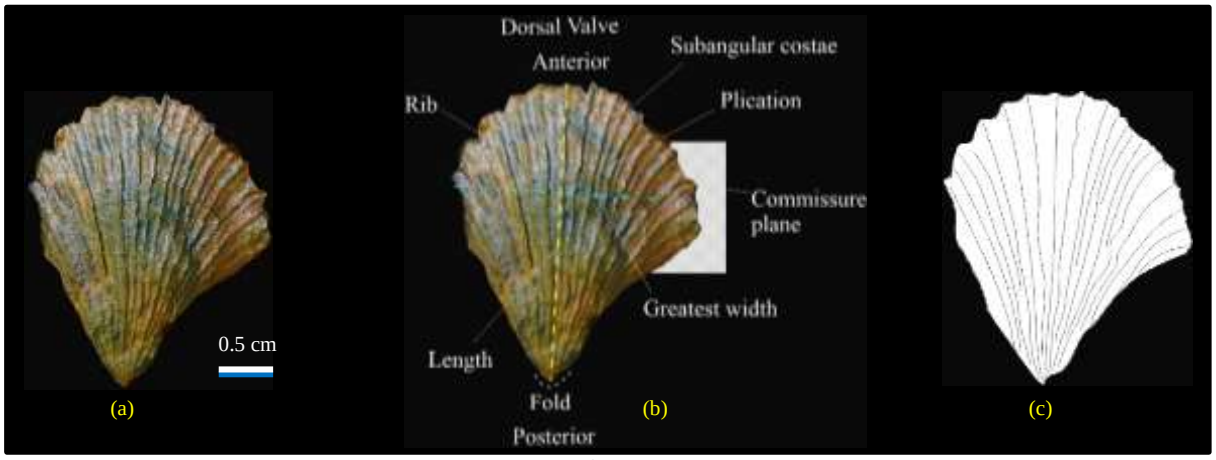

Figure 7. *Tetracamera subcuneata* from C_1t^2 unit of Taungnyo Formation. (a) Exterior view of dorsal valve complete specimen, (b) terminology of the fossil specimen (YUDG-MlmTn 42; X 2), (c) Sketch of the shell outline

***Material*—**External shell (YUDG-MlmTn 42)

Type Locality*—**Occurs in the Pokukku Chaung and near the ***Northeast of Pokukku Monastery.

***Diagnosis*—**Small or medium-sized; acute apical angle; commissure plane or weakly uniplicate; costae sub-angular; capillae may develop. Septalium open; lateral lamellae support hinge below dental sockets and rest on floor of brachial valve on either side of median septum.

***Description*—**Shell rhynchonelli form and elongated outline, small or medium size, triangularly sub-ovate to sub-pentagonal in outline, the medial fold, and sinus poorly developed or nearly obsolete except towards the front, the lateral and anterior margins of both valves deflected so as to stand at nearly right angles to the plane of the valves, both valves marked by simple, sub-angular or rounded plications which reach to the beak. The maximum width is 26 mm and length is 28 mm (Figure 7).

***Discussion*—**The species included in this genus were referred to *Camarophoria* by Hall and Clarke, and usually have been so referred since the publication of their work. The shells do not possess the characteristic cruralium of *Camarophoria*, besides possessing other characters wholly foreign to that genus. The most essential generic characters are the presence of the buttress plates connecting the dental lamella with the inner surface of the outer shell wall, and the presence of the supplementary lamella in the rostra portion of the brachial valve in addition to the median septum. The species *T. subtrigona* which is here included in the genus differs in a rather fundamental manner from the genotype, not only in the general form of the shell but in the arrangement of the internal lamella, and should perhaps be made the type of a distinct genus but the discussion of these characters is reserved for treatment under the specific description.

According to the detail measurements, maximum length and width of *Punctospirifer scabricosta* (10.7/27.7mm), *Tropidoleptus carinatus* (20.2/27.3 mm), and *Tetracamera subcuneata* (28/26mm) as shown in (Table 1) and (Figures 8-11).

Table 1. The Measurements of brachiopod fossils from the Taungnyo Formation, Mon State, Myanmar. Abbreviations: ML = Maximum Length, MW = Maximum Width, SC = Space of Costae

Measurements (in mm)								
Taxon	**Specimen No.**	**ML**	**MW**	**Space of Costae**				
				SC - 1 to SC - 15				
Punctospirifer scabricosta	YUDG-MlmTn 3	10.7	27.7	5.1	2.2	3	3.8	4
				3.6	2.9	2.9	2.5	4.2
Tropidoleptus carinatus	YUDG-MlmTn 40	20.2	27.3	2.4	2.5	2.5	2.4	2.4
				2.3	2.6	2.4	2.5	2.7
Tetracamera subcuneata	YUDG-MlmTn 42	28	26	1	0.8	1.2	1	1.3
				1	1	1	1	1.2
				1.2	1.4	1.7	1.3	-

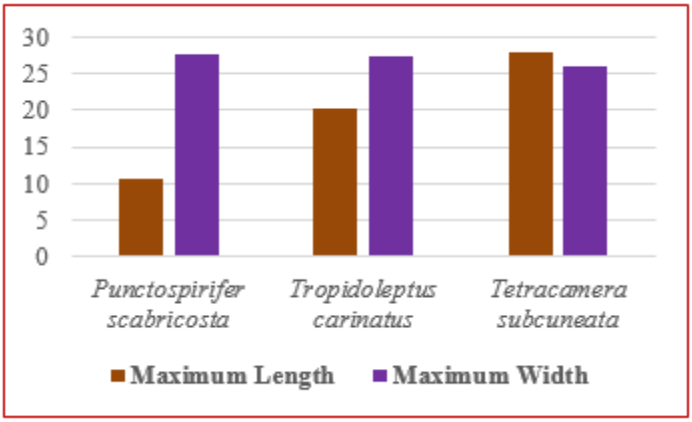

Figure 8. The columnar chart showing maximum length and maximum width of brachiopods

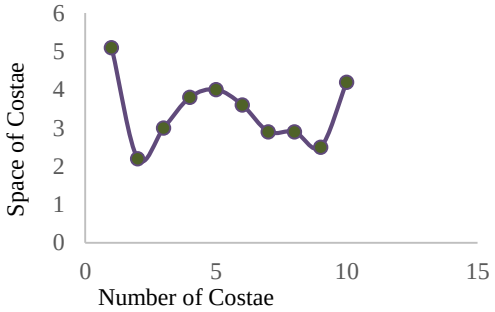

Figure 9. Scatter line and markers of costae measurement; *Punctospirifer scabricosta*

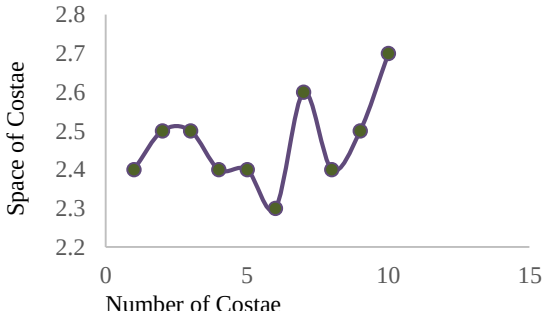

Figure 10. Scatter line and markers of costae measurement; *Tropidoleptus carinatus*

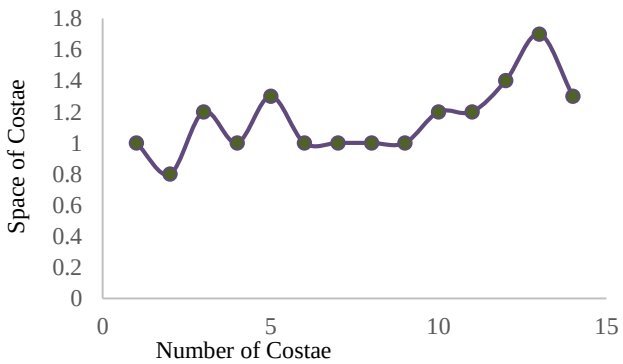

Figure 11. Scatter line and markers of costae measurement; *Tetracamera subcuneata*

Paleoecology

In this section, the discovery of brachiopod fossils is mostly sessile epibentho, epifaunal, suspension feeders, and dwellers illustrated in Table 2. Some may have become deposit feeders and dwellers. The Devonian to Carboniferous seas were dominated by the most brachiopods. The Early Carboniferous brachiopods include; *Punctospirifer scabricosta* and *Tetracamera subcuneata* are display compressed geometries which facilitated suspension on fluid substrates and may have benefited respiration under lower oxygen tension. Late Devonian - Carboniferous brachiopod such as *Tropidoleptus carinatus* is live only in the sea, and most species avoid locations with strong current wave. Now, brachiopods are live mainly in cold water and low light. The occurrence of Late Devonian brachiopod fauna from inhabited deep water soft bottom settings located presumably below the photic zone (Szulczewski 1971; Biernat and Racki 1986a).

Hence, the abundant faunas are indicated deposition in a normal salinity and clear water. Another explanation suggests that the lack of shallow water facies, presence of distinct grading, and resemblance of Bouma'a sequence strongly indicates the Taungnyo Formation were deposited in submarine fan (Day Wa Aung, 2014). Therefore, the depositional environment of Taungnyo Formation is probably submarine fan. These macrofossils found within the mudstone and argillite was considered when determination the depositional setting during the Middle Devonian time.

Table 2. Ecology of the brachiopod faunas in the Taungnyo Range

Formation/Group	Age	Taxon	Localities and Coordinates	Ecology
Taungnyo Formation	Early Carboniferous	*Punctospirifer scabricosta*	Road cut 16° 25' 51.5" N 97° 39' 44.7" E	Stationary epifaunal suspension feeder
	Late Devonian-Carboniferous	*Tropidoleptus carinatus*	Stream section 16° 25' 56.9" N 97° 39' 38.9" E	Ubiquitous dwellers
	Early Carboniferous	*Tetracamera subcuneata*	Stream section 16° 25' 56.9" N 97° 39' 38.9" E	suspension feeder

Results and Discussion

This study mainly based on the morphological characteristics, three different species recognized and find-out the first recorded paleontological data from the Taungnyo Formation. The three brachiopods species were recognized to their morphological features and done by good identification. According to the findings, the fossil brachiopods was discovered colonizing of other fossils such as crinoid stems, corals, and bryozoans in the C_1t^2 unit which it located in very narrow site. Among these fossils, usually common and abundant brachiopod faunas in the study area. The brachiopods were collected from two different localities and fossils distribution sites in the northern part of the Taungnyo Range (Figure 12).

Morphologically, a comparison of different shell outlines is clearly. *Punctospirifer scabricosta*; width is wider than length and the ribs are distinct larger than other species. *Tropidoleptus carinatus* is rounded-shape and *Tetracamera subcuneata* is elongated shell outlines. These species differ from the Zwekabin Range brachiopods of Taungnyo Group. The observed brachiopod faunas are mainly formed by solitary and both of complete pedicle and brachial valve. Until recently, the systematic investigation is less and also paleontological workers are limited. It is remaining the more detail studies of paleontological evidence. This paper is a contribution to the taxonomic classification of the brachiopod fauna and suggest that the paleoecology and geological age of Taungnyo Formation. Moreover, Middle Devonian brachiopods such as *Fimbrispirifer venustus* and *Ovetensispirifer ovetensium* are described by Ye Yint Aung & Chit Sein (2022). Therefore, the age of the Taungnyo Formation is probably Middle Devonian age and should be amendment the geological age according to the discovered brachiopod assemblages.

Figure 12. Showing fossil sites of the C_1t^2 unit of Taungnyo Formation in the Taungnyo Range

Conclusions

The present paper describes three brachiopods species and study detail morphological features. Different type of shell outlines and their morphological features are clearly distinct. This study mainly focused on fossil brachiopods and analyzed here from the C_1t^2 unit of Taungnyo Formation.

I collected fossil specimen number (YUDG-MlmTn 3), (YUDG-MlmTn 40), and (YUDG-MlmTn 42) in the study area. Faunal content of the brachiopods, especially *Punctospirifer scabricosta, Tropidoleptus carinatus,* and *Tetracamera subcuneata* are mentioned in this paper. These fossils are found at the northern portion of the Taungnyo Range especially which are located in the Pokukku Chaung section and along the footpath of Shwekyatkya Monastery.

The recent discovery of fossil sites deserved to be designated as geoheritage site, Taungnyo Range geopark, and regional geologic significance. Furthermore, these latest findings are important for geological age of Taungnyo Formation and one of the significantly recorded of Myanmar Geosciences.

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Conflict of Interest (COI)- The author declares no conflict of interest in this paper.

References

Allan, J. A., Warren, P. S., and Rutherford, R. L. (1932) A Preliminary study of the Eastern Ranges of the Rocky Mountains in Jasper Park, Alberta. Transactions of the Royal Society of Canada, **26**, series 3, section, 4:225-249.

Bender, F. (1983) Geology of Burma. Gebruder Borntraeger, Berlin, Stutgart, 230.

Biernat, G. and Racki, G. (1986) A rhynchonellid dominate Late Famennian brachiopod assemblage from the Holy Cross Mountains. *Acta Palaeontologia Polonica* **31**, 85-106.

https://jlc.jst.go.jp/DN/JALC/00357990382?type=list&lang=ja&from=J-STAGE&dispptn=1

Brown, R. A. C. (1952) Carboniferous stratigraphy and paleontology in the Mount Greenock area, Alberta; *Geological Survey of Canada, Memoir*, **264**, 119 p. https://www.boekwinkeltjes.nl/b/173837876/Carboniferous-stratigraphy-and-paleontology-in-the-Mount Greenock-area-Alberta

Brunnschweiler, R. O. (1970) Contribution to the geology of Burma: New Formations and structures in the northern Shan State and in Karen State; *unpublished report of the Burma Geological Department*. https://doi.org/10.1080/00167617008728724

Butts (1922) The Mississippian Series of Eastern Kentucky," Kentucky Geol. Survey, Ser. **6**, **7**, 188 pp., 19. https://pubs.usgs.gov/pp/1503/report.pdf

Chhibber, H. L. (1934) The Geology of Burma: London, Mac Millan. Co. Ltd., 588pp.

Clegg (1953) The Mergui, Moulmein and Mawchi Series. Rec. Geol.Surv. India, **78**(2) (1953), pp.157-192

Conrad, T. A. (1839) Second Annual Report on the Paleontological Department of the Survey. *New York Geological Survey, Annual Report*, **3**:57-66. https://scholar.google.com/scholar?cites=15269753928370310935&as_sdt=2005&sciodt=0,5&hl=en

Davidson, T. (1884) A monograph of the British fossil Brachiopoda. *Paleontograph. Soc*., **5**, pt. 3, 243-276, pl. 18-21 (London). https://archive.org/details/monographof381884pala/page/n253

Day Wa Aung (2014) Sedimentology of Taungnyo Formation in Mawlamyine Area, Mon State. Proceedings of the 13th Regional Congress on Geology, Mineral and Energy Resources of Southeast Asia, Yangon, 10-11 March 2014, 43.

Dumeril, A. M. C. (1806) Zoologie analytique ou method naturelle de classification des animaux. Xxiv + 344 pp. Allais, Paris.

Hai-Peng Xu *et al.* (2021) A Late Cisuralian (Early Permian) brachiopod fauna from the Taungnyo Group in the Zwekabin Range, eastern Myanmar and its biostratigraphic, paleobiogeographic, and tectonic implications. *Journal of Paleontology* **95**(6), 1158-1188. https://doi.org/10.1017/jpa.2021.66

Hall, J. (1858) Report on the geological survey of the State of Iowa, J. Hall and J.D. Whitney (eds.); *Paleontology*, **I**, pt. **2**, 473-724. https://www.sudoc.fr/025080342

Ivanova, E. A. (1972) Main features of spiriferid evolution (Brachiopoda) [in Russian]. *Paleontologičeskij žurnal;* 28-42.

Kyaw Min (1997) Geology of Taungnyo Area, Mawlamyine, Mudon and Kyaikmayaw Townships. (Unpublished), MSc Thesis, University of Mawlamyine, Myanmar.

Kyaw Htin Khaing (2001) Lithostratigraphy and sedimentary facies analysis on the carbonate rocks of Zwekabin Range, Pa-An Township, Karen State. (Unpublished), MSc Thesis, University of Yangon, 124 pp.

Kyi Pyar Aung, Owens R. & Metcalfe I. (2014) New Evidence for Carboniferous Age of the Taungnyo Group Exposed in the Loikaw Area, Kayah State. Proceedings of the 13th Regional Congress on Geology, Mineral and Energy Resources of Southeast Asia, Yangon, 10-11 March 2014, 34.

https://www.researchgate.net/publication/279058375

Leicester, P. (1930) Geology of Amherst district: *Records of the Geological Survey of India*, **63**, Pt. 1 (Dir, Gen. Rep).

Moe Moe Lwin & Day Wa Aung (2017) Sedimentology of Taungnyo Formation, Mawlamyine, Mudon and Kyaikmaraw Townships, Mon State. The Third AAPG/EAGE/MGS Oil and Gas Conference, Yangon, Myanmar, February 22-24.

Moe Zat (2006) Geological and Petrological Study on Paleozoic Rocks of Mawlamyine and Its Environs. (Unpublished), MSc Thesis, University of Mawlamyine, Myanmar.

Moore, R.C., Teichert, C. and Robison, R.A., Eds. (1965) Treatise on Invertebrate Paleontology. Part H: Brachiopods, I. University Press of Kansas, Lawrence, Kansas, 521 p.

http://paleopolis.rediris.es/BrachNet/REF/Treatise/Treatise6.pdf

Nandar Myint Maung *et al.* (2020) Carbonate Microfacies Analysis of the Karon Area, Kyaikmaraw Township, Mon State. Universities Research Journal, **13**, 6, 29-42.

Nay Zar Zar Linn Aung (2006) Geological Study on Paleozoic Rocks of the Eastern Mudon Area, Mudon Township, Mon State. (Unpublished), MSc Thesis, University of Mawlamyine, Myanmar.

Nelson, S. J. (1960) Mississippian lithostrotionid zones of the southern Canadian Rocky Mountains; *Journal of Paleontology*, **34**, no. 1, 107-126. https://www.jstor,org/stable/1300992

North, F. J. (1920) On Syringothyris Winchell and Certain Carboniferous Brachiopoda Referred to Spiriferina d'Orbigny. *Geological Society of London, Quarterly Journal*, **76** (2):162-227, plates11-13.

https://doi.org/10.1144/gsl.jgs.1920.076.01-04.06

Nyunt Htay (1979) Geology of Mudon, Thanphyuzayat, Mon State. Unpublished geological map of DGSE.

Ohmar Soe Yin *et al.* (2018) The Early Permian Brachiopoda from Zwekabin Range, Hpa-An Township. *Myanmar Academy of Arts and Sciences*, **16**, (5): 55-68.

Pascoe, E. H. (1930) General Report of the Geological Survey of India for the Year 1929. *Records of the Geological Survey of India*, **63**, 1-154. https://www.new.dliernet.in/handle/2015/28685

Pascoe, E. H. (1959) A Manual of the Geology of the India and Burma, 3rd Edn., **2** Government of India Press, Calcutta, 484-1343 pp. https://archive.org/details/dli.ernet.233375

Rzhonsnitskaja, M. A. (1956) *Semeystvo Pentameridae i sem. Camarotoechiidae:* 49-50,53-55, in Khallfin, L. L. (See 465). [*Family Pentameridae and family Camarotoechiidae.*].

Schuchert, C. (1896) *Brachiopoda*; in Zittel., K. A. von (transl. & ed. By Eastman, C. R.), Textbook of Paleontology, **1**, lst ed., 291-343, text-fig. 489-587, Macmillan & Co., Ltd. (London).

Soe Thura Tun, Maung, Thein, Nyunt, Htay and Kyaing, Sein (2014) Geological Map of Myanmar, 2014. Scale 1:2,250,000. Myanmar Geosciences Society.

Szulezewski, M. (1971) Upper Devonian conodonts, stratigraphy and facial development in the Holy Cross Mts. *Acta Geologica Pololonica* **21**, 1-129. https://geojournals.pgi.gov.pl/agp/article/download/ 10262/8782

Waagen, W. (1883) Salt Range Fossils. I. Productus-Limestone Fossils. *Geological Society of India Memoirs, Palaeontologia Indica (Calcutta), Series* **13**, 391-546.

https://www.marinespecies.org/aphia.php?p=sourcedetails&id=222345

Waagen, W. (1884) Salt Range Fossils. I. Productus-Limestone Fossils. *Geological Survey of India, Memoirs, Palaeontologia India, Ser*. **134** (3): 547–610.

Warren, P. S. (1932) Description of new species. *In* J. A. Allan, P. S. Warren, & R. L. Ruther ford, eds., A preliminary study of the eastern ranges of the Rocky Mountains in Jasper Park, Alberta. *Transactions of the Royal Society of Canada* **26** (series3, sec.4): 225-249, 2pl.

Weller, S. (1910) *Internal characters of some Mississippian rhynchonelli form shells:* Geol. Soc. America, Bull., **21**, 497-516, 18 text-figs.

White, C. A. (1860) Observations upon the geology and paleontology of Burlington, Iowa and its vicinity*; Boston Society of Natural History, Journal*, **7**, 209-235.

Ye Yint Aung (2016) Paleontological Study of the Northern part of Taungnyo Area, Mawlamyine Township, Mon State: (Unpublished), MRes Thesis, University of Yangon, 164p.

Ye Yint Aung & Chit Sein (2022) First Record of Brachiopod Species in Myanmar. Open Journal of Geology: **12**, 80-90. https://doi.org/10.4236/ojg.2022.121004

Zaw Win (2009) Fossil Brachiopods from the Zwekabin Range, Hpa-An University Research Journal: **1**, 145-149. https://www.researchgate.net/publication/284848000

https://ci.nii.ac.jp/naid/10004058612/Biernat, G. and Racki, G. (1986) A rhynchonellid dominatem

Late Famennian brachiopod assemblage from the Holy

Cross Muontains. Acta Palaeontologia Polonica 31, 85–106

Biernat, G. and Racki, G. (1986) A rhynchonellid dominatem

Late Famennian brachiopod assemblage from the Holy

Cross Muontains. Acta Palaeontologia Polonica 31, 85–106