A Boreal-type brachiopod species, *Waagenoconcha irginae* (Stuckenberg), from the middle Permian (Wordian) of the South Kitakami Belt, Japan

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Abstract

This study describes a Boreal-type brachiopod species, *Waagenoconcha irginae* (Stuckenberg), from the lower part of the Kamiyasse Formation (Wordian) in the Kamiyasse-Imo area, South Kitakami Belt, northeastern Japan. The occurrence of *W. irginae* in the South Kitakami Belt provides additional evidence for the palaeoposition of South Kitakami in the Wordian, located near North China.

Key words: Boreal, brachiopod, middle Permian, South Kitakami, *Waagenoconcha irginae*

Introduction

During the last three decades Permian geography and biogeography of the South Kitakami Belt, one of the oldest belt in Japan, have been discussed by many authors (e.g., Saito and Hashimoto, 1982; Ozawa, 1987; Taira, 1990; Nakazawa, 1991; Tazawa, 1992, 2000, 2002; Isozaki, 1997; Ehiro, 1997, 2001, 2006; Isozaki, 1997; Kobayashi, 1999; Wang et al., 2006; Isozaki et al., 2011). However, palaeoposition of South Kitakami in the Permian is still controversial and sharply divided into two opinions; namely, South Kitakami was located (1) near South China (Yangtze) in the equatorial region (Kawamura and Machiyama, 1995; Ehiro, 1997, 2001, 2006; Isozaki, 1997; Kobayashi, 1999; Wang et al., 2006; Isozaki et al., 2011; Isozaki and Kase, 2014), and (2) near North China (Sino-Korea) in the mid-latitude.

Fig. 1. Map showing the fossil locality TY1, upper Toyazawa Valley, Shiroishi, Kesennuma City (using the topographic map "Shishiori" scale 1:25,000 published by the Geospatial Information Authority of Japan).

Recently six Boreal-type brachiopod species were described from the middle Permian (Wordian) of the South Kitakami Belt, northeastern Japan: Orbiculoidea jangarensis Ustritsky, Yakovlevia kaluzinensis Fredericks and Gypspirifer kobiyanai Tazawa and Araki by Tazawa and Araki (2013), and Bathymyonia neimongolica (Wang and Zhang), Neospirifer moosakhailensis (Davidson) and Spiriferellina fredericksi Tazawa by Tazawa (2014). These species are regarded as the Boreal elements in the middle Permian mixed Boreal–Tethyan fauna, proposed by Tazawa (1987, 1991, 1992) and Nakamura and Tazawa (1990), of the South Kitakami Belt. Therefore, the presence of Boreal-type brachiopod species or genera in the Permian marine fauna of the South Kitakami Belt is a strong evidence for the second opinion.

The present study describes a Boreal-type brachiopod species, Waagenoconcha irginae (Stuckenberg, 1898), from the middle Permian (Wordian) of the Kamiyasse–Imo area, South Kitakami Belt, and discusses its palaeobiogeographical importance. In this study, H. Araki prepared the material; and J. Tazawa studied systematics and palaeobiogeography of the brachiopod species. The brachiopod specimens described herein are registered and housed in the Kesennuma Board of Education (tentatively placed at the Old Tsukitate Junior High School) in Kesennuma, Japan.

Stratigraphy and collection

The brachiopod specimens were collected by the late Mr. Kiyoshi Konno from greenish grey, fine-grained sandstone of the lower part of the Kamiyasse Formation (designated by Misaki and Ehiro, 2004; equal to the upper part of the lower Kanokura Series of Tazawa, 1976), cropped out at locality TY1 (lat. 38°59′22″N, long. 141°31′59″E), upper Toyazawa Valley, Shiroishi, Kesennuma City, Miyagi Prefecture, northeastern Japan. The topographical and stratigraphical positions of the fossil locality are shown in Fig. 1 and Fig. 2, respectively. The age of the fossil horizon is assigned to the Wordian based on ammonoids (Ehiro and Misaki, 2004), fusulinids (Kobayashi et al., 2009) and brachiopods (Tazawa, 2014).

Palaeobiogeographical importance of Waagenoconcha irginae

Waagenoconcha is an antitropical productoid brachiopod genus, distributed in the Upper Carboniferous–upper Permian, mostly in the lower and middle Permian, of both Boreal and Gondwanan regions and their surrounding areas (Muir-Wood and Cooper, 1960; Grant, 1966; Nakamura and Tazawa, 1990; Brunton et al., 2000).

Waagenoconcha irginae is known from the lower and middle Permian (Asselian–Capitanian) of Spitsbergen (Gobbett, 1963), Kanin Peninsula, Pechora Basin, Timan, northern Urals and Kolyma in northern Russia (Solomina, 1960; Zavodovsky and Stepanov, 1970; Ifanova, 1972; Kalashnikov, 1986, 1993), southern Urals in central Russia (Stuckenber, 1898; Tschernyschew, 1902; Muir-Wood and Cooper, 1960), southern Mongolia (Manankov, 1991), Inner Mongolia in northern China (Lee and Gu, 1976), South Primorye in eastern Russia (Fredericks, 1925), Hida Gaien Belt in central Japan (Tazawa, 2001) and South Kitakami Belt.
in northeastern Japan (Tazawa, 1974; Tazawa and Ibaraki, 2001; Tazawa and Araki, this study). It is noteworthy that the geographical distribution of *W. irginae* is restricted in the Boreal region (Spitsbergen and northern Russia) and the transitional (boundary) zone between Boreal and Tethyan realms (southern Urals, southern Mongolia, northern China, South Primorye, Hida Gaien and South Kitakami), and have never been recorded from South China (eastern, central-southern and southwestern China) (Fig. 3).

In summary, *Waagenoconcha irginae* from the middle Permian of the upper Toyazawa Valley, Shiroishi, Kesennuma, is a Boreal element in the middle Permian mixed Boreal–Tethyan brachiopod fauna of the South Kitakami Belt. This conclusion supports the preceding second opinion, and supports also the strike-slip model by Tazawa (1993, 2000, 2004), in which South Kitakami was placed on the eastern margin of North China in the middle Permian (Wordian).

**Systematic descriptions**

Order Productida Sarytcheva and Sokolskaya, 1959  
Suborder Productidina Waagen, 1883  
Superfamily Echinoconchoidea Stehli, 1954  
Family Waagenoconchidae Muir-Wood and Cooper, 1960  
Subfamily Waagenoconchinae Muir-Wood and Cooper, 1960  
Genus *Waagenoconcha* Chao, 1927

*Type species.* – *Productus humboldti* d’ Orbigny, 1842.

*Waagenoconcha irginae* (Stuckenberg, 1898)

Figs. 4.1–4.6

*Productus irginae* Stuckenberg, 1898, p. 220, pl. 2, fig. 16; Tschernyschew, 1902, p. 273, 618, pl. 30, figs. 3, 4; pl. 52, figs. 1–4.

*Productus cf. humboldti irginae* Stuckenberg. Fredericks, 1925, p. 19, pl. 4, fig. 117.


*Waagenoconcha irginae* (Stuckenberg). Muir-Wood and Cooper, 1960, pl. 89, figs. 15, 16; Gobbett, 1963, p. 76, pl. 5, fig. 7; pl. 6, figs. 1–5; Zavodowsky and Stepanov, 1970, p. 89, pl. 3, figs. 3, 4; Ifanova, 1972, p. 103, pl. 3, figs. 14–16; Lee and Gu, 1976, p. 252, pl. 155, figs. 3, 4; pl. 170, fig. 3; Kalashnikov, 1986, pl. 118, figs. 2, 3; Kalashnikov, 1993, p. 70, pl. 36, figs. 3–5.

*Waagenoconcha imperfecta* Prendergast. Tazawa, 1974, p. 127, pl. 1, figs. 4–6; pl. 2, figs. 2–7; pl. 3, figs. 1–3; pl. 4, figs. 1–4, 7 (excluding pl. 2, fig. 6; pl. 3, fig. 2); Tazawa, 1976, pl. 2, fig. 6; Minato et al., 1979, pl. 65, figs. 1, 2; Manankov, 1991, p. 112, pl. 23, figs. 4–7; Tazawa, 2002, figs. 10.12; Tazawa, 2007, fig. 4.12.

*Waagenoconcha* sp. Tazawa and Ibaraki, 2001, p. 9, pl. 1, fig. 4.
Fig. 4. *Waagenoconcha irginae* (Stuckenberg) from the lower Kamiyasse Formation, at the locality TY1, upper Toyazawa Valley, Shiroishi, Kesennuma City. 1a, 1b, ventral and dorsal views of internal mould of conjoined shell, KCG028; 2, internal mould of ventral valve, KCG031; 3a–3c, ventral and dorsal views of internal mould of conjoined shell, KCG024; 4, internal mould of ventral valve, KCG050; 5, external mould of dorsal valve, KCG048; 6a, 6b, external mould of dorsal valve, KCG046. Scale bars represent 1 cm.
Material. – Twenty-six specimens: (1) internal moulds of six conjoined shells, KCG024–029; (2) internal moulds of fifteen ventral valves, KCG030–044; (3) external moulds of five dorsal valves, KCG045–049.

Description. – Shell medium in size for genus, equidimensional to slightly longer subrectangular in outline, with greatest width at about two-thirds length from umbo; length 49 mm, width 46 mm in the largest specimen (KCG030). Ventral valve moderately convex in lateral profile, most convex at umbonal region; umbo massive, strongly incurved; ears small, not clearly demarcated from visceral region; sulcus nearly flat on visceral disc, strongly geniculated, to anterior valve margin; lateral slopes steep. Dorsal valve interior with spine bases finer in dorsal valve. Ventral valve interior not well preserved and obscure. Dorsal valve interior with spine bases finer on the ventral valve. Dorsal valve nearly flat on visceral disc, strongly geniculated, and followed by short tail; fold narrow and low on anterior half of valve. External surface of ventral valve ornamented with several irregular concentric rugae and numerous spine bases; spine bases fine, elongate, quincunxially arranged, and becoming smaller in size anteriorly, numbering 8 in 5 mm width at midlength, 8–9 in 5 mm width near anterior margin. External ornament of dorsal valve same as that of opposite valve, although concentric rugae being less strong and spine bases finer in dorsal valve. Ventral valve interior not well preserved and obscure. Dorsal valve interior with moderately large, trifid cardinal process; median septum thin and long, extending to half or more length of valve; lateral ridges short and straight; adductor scars large and dendritic in anterior ones and small, elongate and smooth in posterior ones; numerous pustules becoming coarser anteriorly.

Remarks. – These specimens are referred to Waagenoconcha irginae (Stuckenberge, 1898), redescribed by Tschernyschew (1902, p. 273, 618, pl. 30, figs. 3, 4; pl. 52, figs. 1–4) from the lower Permian (Sakmarian?) of Ufa, central Russia, in size, shape and external ornament of both valves, especially, in having fine quincunxially arranged spine bases becoming finer anteriorly. The Toyazawa specimens very like shells, described by Tazawa (1974, p. 127, pl. 1, figs. 4–6; pl. 2, figs. 2–7; pl. 3, figs. 1–3; pl. 4, figs. 1–4, 7) as Waagenoconcha imperfecta Prendergast, 1935, from the lower Kanokura Series (=lower Kamiyasse Formation) at the Shigejisawa Valley in the Kamiyasse–Imo area; the latter are now referred to W. irginae on account of the external characters of both valves.

Waagenoconcha imperficta Prendergast, 1935, redescribed by Archbold (1993, p. 20, figs. 11–13) from the upper Permian (Wuchiapigian) of the Canning and Bonaparte Gulf basins of western Australia, differs from the present species in its much larger size and in having finer spine bases on the ventral valve.

The type species, Waagenoconcha humboldti (d’Orbigny, 1842), redescribed by Tschernyschew (1972, p. 275, 620, pl. 53, figs. 1–3) from the lower Permian (Asselian) of the Urals and Timan, is readily distinguished from Waagenoconcha irginae in having coarser spine bases on both ventral and dorsal valves.

Distribution. – Asselian–Capitanian: Spitsbergen, northern Russia (Kanin Peninsula, Pechora Basin, Timan, northern Urals and Kolyma), central Russia (southern Urals), southern Mongolia, northern China (Inner Mongolia), eastern Russia (South Primorye), central Japan (Hida Gaien Belt) and northeastern Japan (South Kitakami Belt).

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

**用語対比**

| Hida Gaien Belt | 飛騨縄波带 |
| Kamiyasse Formation | 上白瀬層 |
| Kamiyasse–Imo area | 上白瀬-飯森地域 |
| Kanokura Series | 叶倉組 |
| Kesennuma City | 気仙沼市 |
| Shigejisawa Valley | 茂路沢 |
| Shiroishi | 白石 |
| South Kitakami Belt | 南部北上带 |
| Toyazawa Valley | 戸屋沢 |

(要旨)


南部北上帯上白瀬-飯森地域(宮城県気仙沼市白石、戸屋沢上流)の上白瀬層下部(ワード階)から産出したボレアリ型殻足類 *Waagenoconcha irginae* (Stuckenber)を記載した。*Waagenoconcha irginae*が南部北上帯の中部ペルム系から産出することは、ペルム紀中期(ワード階)に、南部北上地域が北中国近辺に存在したことの新たな証拠となる。

科学論文では、学説の検証可能性を示すことが重要です。そのため、地質学雑誌掲載論文には、重要な証拠となった試料がどこで得られたかを示しているものがあります。言うまでもないことです。見学や採集を行う場合、各自の責任において地権者や関係官庁との連絡と許可の取得の必要があることにご注意下さい。詳しくは、以下のサイトをご覧ください。

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