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# *Pararigbyella* and *Dicystoconcha* (Lyttoniidina, Brachiopoda) from the middle Permian (Wordian) of Japan

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Abstract. Permianellids are a specialized fossil group of Brachiopoda characterized by a complicated forking lobe system. In this paper, we report two permianellid species (*Pararigbyella doulingensis* Shen and Zhang, 2008 and *Dicystoconcha lapparenti* Termier and Termier in Termier *et al.*, 1974), from the middle Guadalupian (Wordian, middle Permian) of the Kamiyasse-Imo area, South Kitakami Belt, Northeast Japan, of which *Pararigbyella doulingensis* is the first record in Japan. A global review of all occurrences of the two genera suggests that *Pararigbyella* is restricted to the Cathaysian Province, while *Dicystoconcha* is mainly distributed in the Paleotethyan region and the two transitional zones between the Boreal or Gondwanan and Paleotethyan realms.

Key words: Dicystoconcha, Pararigbyella, Permian, South Kitakami Belt, Wordian

### Introduction

This paper presents the first description of two unusual Permian lyttoniid brachiopods, *Pararigbyella* and *Dicystoconcha*, from Japan, i.e., *Pararigbyella doulingensis* Shen and Zhang, 2008 and *Dicystoconcha lapparenti* Termier and Termier in Termier *et al.*, 1974, from the middle Guadalupian (Wordian, middle Permian) of the Kamiyasse-Imo area, South Kitakami Belt, northeast Japan.

The material was collected from sandstone and argillaceous limestone of the lower Kamiyasse Formation (Wordian) at localities KF217 and KF218, upper Imosawa Valley, Kamiyasse-Imo area in South Kitakami Belt (Figures 1, 2). The Kamiyasse Formation (designated by Misaki and Ehiro, 2004) consists mostly of sandstone and shale, associated with limestone and conglomerate, and is 288 m thick. The age of the lower Kamiyasse Formation is considered to be Wordian on the basis of ammonoids (Ehiro and Misaki, 2005), and early Midian on the basis of fusulinids (Kobayashi *et al.*, 2009).

*Pararigbyella* has been recorded from the uppermost part of the Douling Formation (basal Wuchiapingian) in Hunan, central South China. Its allied genus *Rigbyella* Stehli, 1956 has been reported from the Lamar Limestone (Capitanian) of the Bell Canyon Formation in West Texas, USA. *Dicystoconcha* has been recorded from the unnamed Murgabian (middle Guadalupian) limestones in Wardak, central Afghanistan (Termier and Termier in Termier et al., 1974), which palaeobiogeographically belongs to the southern transitional Cimmerian Province during the middle Guadalupian (Shi et al., 1995), the Lengwu Formation (Capitanian) in Zhejiang, Southeast China (Liang, 1990), the Chihsia Formation in Hubei, central South China (Yang, 1984), the upper Douling Formation (Capitanian) in Guangdong, South China (Mou and Liu, 1989), the Tongziyan Formation (Capitanian) in Fujian, East China (Zhu, 1990) and the Chandalaz Formation (Capitanian) in South Primorye, Russian Far East (Licharew and Kotlyar, 1978). Thus, Pararigbyella is restricted to the Cathaysian Province (Shen et al., 2009); and Dicystoconcha is mainly distributed in the Paleotethyan region and the two transitional zones between the Boreal or Gondwanan and Paleotethyan realms (Shi et al., 1995). The middle Guadalupian (Wordian) brachiopod fauna of the South Kitakami Belt is characterized by a mixture of both Boreal and Paleotethyan elements (Tazawa, 1991, 2002, 2007). Therefore, the specimens of Pararigbyella and Dicystoconcha from the Kamiyasse-Imo area are newly additional Paleotethyan elements of the South Kitakami fauna.

The brachiopod specimens described herein are registered and housed in the Department of Geology, Niigata University (NU-B), and the Rikuzentakata City Museum,



**Figure 1.** Map showing the fossil localities KF217 and KF218 in the Kamiyasse-Imo area (using the topographical maps of "Imaizumi" and "Shishiori" scale 1:25,000 published by the Geospatial Information Authority of Japan).

**Figure 2.** Columnar section of the middle Permian of the Kamiyasse-Imo area, showing the fossil horizons KF217 and KF218 (modified and adapted from Tazawa, 1973, 1976).

Rikuzentakata, Iwate Prefecture (RCM-F).

# Systematic descriptions

Order Productida Sarytcheva and Sokolskaya, 1959 Suborder Lyttoniidina Williams, Harper and Grant, 2000 Superfamily Lyttonioidea Waagen, 1883 Family Lyttoniidae Waagen, 1883 Subfamily Lyttoniinae Waagen, 1883 Genus *Pararigbyella* Shen and Zhang, 2008

*Type species.—Pararigbyella quodrilobata* Shen and Zhang, 2008, p. 933, figs. 5.1–5.11.

*Discussion.*—Williams *et al.* in Brunton *et al.* (2000) proposed a new family Rigbyellidae to accommodate two genera (*Rigbyella* and *Paralyttonia*) in view of their lobe system nearly parallel to the median axis. However, the general outline of the ventral valve of these two genera is very similar to other members of Lyttoniidae Waagen, 1883. The septum and its corresponding lobe

systems of the dorsal valve in Lyttoniidae are highly variable in direction, from vertical (e.g. *Leptodus*), to oblique (e.g. *Oldhamina*, *Sceletonia*) to parallel to the median axis (e.g. *Rigbyella*, *Pararigbyella*). Therefore, we consider *Pararigbyella* is a member of Lyttoniidae Waagen, 1883.

Pararigbyella differs from Rigbyella Stehli, 1956 in its complicated forking lobes, more elongate outline and much more distinct median septum. The elongate triangular outline of Pararigbyella indicates that it is different from the cup-like shape of Rigbyella with a very strong cicatrix on the beak. Pararigbyella is similar to Paralyttonia Wanner in Wanner and Sieverts, 1935 in its septal system but differs in having more complicated lobes and a distinct median septum. Pararigbyella is also somewhat similar to permianellids (Permianella He and Zhu, 1979 and allied genera) in view of their symmetrically bifurcated lobes. But the permianellids have two lobes only, often deeply incised both valves, and a thin knifeedged median septum or a central median platform in the



**Figure 3.** 1–5, *Dicystoconcha lapparenti* Termier and Termier in Termier *et al.*, 1974; 1, internal molds of two ventral valves, RCM-F-10001 (right), RCM-F-10002 (left); 2–5, four internal molds of ventral valves, immature specimens, RCM-F-10005 (2), RCM-F-10003, RCM-F-10004 (4), and RCM-F-10006 (5); 6–8, Pararigbyella doulingensis Shen and Zhang, 2008; 6–7, ventral view of an internal mold of a ventral valve; 8, enlargement of the right side of a ventral valve showing the bifurcation of lobes (white arrows), NU-B1756.

ventral valve.

#### Pararigbyella doulingensis Shen and Zhang, 2008

#### Figures 3.6-3.8

Pararigbyella doulingensis Shen and Zhang, 2008, p. 933, figs. 5.12– 5.14.

*Material.*—One specimen, internal mold of a ventral valve, NU-B1756, collected from argillaceous limestone of the lower Kamiyasse Formation at locality KF218, Kamiyasse-Imo area.

*Description.*—Shell large size for genus, elongate triangular in outline, with the greatest width at anterior margin; length 35 mm, width about 26 mm in the specimen NU-B1756. Ventral valve gently convex; median septum distinct, bounded by two sinuses in posterior onethird; a pair of lateral septa symmetrically developed from one-third of shell length; crests of all septa rounded; sinuses narrower than septa, bifurcated three to four times anteriorly and forming about ten sinuses.

*Discussion.*—The present specimen is not very well preserved. However, its size, outline, bifurcated lobes and distinct median septum are generally comparable

with those of *Pararigbyella doulingensis* Shen and Zhang, 2008, from the uppermost Douling Formation (lowest Wuchiapingian) in Chenxian, Hunan, central South China. The Kitakami specimen bifurcates three to four times to form more sinuses than those from Hunan. However, we consider that this reflects different growth stages, and being an intraspecific variation.

The type species, *Pararigbyella quadrilobata* Shen and Zhang (2008, p. 933, figs. 5.5–5.11), from the uppermost part of the Douling Formation (lowest Wuchiapingian) in Hunan, is readily distinguished from the present species by its much smaller dimensions and fewer sinuses.

*Distribution.*—Wordian–basal Wuchiapingian; northeast Japan (South Kitakami Belt) and central South China (Hunan).

# Superfamily Permianelloidea He and Zhu, 1979 Family Permianellidae He and Zhu, 1979 Genus *Dicystoconcha* Termier and Termier in Termier *et al.*, 1974

*Type species.*—*Dicystoconcha lapparenti* Termier and Termier in Termier *et al.*, 1974.

Discussion.-Dicystoconcha Termier and Termier in Termier et al., 1974 differs from its allied genera Permianella He and Zhu, 1979 and Laterispina Wang and Jin, 1991 in its short and rounded outline, shallaw anterior incision, no distinct lateral brim and two septa on the central platform in the ventral valve. Both Permianella and Laterispina possess a strong median septum on the central platform, which can be readily distinguished from Dicystoconcha (see Shen and Tazawa, 1997). Frech (1901, p. 503) proposed the genus Loczyella with Loczyella nankingensis Frech, 1901, from the Chihsia Formation (upper Cisuralian) in Nanjing as the type species. However, this genus was established based on a poorly preserved incomplete specimen. It is nearly impossible to compare with any other genera except that it looks like a lytoniid. A Loczyella species has been subsequently described by Licharew (1930, p. 436, figs. 1, 2) as Loczyella? parvula Licharew, 1930, from the lower Permian of the Caucasus Mountians, but the Caucasus species has been assigned to Permianella grunti by Shen and Shi (1997, p. 273). If the specimen under the name Loczyella nankingensis from the Chihsia Formation in Nanjing (Frech, 1901) is confirmed as a permianellid in a future study, Dicystoconcha would be a junior synonym of Loczyella. A Loczyella species was also reported from the Lengwu Formation in Zhejiang, Southeast China (Liang, 1990, p. 216, pl. 39, fig. 9), but it is highly likely a species of Dicystoconcha.

# *Dicystoconcha lapparenti* Termier and Termier in Termier *et al.*, 1974

## Figures 3.1-3.5

- Dicystoconcha lapparenti Termier and Termier in Termier et al., 1974, p. 123, pl. 22, figs. 1–2, text-fig. 22.
- Guangjiayuanella guangjiayanensis Yang, 1984, p. 211, pl. 31, figs. 11-16, text-fig. 5-9.
- *Guangdongina xiamaoensis* Mou and Liu, 1989, p. 458, pl. 1, figs. 1–9; pl. 2, figs. 1–7, text-fig. 5.
- Guangdongina leguminiformis Mou and Liu, 1989, p. 458, pl. 3, figs. 4–8.
- *Guangdongina perforans* Mou and Liu, 1989, p. 459, pl. 2, fig. 8; pl. 3, figs. 1–3.

Guangdongina sp. Mou and Liu, 1989, p. 460, pl. 2, fig. 9.

Fabulasteges planata Liang, 1990, p. 381, pl. 42, figs. 3-4.

*Material.*—Six specimens, internal molds of six ventral valves (RCM-F-10001-10006), collected from the sandstone in the lower Kamiyasse Formation at locality KF217, Kamiyasse-Imo area.

Description.-Shell small, consisting of two lobes, slightly triangular or ovate in outline, with maximum width near anterior margin; no distinct hinge line on posterior end probably attaching other objects; lateral margins generally rounded and divergent anteriorly in immature specimens, but becoming less divergent in large specimens; length 25 mm, width 27 mm in the largest specimen (RCM-F-10001); length 19 mm, width 22 mm in an average-sized specimen (RCM-F-10003). Ventral valve with a deep sulcus and anterior incision dividing the shell into two equal lobes; sulcus originating from beak, slightly broader anteriorly, anterior incision very shallow, irregular marginal brim may be present; ventral surface with 1-2 strong concentric growth lines. Ventral interior with a distinct central platform, but septum not observed. Dorsal valve not preserved.

*Discussion.*—The Kitakami specimens are not well preserved in the internal structures of both valves, but they can be referred to *Dicystoconcha lapparenti* Termier and Termier in Termier *et al.*, 1974, described from the middle Guadalupian of Wardak, central Afghanistan, in the ovate outline, shallow anterior incision, deep ventral sulcus and the strong concentric growth lines on the ventral valve.

The following six forms from the Permian of Southeast to South China are considered to be junior synonyms of the present species: *Guangjiayuanella guangjiayuanensis* Yang, 1984 from the basal part of the Chihsia Formation in the Yangtze Gorge area in Hubei and Hunan; four species of *Guangdongina*, described by Mou and Liu (1989) from the upper Douling Formation of Guangzhou, Guangdong Province, i.e., *G. xiamaoensis, G. leguminiformis, G. permforans* and *G.* sp.; and *Fabulasteges planata* (Liang, 1990), from the Lengwu Formation of Zhejiang Province.

*Distribution.*—Artinskian-Capitanian; central Afghanistan, Northeast Japan (South Kitakami Belt), North China (Inner Mongolia), central South China (Hubei, Hunan and Guangdong).

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