

First Record of Brachiopod Species in Myanmar

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Abstract

The Paleozoic rocks are well exposed in the Taungnyo area and the main purpose of classification is taxonomic status of the invertebrate fossils and describing the systematic paleontology of brachiopod fossils from Taungnyo Formation. Mainly distributed clastic sedimentary rocks of Taungnyo Formation (Early Carboniferous) and carbonate rocks of Moulmein Limestone Group (Permian to Middle Triassic) are well exposed in the Taungnyo area. In this study, mainly, a total of five species are recognized in the clastic sediments of Taungnyo Formation. Most brachiopods are generally found abundant and well preserved in the mudstone unit. Among them, most of the taxa have not been recorded previously. The brachiopods include: *Fimbrispirifer venustus*, *Ovetensispirifer ovetensium*, *Aullacella* sp., *Kayserehellae emanuelensis*, and *Chonopectus* sp. All of the species are first recorded in Myanmar.

Keywords

Brachiopod, Taungnyo Formation, Systematic Paleontology, Myanmar

1. Introduction

Carboniferous to Lower Permian rock units are widely distributed in the southeastern part of the Taungnyo range. A few previous workers were carried out in this area for geological, sedimentological purposes, and the brachiopod fossils have been found from the rocks of Taungnyo Formation (cited previous authors, e.g. Kyaw Min, 1997; Moe Zat, 2006; Nay Zar Zar Linn Aung, 2006; Day Wa Aung, 2014) [1] [2] [3] [4]. However, the systematic paleontological analysis of Taungnyo Formation is still lacking in this area. The present study aims the first attempt to identify and study invertebrate fossils in Taungnyo Formation from the interior to discuss their systematic paleontology of brachiopods in the Taungnyo range.

Location, Materials, and Methods

The study area is located in the Taungnyo area, about 4.8 km from south-southeast of Mawlamyine Township, Mon State (**Figure 1**). The detailed field-work was carried out to record different rock units and their lithologic characters. The stratigraphic sections were measured by Jacob's staff methods, on different desired localities and fossils were collected systematically during the stratigraphic section measurements. All the brachiopods species in the Taungnyo Formation are arranged systematically described taxonomically. All types of species were selected and their images were photographed.

2. Regional Geologic Setting

The study area is positioned in the southeastern part of Mawlamyine and Taungnyo range, Shan Tanintharyi Belt [5]. The region corresponding to present day Taungnyo range is located in the central Shan Tanintharyi Belt between the latitudes 16° and 17°. The study area comprises clastic sedimentary rocks of Taungnyo Formation which has been correlated with the Lebyin Group of southern Shan State and Mergui Group of Tanintharyi Region. Regionally, the Taungnyo range is primarily covered by the Paleozoic strata with the brachiopods and other marine invertebrate fauna in this area. Nearly N-S trending features of the range are mainly reflected by the orogenic movements. The study

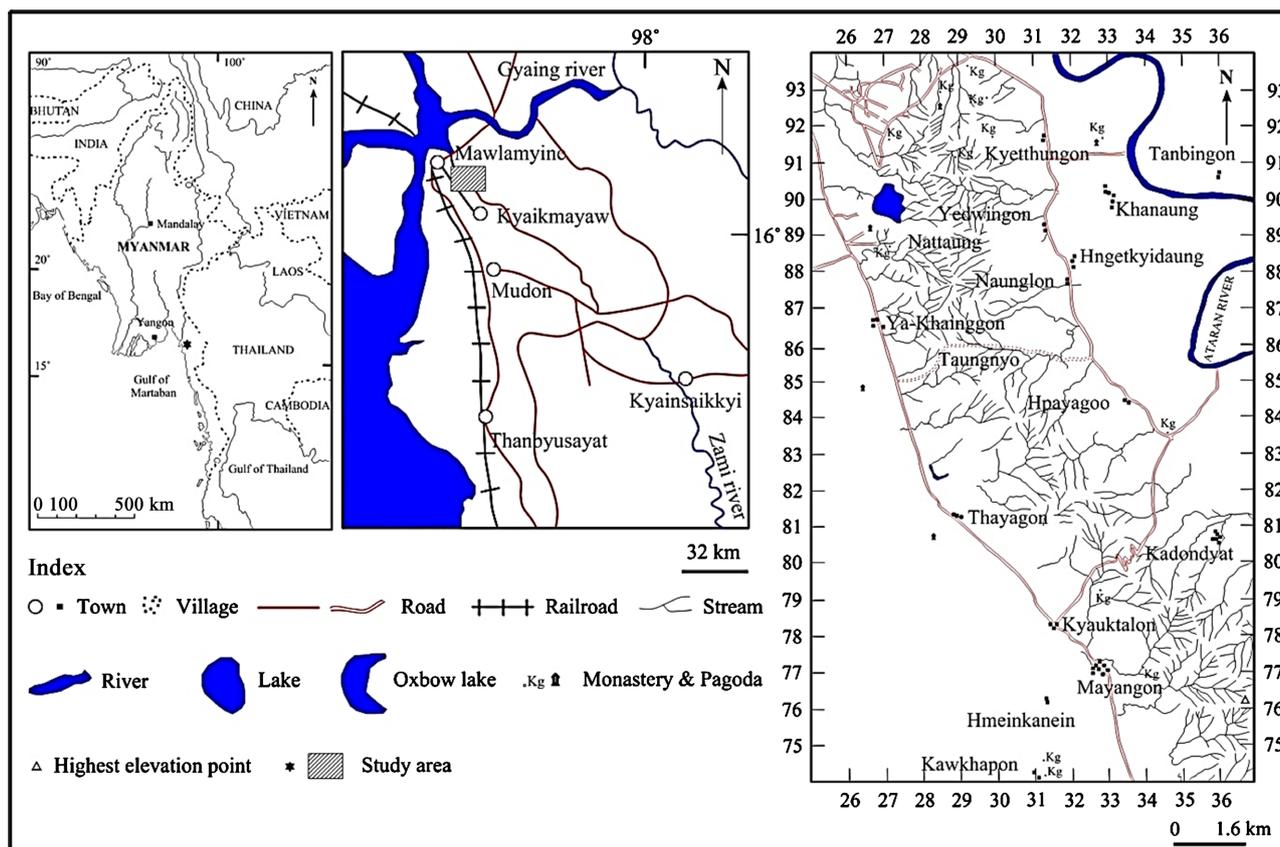


Figure 1. Location map of the study area.

area consists of clastic sedimentary rocks and limestone that occurred as belts trending NW-SE direction. The regional geological map of the study area is shown in **Figure 2**.

The Paleozoic rock units are well exposed in the Taungnyo range. The Lower Paleozoic rock units are Mogok Group (Paleozoic and partly Jurassic). Paleozoic to Mesozoic units are Taungnyo Group (Carboniferous to Lower Permian), Plateau Limestone Group (Middle Permian to Middle Triassic), Bawgyo Group (Triassic). A Cenozoic rock unit is Irrawaddy Formation (Upper Miocene to Pliocene).

A sequence of argillite, quartzite, and sandstone several thousands of meters thick were grouped by Leicester (Pescoe, 1930) [7] as the Taungnyo Series (after the Taungnyo range south of Moulmein). In the Zwekabin range south of Pa-an Township, an Upper Carboniferous fauna was recovered by Brunnschweiler (1970) [8] from the calcareous sandstone of the Taungnyo Series. The fossils assemblage includes gastropods, brachiopods, bryozoans, corals, and ostracods. Kyaw Min (1997) [1] carried out research work and he described the Geology of Taungnyo area (Mawlamyine, Mudon, and Kyaikmaraw Twonships) which is the north part of the present research work and he found that the Carboniferous

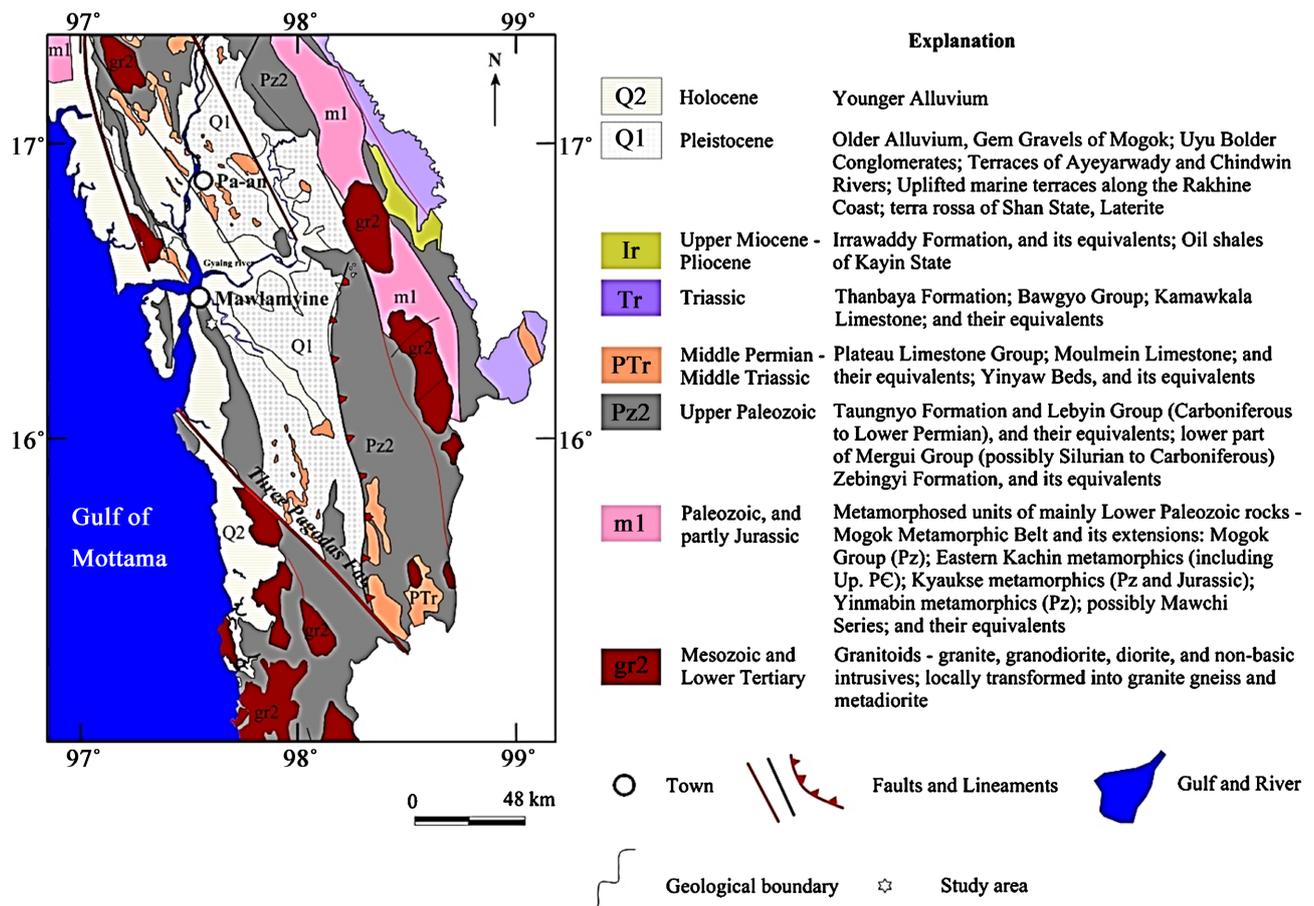


Figure 2. Regional Geological map of the study area (cited from a geological map of Myanmar, Soe Thura Tun, Maung Thein, Nyunt Htay and Kyaing Sein, 2014) [6].

fauna such as brachiopods, gastropods, bryozoans, and crinoids in the Taungnyo Formation. Brachiopods are the most abundant group. This formation consists of clastic sedimentary rocks such as sandstone, shale, slate, siltstone, argillite, and mudstone. Sandstone is mostly quartzose sandstone, arenite, pebbly grey-wacke, and quartzwacke. Shale is pink, purple, reddish, and yellowish in color.

The Taungnyo Formation is overlain by Moulmein limestone (Permian age) with an unconformity. The existence of an unconformity is seen in Zwekabin range, which is located in the north of the study area. Taungnyo Formation is a general trend of NNW-SSE direction and has been subdivided into three major lithologic units; C_1t^1 unit, C_1t^2 unit, and C_1t^3 unit. Brachiopods were found in fossiliferous mudstone of C_1t^2 unit.

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 chiefly composed of carbonate sedimentary rocks with a general trend of NW-SE direction. Moulmein Limestone Group is Permian age and can be correlated with Plateau Limestone Group of southern Shan State, due to lithological and biological characters.

3. Systematic Paleontology

The classification of brachiopod follows by *Treatise on Invertebrate Paleontology* (Moore R. C., 1965) [9] and other international papers.

Phylum	BRACHIOPODA (Dumeril, 1806) [10]
Subphylum	RHYNCHONELLIFORMEA (Williams, Carlson, Brunton Holmer and Popov, 1996) [11]
Class	RHYNCHONELLATA (Williams, Carlson, Brunton Holmer and Popov, 1996)
Order	SPIRIFERINIDA (Ivanova, 1972) [12]
Suborder	DELTHYRIDINA (Ivanova, 1972)
Superfamily	DELTHYRIDOIDEA (Phillips, 1841) [13]
Family	FIMBRISPIRIFERIDAE (Pitrat, 1965) [14]
Genus	<i>Fimbrispirifer</i> (Cooper, 1942) [15]
	<i>Fimbrispirifer venustus</i> (Hall, 1860) [16] [17] (Figure 3)

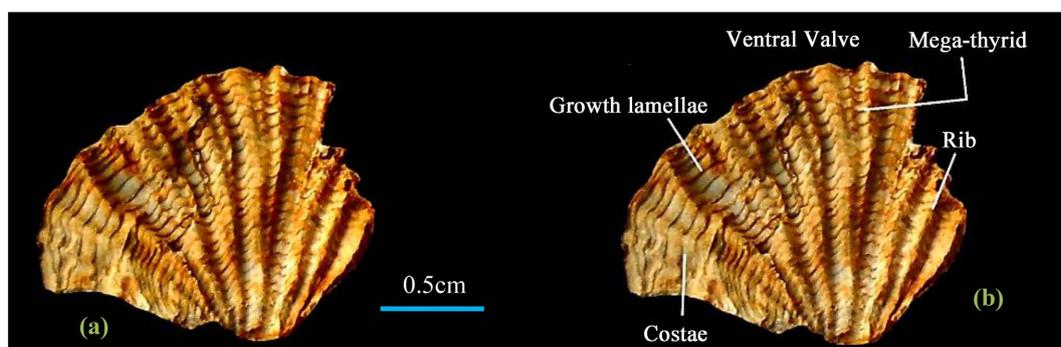


Figure 3. *Fimbrispirifer venustus* from Taungnyo Fm. in Myanmar. (a) Interior view of ventral valve in internal mould, (b) terminology of the fossil specimen (TN-6).

Material—The specimen is collected from the light grey to dark grey color mudstone of Taungnyo Formation, near the west of Shwekyatkya monastery.

Locality—Near the west of Shwekyatkya Monastery, south-east of Pokukku monastery.

Description—Form and size; shells medium-sized with bifurcating and trifurcating ribs on flanks. Outline semi-elliptic to sub-triangular. Exterior of ventral valve; interarea high, catacline to apsacline, and curved in the upper part. Delthyrium open. Deltidial lamella and deltidium lacking. Sulcus broad and rounded in cross section. Exterior of dorsal valve; interarea low and ancline. Folds are moderately high. Coarse ornamentation; ribs unequally bifurcating and trifurcating on the posterior half of the flanks at the same growth stage. Each rib multiplies only once. Sulcus with a median furrow. Ribs are bifurcating to median form the sulcus bordering ribs always at the same growth stage. Ribs on hold bifurcating from the most lateral rib to median or from the first pair of a rib to lateral. Ribs on the fold and in the sulcus are of the same size as ribs on the flanks. All ribs are fine, separated by fine furrows. Ribs and furrows rounded to angular in cross-section.

Age—Middle Devonian to Carboniferous

Family OVENSPIRIFERIDAE (Pitrat, 1965)

Genus *Ovenspirifer* nov. (Carls, 1986) [18]

Ovetenspirifer ovetensium (Carls, 1986) (Figure 4)

Material—The specimen is collected from the light grey to dark grey color mudstone of Taungnyo Formation, near the west of Shwekyatkya monastery.

Locality—Near the west of Shwekyatkya Monastery, south-east of Pokukku monastery.

Description—Shells medium-sized, megathyrid without mucronations, and sub-elliptical in outline; equibiconvex to dorsibiconvex in longitudinal section. The exterior of ventral valve; ventral interarea moderately high, apsacline, and curved. Delthyrium open, deltidial lamellae clearly developed, deltidium lacking.

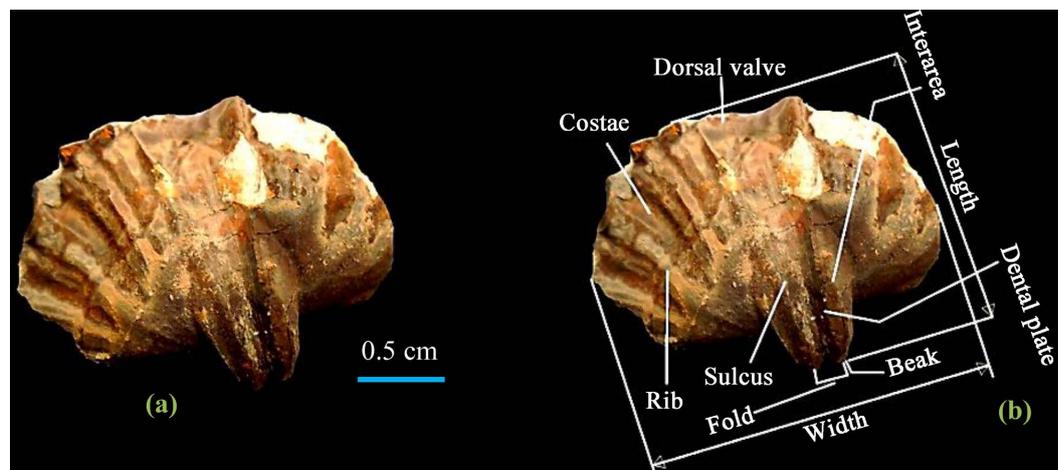


Figure 4. *Ovetenspirifer ovetensium* from Taungnyo Fm. in Myanmar. (a) Exterior view of dorsal valve complete specimen, (b) terminology of the fossil specimen (TN-50).

Exterior of dorsal valve; dorsal interarea low, anacline and curved. Notothyrium is not recognizable. Coarse ornamentation; ventral and dorsal valves are covered by numerous fine ribs with furrows of the same size. Ribs are angular to rounded in cross-section and do not bifurcate on flanks, furrows are angular in cross-section. Lateral ribs in the sulcus and on fold bifurcate once in the adult stage. Usually 3 ribs in the sulcus and 4 ribs on the fold, in geronitic stage 5 ribs in the sulcus and 6 ribs on the fold. Growth lamellae are rarely developed at the anterior margin.

Discussion—*Ovetensipirifer ovetensium* is smaller than *O. novascotianus* has 2 ribs less in the sulcus, and 2 impressions of ribs on each side of the internal mould of the ventral muscle field whereas *O. novascotianus* has 4 to 5 impression of ribs on the internal mould of the ventral muscle field.

Age—Middle Devonian to Carboniferous

Family RHIPIDOMELLIDAE (Schuchert, 1913) [19]

Subfamily RHIPIDOMELLIDAE (Schuchert, 1913) [19]

Genus *Aulacella* (Schuchert & Cooper, 1931) [20]

Aulacella sp. (Schuchert & Cooper, 1931) [20] (Figure 5)

Material—The specimen is collected from the light grey to dark grey color mudstone of Taungnyo Formation, near the west of Shwekyatkya monastery.

Locality—Near the west of Shwekyatkya Monastery, south-east of Pokukku monastery.

Description—Shells medium-sized, wider than long (width/length ratio; 1.09 - 1.36), dorsibiconvex, sub-quadrangular in outline; hinge line shorter than greatest width (hinge line width/width; 0.34 - 0.56); maximum width at about mid-length or slightly anteriorly; anterior commissure rectimarginate to uniplicate, rarely paraplicate. Ventral valve regularly convex in lateral profile, semi-elliptical in posterior view; sulcus either absent or shallow, with bottom flattened to round. Dorsal valve regularly and moderately inflated in lateral profile; highest at about mid valve or more anteriorly but not at the front; median depression in some specimens developed in its posterior part but reaching rarely the front;

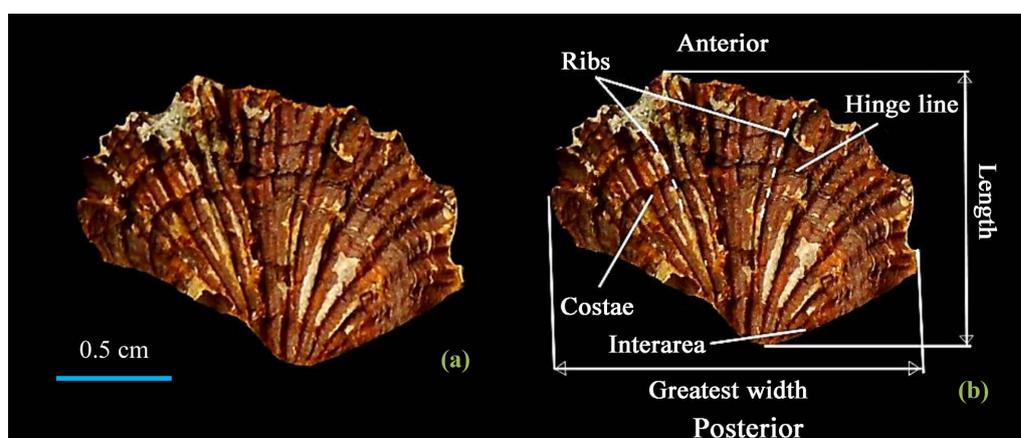


Figure 5. *Aulacella* sp. from the locality of Taungnyo range, Taungnyo Fm. in Myanmar. (a) Exterior view of dorsal valve in internal mould, (b) terminology of the fossil specimen (TN-5).

interarea orthocline, flat, generally less developed than the ventral one.

Discussion—*Aulacella* sp. was long misidentified as *A. arcuate* (Phillips, 1841) [13], a poorly known species from the Middle Devonian of Hope's Nose, Torquay in south Devon (England) but, however, it differs from the latter by a greater size and a narrower outline. *Aulacella* sp. has a less delimited and less elongated ventral muscle field than that of *A. interlineate* (Sowerby, 1840) [21]. *Aulacella* sp. is never as inflated as *A. eifliensis* (Schnur, 1853) [22]. Moreover, its outline is more developed in width and its ornamentation is coarser. *Aulacella* sp. differs from *Rhipidomella manticula* (Stainbrook, 1947) [23] by its greater size and its equibiconvex to dorsibiconvex profile. This species has been assigned to *Aulacella* by Cooper & Dutro (1982) [24]. *Aulacella* sp. is distinguished from *A. xinanensis* (Chen, 1978) [25] by its larger size, a more flattened profile and its wider outline. *Aulacella* sp. is larger than *A. elliptica* (Cooper & Dutro, 1982) [24] form which it also differs in its coarser ornamentation.

Age—Late Devonian to Carboniferous

Family KAYSERELLIDAE (Schnur, 1854) [22]

Genus *Kaysarella* (Hall & Clarke, 1892) [26], emended (Cooper, 1955) [27] [28] [29]

Kaysarella emanuelensis (Figure 6)

Material—The specimen is collected from the light grey to dark grey color mudstone of Taungnyo Formation, near the west of Shwekyatkya monastery.

Locality—Near the west of Shwekyatkya Monastery, south-east of Pokukku monastery.

Description—Outline sub-circular, profile biconvex, ventral valve with greater depth. Convexity of both valves greatest posteriorly, least along anterior borders which are almost flat. Hinge line two-thirds shell width, measured at midlength. Cardinal margins are obtuse, rounded in some specimens but usually angular. The dorsal valve is shallowly and broadly sulcate, anterior commissure broadly sulcate to nearly straight. The ventral valve of the interarea is moderately long, apsacline umbo straight to nearly erect. The dorsal valve of interarea is half-length

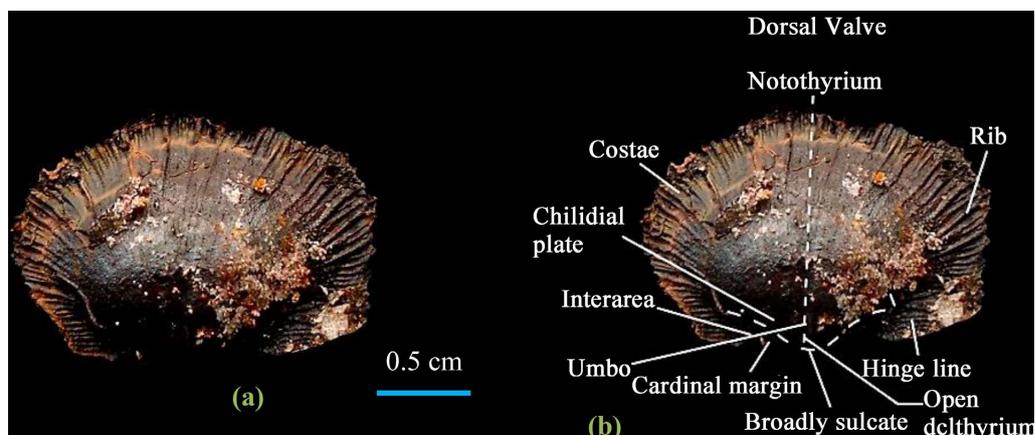


Figure 6. *Kaysarella emanuelensis* from Taungnyo Fm. in Myanmar. (a) Exterior view of dorsal valve, complete and well preserved shell, (b) Terminology of the fossil specimen (TN-48).

of ventral interarea, anacline. Delthyrium open, wide with thickened margins. Notothyrium is partly closed by cardinal process and narrow chilidial plates.

Discussion—As a result of Cooper's (1955) revision, *Kaysarella* has become a finely drawn genus, narrowly separable from similar orthoidgenera, such as *My-strophora* (Kayser, 1871) [30] and *Monelasmina* (Cooper, 1955). In fact, these genera, as now defined, can only be distinguished with suitable well preserved material. Fortunately the new species is sufficiently well preserved for a detailed examination, which shows that the species, with its long high median septum dividing the shell into two halves, and inner socket plates supported by a long narrow cruralium, is a member of *Kaysarella*, *K. emanuelensis* differs specifically from the type species, *K. lepida* (Schnur), in being more weakly sulcate and in having a more highly longer crurlium. *K. emanuelensis* also differs from the basal Middle Devonian species *K. americans* (Cooper, 1955), with which it agrees in external shape, in having a longer cruralium. *Kaysarella?* *Karaghensis* (Reed, 1922) [31] (pp. 35, 36, pl.6, figs. 14, 15) from the Upper Devonian of Koragh near Reshun Chitral, is very similar externally to *K. emanuelensis*. As the interior of Reed's species is unknown it is of course possible that this external similarity is not maintained internally.

Age—Late Devonian to Carboniferous

Super Family STROPHALOSIOIDEA (Schuchert, 1913) [19]

Genus *Chonopectus* (Hall & Clarke, 1892) [26]

Chonopectus sp. (Hall & Clarke, 1892) [26] (Figure 7)

Material—The specimen is collected from the light grey to dark grey color mudstone of Taungnyo Formation, near the west of Shwekyatkya monastery.

Locality—Near the west of Shwekyatkya Monastery, south-east of Pokukku monastery.

Description—Shell concavo-convex, sub-elliptical or sub-circular in outline, usually wider than long, the hinge-line usually a little shorter than the greatest width of the shell, the hinge extremities sub-rectangular or a little rounded. The dimensions of two individuals are; length 26 cm and width 40.8 cm and 7.5 cm thickness. Pedicle valve most convex near the middle, becoming moderately

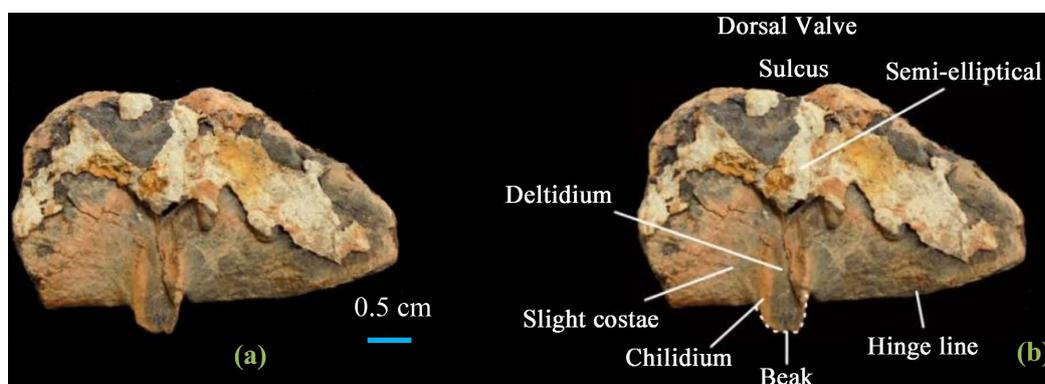


Figure 7. *Chonopectus* sp. from Taungnyo Formation in Myanmar. (a) Exterior view of dorsal valve, well preserved and exfoliated shell, (b) terminology of the fossil specimen (TN-49).

compressed towards the cardinal extremities, with no medial sinus or medial flattening of the valve; the umbonal region usually a little flattened, the beak scarcely protuberant beyond the cardinal margin; the cardinal margin sharply defined, bearing about four, slender, obliquely curved spines. Brachial valve moderately concave with the greatest concavity near the middle, the surface becoming flattened towards the cardinal extremities; at the beak or initial point of the valve, close to the cardinal margin, is a small, round, node-like protuberance. The cardinal area, cardinal process, and internal features of the shell not observed.

Discussion—This species is by far the most abundant in the sandstone. Not a fragment of the rock in the fossiliferous layers can be broken without exposing one or more specimens of this species and the number of individuals' present is many times that of other species in the fauna. As they occur in the sandstone, the surface markings are usually obliterated to a very great extent so that they appear to be nearly smooth but the concentric lines or wrinkles of growth may usually be observed near the hinge-line, and also the curved diagonal lines.

Age—Late Devonian

4. Conclusions

1) The present paper focus on the analysis of brachiopod is described by five species in this work. These species have not been recorded from Myanmar but were previously named in the world.

2) The brachiopod fauna was able to be rich in the widespread in the mudstone unit of Taungnyo range. Brachiopods, especially, *Spirifer*, *Aulacella*, *Kaysereellae* and *Chonopectus* are the most common element in the Taungnyo Formation.

3) New discovery of brachiopods fossils was very significant for the geological age of Taungnyo Formation. The geological age of Taungnyo Formation is Carboniferous age but the research area is found Devonian age of Brachiopods fauna.

4) According to the discovery of brachiopod fauna, Taungnyo Formation is possible until the Middle Devonian-Carboniferous age and this formation should be made amendments to the geological age.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Abbreviation

- TN Taungnyo (name of the fossil specimen number)
- Fm. Formation (name of rock unit in the study area)