Early Carboniferous (late Tournaisian) brachiopod fauna from the Shittakazawa Formation in the Okuhinotsuchi area, South Kitakami Belt, Japan

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Introduction

Carboniferous rocks are widely distributed in the South Kitakami Belt, northeastern Japan. The Shittakazawa Formation (named by Kawamura and Kawamura, 1981) is the earliest Carboniferous formation in the central part of the South Kitakami Belt (i.e., Shimoarisu, Yokota and Okuhinotsuchi areas) (Fig. 1). The stratigraphy of the Shittakazawa Formation has been studied by Minato et al. (1953), Takeda (1960), Saito (1966, 1968), Tazawa and Katayama (1979), Minato et al. (1979), Kawamura and Kawamura (1981), Kawamura (1985a, b), Tazawa and Iryu (2019) and Tazawa and Kurita (2019). However, the age of the formation is uncertain owing to a paucity of fossil evidence.

In the present paper, we describe four brachiopod spe-

Fig. 1. Topographic map of Okuhinotsuchi area (South Kitakami Belt) showing the fossil locality KAR1 (base map is from the Geospatial Information Authority of Japan).
cies (the Shittakazawa fauna) from the upper part of the Shittakazawa Formation in the Okuhinotsuchi area, and discuss the age of the fauna. The material was collected by H. Kurita in 1982, in the course of his graduate thesis at the Institute of Geology and Paleontology, Faculty of Science, Tohoku University, under the supervision of J. Tazawa. The brachiopod specimens described herein are now registered and housed in the Tohoku University Museum, Sendai (prefix IGPS, numbers 99006–99008 and 111760–111764).

Stratigraphy and material

According to Tazawa and Kurita (2019), the Carboniferous rocks of the Okuhinotsuchi area are divided into the Shittakazawa, Arisu, Odaira, Onimaru and Nagaiwa formations, in ascending stratigraphic order (Fig. 2). The Odaira Formation in this study corresponds to the Karoyama Formation of Tazawa et al. (1981) and also to the middle and upper parts of the Karosawa Formation of Kawamura and Kawamura (1981). The Shittakazawa Formation (986 m thick) is subdivided into a lower part (alternating light grey to light greenish-grey rhyolitic tuff and conglomerate, with thin layers of limestone and green to dark green andesitic–basaltic tuff, 257 m thick), a middle part (rhyolitic tuff, 500 m thick) and an upper part (alternating rhyolitic tuff, sandstone and shale, with a thin limestone layer, 229 m thick). The brachiopod fossils described herein were collected from light grey tuffaceous shale in the upper part (214 m below the top) of the Shittakazawa Formation, exposed at locality KAR1 (39°11′36″N, 141°30′47″E), which is a small tributary on the northern bank of the Hinotsucigawa River, 1.4 km northwest of the junction of the Hinotsucigawa and Yokokawa rivers in the Okuhinotsuchi area.

The Shittakazawa fauna

The brachiopod fauna described herein contains four species in three genera: *Rhipidomella kusbassica* Besnossova in Sarytcheva et al., 1963, *Schizophoria pinguis* Demanet, 1934, *S. mayesensis* Carter, 1999 and *Unispirifer kozuboensis* (Minato, 1952). The stratigraphic distributions of the brachiopod species of the Shittakazawa fauna are summarized in Fig. 3. Of the brachiopods listed above, *Rhipidomella kusbassica* is known from the lower Tournaisian to lower Visean, *Schizophoria pinguis* is known from the upper Tournaisian to upper Visean, *Schizophoria mayesensis* is known from the upper Tournaisian, and *Unispirifer kozuboensis* is known from the upper Tournaisian to lower Visean. In summary, the age of the Shittakazawa fauna is identified as late Tournaisian.

Discussion

The age of the Shittakazawa Formation was discussed
previously by Minato and Ogata (1977), Minato and Kato (1979) and Tazawa and Kurita (1986). First, Minato and Ogata (1977) described a rugose coral, *Palaeosmilia membiensis* Minato and Ogata, from the Shittakazawa Formation (exact horizon uncertain) from southwest of the Mt. Membiyama peak in the Okuhinotsuchi area. They noted that *P. membiensis* from Okuhinotsuchi resembles Tournaisian species of *Palaeosmilia*, such as *P. tschumyshensis* Dobrolyubova and *P. aquisgranensis* (Frech). On the basis of the fossil evidence, the fossil-bearing horizon of the Shittakazawa Formation was correlated with the Tournaisian, probably the lower Tournaisian by Minato and Ogata (1977), and the upper Tournaisian by Minato and Kato (1979). Subsequently, Tazawa and Kurita (1986) described two brachiopod species, *Schizophoria pinguis* Demanet and *Unispirifer kozuboensis* (Minato), from the upper part (revised from the middle part by Tazawa and Kurita, 1986, p. 167) of the Shittakazawa Formation at the same locality (KARI) in the Okuhinotsuchi area, and assigned the Shittakazawa Formation to the upper Tournaisian based mainly on the presence of *U. kozuboensis*, which was considered to be a Tournaisian species by Minato (1952) and Minato and Kato (1979).

In the present study, we concluded that the age of the upper part of the Shittakazawa Formation is late Tournaisian based on the occurrence of the brachiopods, *Rhipidomella kusbassica*, *Schizophoria pinguis*, *S. mayesensis* and *Unispirifer kozuboensis*, particularly on the presence of *S. mayesensis*, which was previously known only from the upper Tournaisian of Oklahoma, USA (Carter, 1999).

**Systematic descriptions**

Order *Orthida* Schuchert and Cooper, 1932  
Suborder *Dalmanellidina* Moore, 1952  
Superfamily *Dalmanelloidea* Schuchert, 1913  
Family *Rhipidomellidae* Schuchert, 1913  
Subfamily *Rhipidomellinae* Schuchert, 1913  
Genus *Rhipidomella* Oehlert, 1890

**Type species.** — *Terebratula michelini* Léveillé, 1835.

***Rhipidomella kusbassica*** Besnossova in Sarycheva et al., 1963  
(Fig. 4A)

*Rhipidomella michelini* (Léveillé), Tolmatchoff, 1924, p. 212, 569, pl. 13, fig. 4; Nalivkin, 1937, p. 36, pl. 3, figs. 6, 7.

*Rhipidomella kusbassica* Besnossova in Sarycheva et al., 1963, p. 74, pl. 2, figs. 9–11; Grechishnicova, 1966, p. 91, pl. 1, figs. 5–10; Zhang et al., 1983, p. 264, pl. 106, fig. 9.

**Material.** — One specimen, internal mould of a dorsal valve, IGPS111760.

**Remarks.** — This specimen is poorly preserved but can be referred to *Rhipidomella kusbassica* Besnossova in Sarycheva et al., 1963, from the lower Tournaisian–lower Visean of the Kuznetsk Basin, central Russia, in the small size (length more than 14 mm, width about 15 mm) and in having wide hinge and strong brachiophores diverging anteriorly. *Rhipidomella altaica* Tolmatchoff (1924, p. 213, 569, pl. 13, figs. 5–7, 9, 10), from the Tournaisian of the Kuznetsk Basin, differs from *R. kusbassica* in having more transverse outline and in having slightly shorter hinge. The type species, *Rhipidomella michelini* (Léveillé, 1835), redescribed by Brunton (1968, p. 17, pl. 3, figs. 1–25, text-fig. 5) from the Visean of Fermanagh, northern Ireland, differs from *R. kusbassica* in having much shorter hinge.

**Distribution.** — Lower Tournaisian–lower Visean: northeastern Japan (Okuhinotsuchi in the South Kitakami Belt), central Russia (Kuznetsk Basin), Kazakhstan and northwestern China (Xinjiang).

Superfamily *Enteletoidea* Waagen, 1884  
Family *Schizophoriidae* Schuchert and LeVene, 1929  
Genus *Schizophoria* King, 1850

**Type species.** — *Conchyliolithus* (Anomites) *resupinatus* Martin, 1809.
Schizophoria pinguis Demanet, 1934
(Fig. 4B, 4C)

Schizophoria resupinata var. pinguis Demanet, 1934, p. 59, pl. 4, figs. 9–11; Bond, 1941, figs. 33, 34; Pocock, 1968, text-fig. 21.

Schizophoria pinguis Demanet. George and Ponsford, 1938, figs. 8, 9.

Schizophoria resupinata pinguis Demanet. Tazawa and Kurita, 1986, p. 167, figs. 2.2, 2.3.

Schizophoria (Schizophoria) resupinata forma pinguis Demanet. Zakowa, 1989, p. 109, pl. 6, figs. 1–10; pl. 7, figs. 1–4; text-figs. 2–9, table 6.

Material.—Two specimens, internal moulds of two dorsal valves, IGPS99006, 99007.

Remarks.—The specimens from Okuhinotsuchi are preserved as internal moulds of two dorsal valves. However, they are safely assigned to the genus Schizo-
**Schizophoria mayesensis** Carter, 1999  
(Fig. 4D–4F)

**Schizophoria mayesensis** Carter, 1999, p. 109, figs. 6A–nn, tt, 7.

**Material.**—Three specimens: (1) internal mould of a ventral valve, IGPS111762; and (2) external and internal moulds of two dorsal valves, IGPS111763, 111764.

**Remarks.**—These specimens are safely assigned to the genus *Schizophoria* by the transversely subelliptical outline, and the presence of strong teeth in the ventral valve and divergent brachiophores and a low median ridge in the dorsal valve. The Okuhinotsuchi specimens are referred to *Schizophoria mayesensis* Carter, 1999, from the St. Joe Formation of Mayes County, northeastern Oklahoma, in the medium size (length 21 mm, width more than 25 mm in the largest specimen, IGPS111763), transversely subelliptical outline with the greatest width at slightly posterior to midlength, and thin-bodied shell with flattened ventral valve and gently convex dorsal valve. This species resembles *Schizophoria chouteaensis* Weller (1914, p. 163, pl. 23, figs. 6–19) from the Chouteau Limestone of Missouri, but the latter differs from *S. mayesensis* in having less transverse outline and the maximum width at about midlength. *Schizophoria resupinata* (Martin, 1809), differs from the present species in the much larger dimensions and the outline with the widest at midlength.

**Distribution.**—Upper Tournaisian: northeastern Japan (Okuhinotsuchi in the South Kitakami Belt) and USA (Oklahoma).

Order *Spiriferida* Waagen, 1883  
Suborder *Spiriferidina* Waagen, 1883  
Superfamily *Spiriferoida* King, 1846  
Family *Spiriferidae* King, 1846  
Subfamily *Prospirinae* Carter, 1974  
Genus *Unispirifer* Campbell, 1957

**Type species.**—*Spirifer striatoconvolutus* Dun and Benson, 1920.

**Unispirifer kozuboensis** (Minato, 1952)  
(Fig. 4G, 4H)

*Spirifer kozuboensis* Minato, 1952, p. 155, pl. 5, fig. 7.  
*Unispirifer kozuboensis* (Minato). Tazawa and Kurita, 1986, p. 167, fig. 2.1; Tazawa, 2018, p. 66, fig. 28A–E.

**Material.**—Two specimens, internal moulds of two ventral valves, IGPS99008, 111761.

**Remarks.**—One of the specimens was described by Tazawa and Kurita (1986, p. 167, fig. 2.1) as *Unispirifer kozuboensis* (Minato, 1952), from the middle part of the Arisu Formation (=D₀ Zone) of Kozubo (Otsubo), Yokota area, South Kitakami Belt, in the medium size (length about 43 mm, width about 35 mm in the larger specimen, IGPS111761) and in having acute cardinal extremities (see Fig. 4H). *Unispirifer tornacensis* (de Koninck, 1883), redescribed by Sartenaer and Plodowski (1996, p. 60, pl. 1, figs. 1–10; pl. 2, figs. 11–19; pl. 3, figs. 27–41; pl. 4, figs. 42–58; pl. 5, figs. 60–73) as *Atylephorus tornacensis* (de Koninck, 1883) from the upper Tournaisian of Belgium, resembles *U. kozuboensis* in general shape and outline, but the Belgian species differs from the Kitakami specimens in the much larger dimensions and in having less numerous, stronger costae on the ventral valve.

**Distribution.**—Upper Tournaisian—lower Visean: northeastern Japan (Hikoroichi, Yokota and Okuhinotsuchi in the South Kitakami Belt).

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* in Japanese
** in Chinese
*** in Russian

(要旨)


本論文では、南部北上帯奥火の地域の火口原層上部から採集された3属4種からなる前期炭紀群足類フォーナ（奥火の土フォーナ）を記載する。このフォーナは以下の種からなる：Rhipidomella kusbasica Besnossova, Schizophoria pinguis Demanet, S. mayesensis Carter, Unispirifer kozuboensis (Minato). 奥火の土フォーナはトルネー期後期（late Tournaisian）を示すので、火口原層上部は上部トルネー階（upper Tournaisian）に対比される。

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