Four brachiopod species newly described from the Middle Permian of Kesennuma, South Kitakami Belt, northeast Japan

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Four brachiopod species newly described from the Middle Permian of Kesennuma, South Kitakami Belt, northeast Japan

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Abstract

Four brachiopod species, *Orbiculoidea jangarensis* Ustritsky, *Yakovlevia kaluzinensis* Fredericks, *Gypospirifer kobiyamai* Tazawa and Araki sp. nov. and *Licharewina arakii* (Hayasaka), are described from the Middle Permian (Wordian) of Kesennuma, South Kitakami Belt, northeast Japan. Among the species, *O. jangarensis, Y. kaluzinensis* and *G. kobiyamai* are Boreal-type species.

Key words: Boreal-type species, brachiopod, Kesennuma, Middle Permian, South Kitakami Belt.

Introduction

The area of Kesennuma in the South Kitakami Belt, northeast Japan (Fig. 1-1) has been a renowned and classic locality for Permian marine invertebrate fossils since the pioneering works of Harada (1890), Yabe (1900) and Yabe and Hayasaka (1915). Many brachiopod species have been previously described from the Permian formations of the Kesennuma area by the following authors: Yabe (1900), Hayasaka (1917, 1922, 1925, 1937, 1960, 1963a, 1963b, 1964, 1966, 1967), Minato (1955), Minato and Nakamura (1956), Nakamura (1972a, 1972b, 1979), Tazawa (1974a, 1974b, 1975, 1979, 1999, 2012), Tazawa and Araki (1984a, 1984b, 1999), Tazawa and Takaizumi (1987), Shen and Tazawa (1997) and Shiino (2009). The stratigraphy of the Permian formations in the Kesennuma area has been studied by Shiida (1940), Kambe and Shimazu (1961), Tazawa (1973, 1975, 1976), Ehiro (1974, 1977) and Misaki

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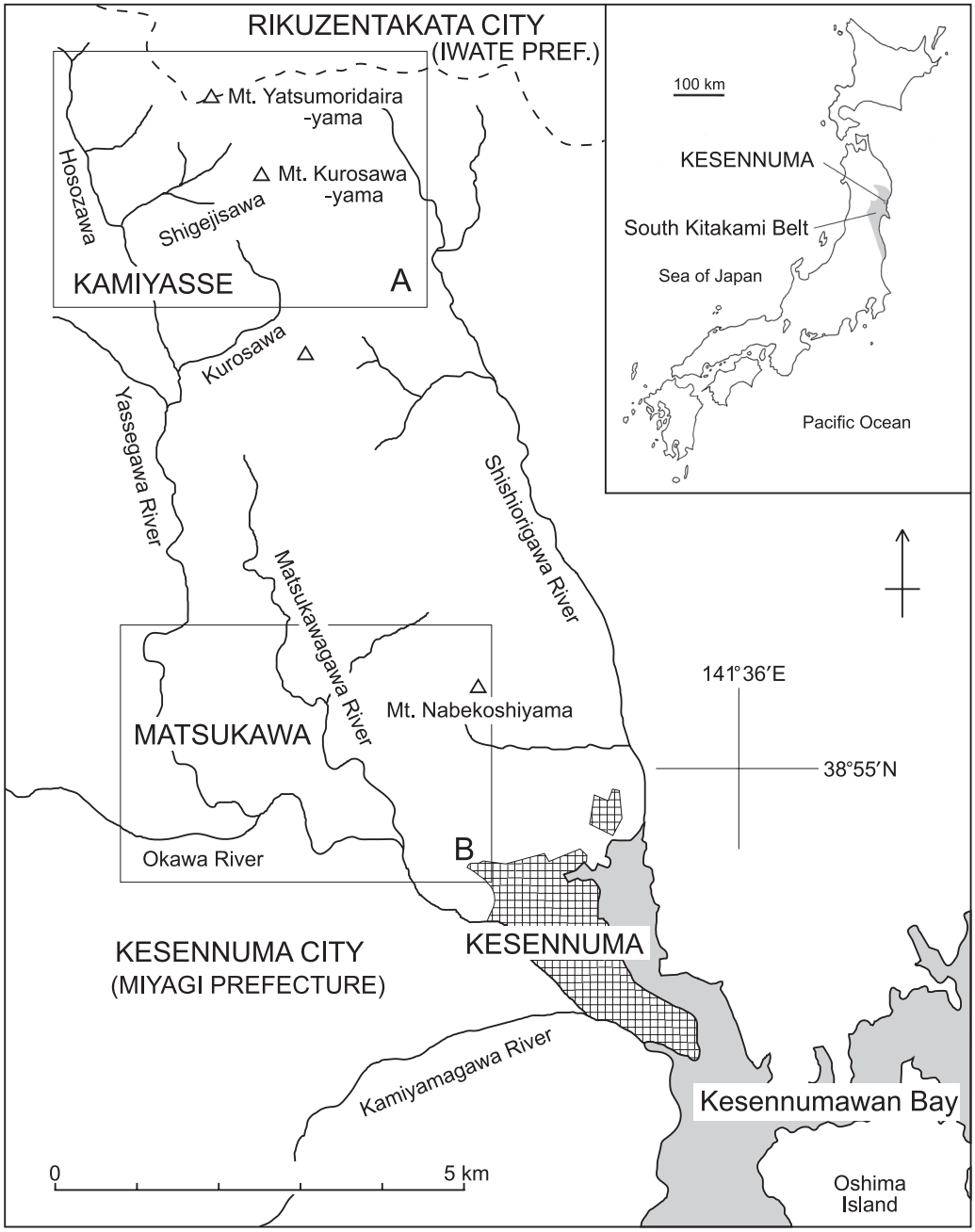

Fig. 1–1. Index map showing the fossil localities of Kamiyasse (A) and Matsukawa (B) in the Kesennuma area, South Kitakami Belt, northeast Japan.

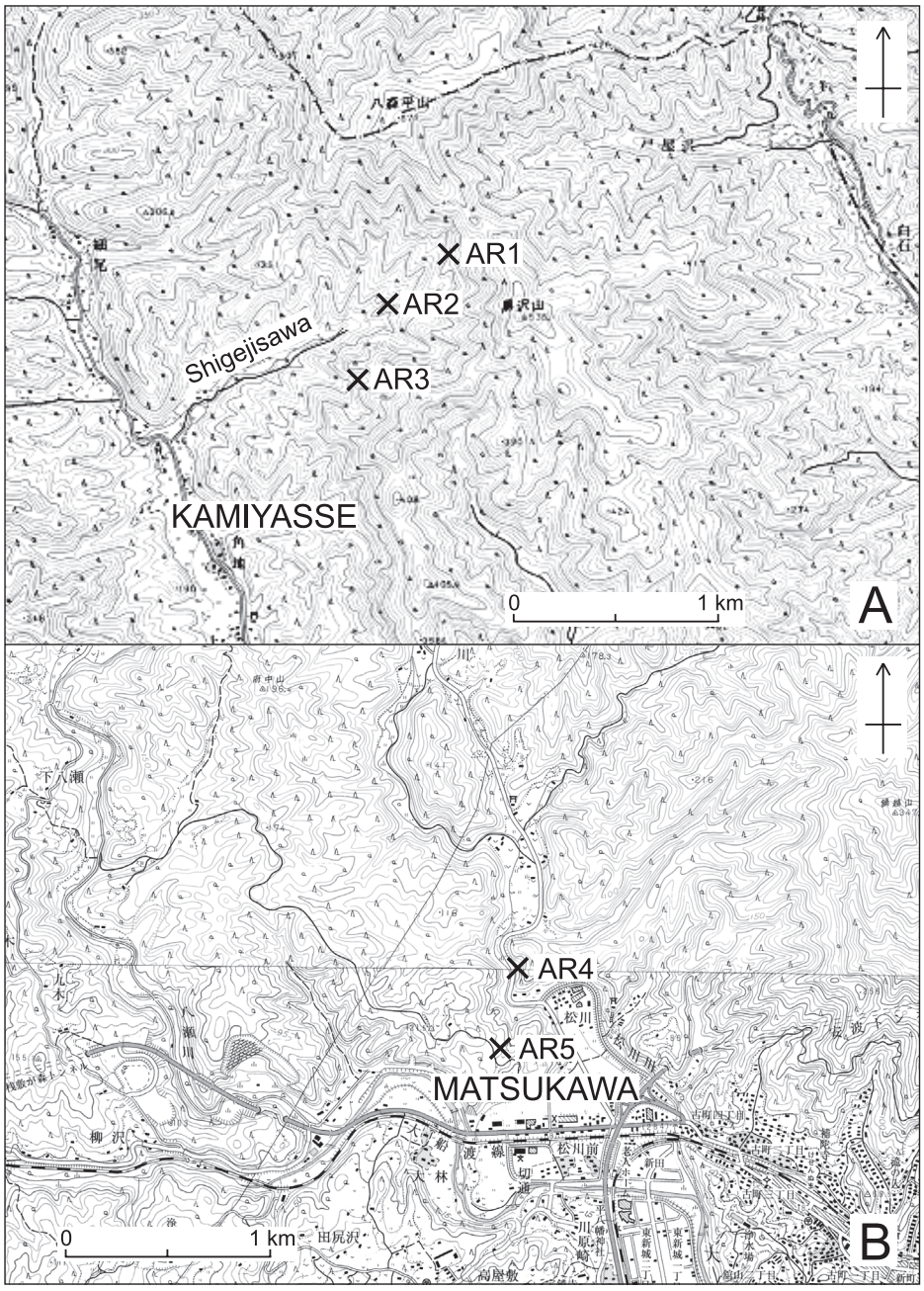

Fig. 1–2. (Continue) Index map showing the fossil localities AR1, AR2 and AR3 in Kamiyasse (A), and AR4 and AR5 in Matsukawa (B). Using the topographical maps of "Shishiori" and "Kesennuma" scale 1 : 25,000 published by the Geospatial Information Authority of Japan.

and Ehiro (2004).

The brachiopod fossils treated in the present paper were collected by the second author (H. A.) from grey to greenish grey, fine-grained sandstone of the upper part of the lower Kanokura Formation (equivalent to the lower part of the Kamiyasse Formation of Misaki and Ehiro, 2004) at Shigejisawa (AR1, AR2, AR3) in Kamiyasse, and at Anabuchi (AR4) and Matsukawamae (AR5) in Matsukawa (see Figs. 1-1, 1-2). The fossil horizons are within the *Monodiexodina matsubaishi* Zone of Tazawa (1976) and the *Leptodus nobilis* Zone of Minato et al. (1979). These fossil zones are now correlated with the Wordian or Midian, based on the assemblages of ammonoids (Ehiro and Misaki, 2005) and fusulinids (Kobayashi et al., 2009), respectively.

The brachiopods described herein are *Orbiculoidea jangarensis* Ustritsky, 1960, *Yakovlevia kaluzinensis* Fredericks, 1925, *Gypospirifer kobiyamai* Tazawa and Araki sp. nov. and *Licharewina arakii* (Hayasaka, 1963a). It is noteworthy that the three of these species, *O. jangarensis, Y. kaluzinensis* and *G. kobiyamai* are Boreal-type species that inhabited in the middle- to high-latitude areas of the Northern Hemisphere in the Middle Permian. The palaeobiogeographical data support the Middle Permian reconstruction reported by Tazawa (2000, 2007), in which the South Kitakami region was located immediately east of North China (Sino-Korea) at mid-latitudes in the Northern Hemisphere.

All the specimens described in this paper are housed in the Kesennuma Board of Education (tentatively at Old Tsukitate Junior High School), Kesennuma City, Miyagi Prefecture, as indicated by the prefix to the registered numbers (KCG).

Systematic descriptions

Order Lingulida Waagen, 1885
Superfamily Discinoidea Gray, 1840
Family Discinidae Gray, 1840
Genus *Orbiculoidea* d'Orbigny, 1847

Type species.—*Orbicula forbessi* Davidson, 1848.

Orbiculoidea jangarensis Ustritsky, 1960
Fig. 2.1

Orbiculoidea jangarensis Ustritsky, 1960, p. 98, pl. 1, figs. 10–12; Ustritsky and Tschernyak, 1963, p. 68, pl. 1, figs. 5–9; Ifanova, 1972, p. 84, pl. 1, figs. 26, 27; Kalashnikov, 1983, p. 204, pl. 45, figs. 3, 4; Kalashnikov, 1986, pl. 116, fig. 2; Kalashnikov, 1993, p. 14, pl. 2, fig. 13; pl. 3, fig. 5; pl. 4, fig. 3.

Orbiculoidea sp. Hayasaka, 1963a, p. 479, fig. 1.
Orbiculoidea cf. *jangarensis* Ustritsky: Tazawa, 2001, p. 288, fig. 6.11.

Material.—One specimen from locality AR3, external mould of a ventral valve, KCG007.

Description.—Shell large size for genus, subcircular in outline, widest at slightly anterior to midlength; length 24 mm, width 19 mm. Ventral valve almost flat; pedicle opening about 7 mm length, occupying about a quarter valve length in posteriorly; concentric growth lines fine, regular and numerous, numbering 13–14 in 5 mm at anterior portion of valve.

Remarks.—This specimen is referred to *Orbiculoidea jangarensis* Ustritsky, 1960, originally described by Ustritsky (1960) from the upper Talatin Formation (upper Artinskian or Kungurian) of Pay Khoy, northern Russia in size and shape of the shell and in having numerous fine growth lines on the ventral valve. Both species, *Orbiculoidea* sp., described by Hayasaka (1963a) from the lower Kanokura Formation of Omotematsukawa in the Kesennuma area, South Kitakami Belt, northeast Japan, and *Orbiculoidea* cf. *jangarensis* Ustritsky, 1960, described by Tazawa (2001) from the Moribu Formation of the Moribu area, Hida Gaien Belt, central Japan may be conspecific with the present species.

Distribution.—Lower Permian (Artinskian) to Middle Permian (Wordian): northern Russia (northern Urals, Pay Khoy, Pechora Basin, Taimyr), northeast Japan (Kesennuma in the South Kitakami Belt) and central Japan (Moribu in the Hida Gaien Belt).

Order Productida Sarytcheva and Sokolskaya, 1959
Suborder Productidina Waagen, 1883
Superfamily Linoproductoidea Stehli, 1954
Family Yakovleviidae Waterhouse, 1975
Genus *Yakovlevia* Fredericks, 1925

Type species.—*Chonetes* (*Yakovlevia*) *kaluzinensis* Fredericks, 1925.

Yakovlevia kaluzinensis Fredericks, 1925
Fig. 2.2

Chonetes (*Yakovlevia*) *kaluzinensis* Fredericks, 1925, p. 7, pl. 2, figs. 64–66.
Yakovlevia kaluzinensis Fredericks: Kotlyar, 1961, text-figs. 1–3; Licharew and Kotlyar, 1978, pl. 14, figs. 1, 2; Manankov, 1998, pl. 8, figs. 18, 19; Tazawa, 1999, p. 90, figs. 3.7–3.15; Tazawa, 2001, p. 291, figs. 6.20–6.25; Tazawa, 2008b, p. 49, fig. 7.14.
Yakovlevia sp. Horikoshi et al., 1987, fig. 3.

Material.—One specimen from locality AR5, internal mould of a ventral valve, KCG008.

Remarks.—The single ventral valve specimen from Matsukawamae in the Kesennuma area is large in size (length 49 mm, width 58 mm), transversely rectangular in outline, and strongly convex in lateral profile. Interior of ventral valve with a pair of small, elongate subtrigonal and dendritic adductor scars and two large, flabellate and radially striated

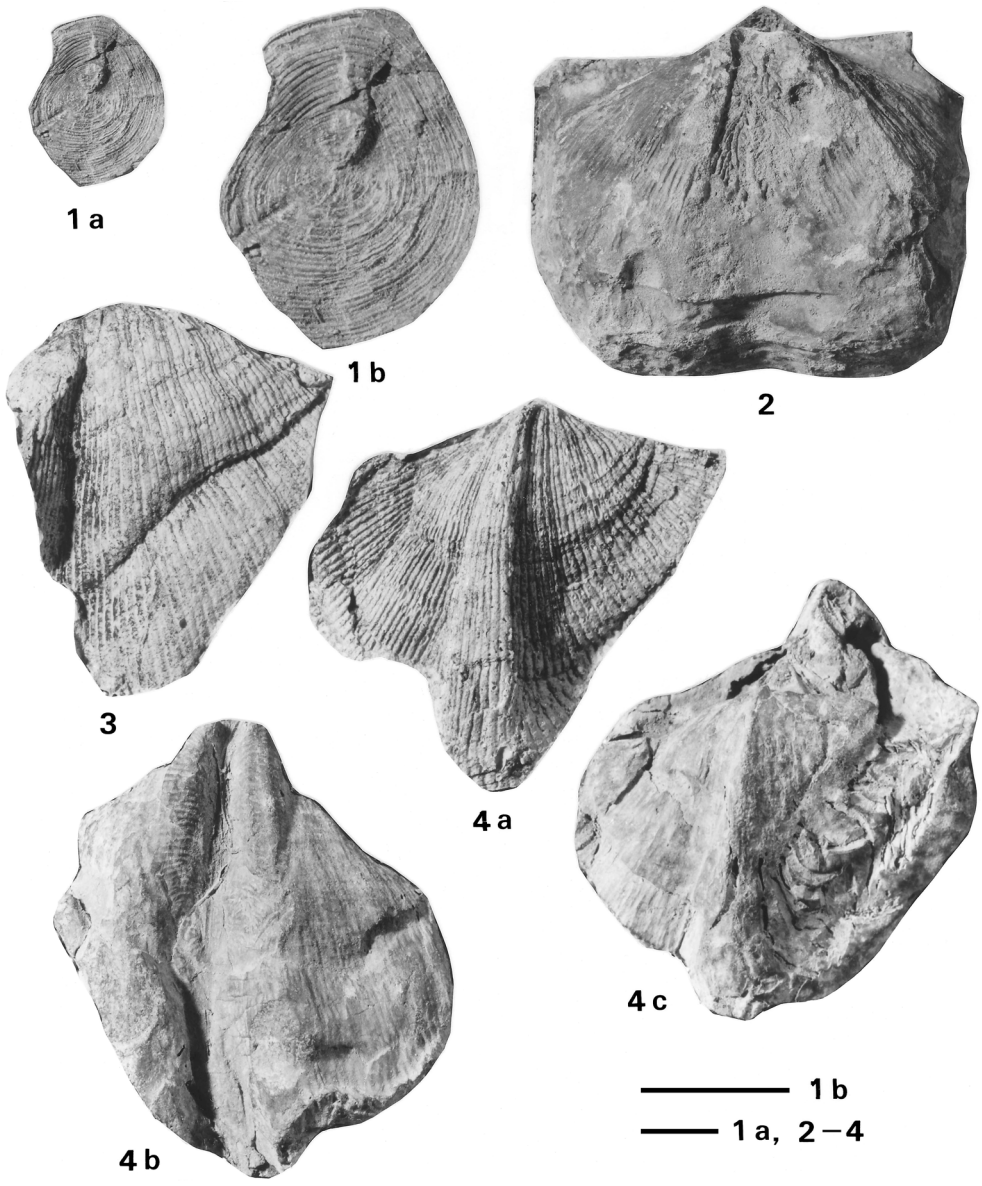

Fig. 2. 1. *Orbiculoidea jangarensis* Ustritsky, 1a, 1b: external mould of ventral valve, KCG007. 2: *Yakovlevia kaluzinensis* Fredericks, internal mould of ventral valve, KCG008. 3, 4: *Gypospirifer kobiyamai* Tazawa and Araki sp. nov., 3: external latex cast of ventral valve, KCG002 (paratype), 4a, 4b, 4c: external latex cast of dorsal valve, internal mould of ventral valve, and internal mould of dorsal valve, KCG001 (holotype). Scale bars represent 1 cm.

diductor scars. This specimen is referred to *Yakovlevia kaluzinensis* Fredericks, 1925, from the Chandalaz Formation of the Vladivostok area, South Primorye, eastern Russia, in size, shape and internal structures of the ventral valve.

Yakovlevia impressa (Toula, 1875, p. 236, pl. 5, fig. 11), from the Middle Permian of Spitsbergen, differs from *Y. kaluzinensis* in having larger and more prominent ears.

Distribution.—Middle Permian (Kungurian) to Upper Permian (Lopingian): southeastern Mongolia (Mt. Dzhirem-Ula), eastern Russia (South Primorye), northeast Japan (Kesennuma in the South Kitakami Belt), central Japan (Moribu in the Hida Gaien Belt) and southwest Japan (Mizukoshi, central Kyushu, western extension of the Hida Gaien Belt).

Order Spiriferida Waagen, 1883
Suborder Spiriferidina Waagen, 1883
Superfamily Spiriferoidea King, 1846
Family Trigonotretidae Schuchert, 1893
Subfamily Neospiriferinae Waterhouse, 1968
Genus *Gypospirifer Cooper* and Grant, 1976

Type species.—*Gypospirifer nelsoni* Cooper and Grant, 1976.

Gypospirifer kobiyamai sp. nov.
Figs. 2.3, 2.4

Spirifer fasciger var. *simplex* Grabau: Kobiyama, 1956, fig. 4.

Neospirifer fasciger (Keyserling): Hayasaka, 1960, p. 42, pl. 2, figs. 1, 2 only; Yanagida, 1963, p. 71, pl. 8, figs. 3, 6; pl. 9, fig. 3 only; Koizumi, 1979, pl. 1, fig. 16 only.

Neospirifer aff. *cameratus* Morton: Yanagisawa, 1967, p. 91, pl. 2, fig. 11.

Neospirifer striato-paradoxus (Toula): Licharew and Kotlyar, 1978, pl. 18, fig. 1; Lee et al., 1980, p. 412, pl. 177, figs. 3, 6, 9.

Gypospirifer volatilis Duan and Li: Tazawa, 2001, p. 302, figs. 8.23–8.26; Tazawa and Hasegawa, 2007, p. 7, figs. 4.8–4.12, 5.1, 5.2; Tazawa, 2008a, p. 39, fig. 6.17; Tazawa, 2008b, p. 54, figs. 9.3–9.7.

Etymology.—Named for Mr. Moto Kobiyama who first documented the present species as *Spirifer fasciger* var. *simplex* Grabau, 1936 from the Upper Permian of the Takakurayama area, Abukuma Mountains, northeast Japan.

Material.—Two specimens from locality AR1: (1) internal mould of a conjoined shell, with external mould of the dorsal valve, KCG001 (holotype); (2) external mould of a ventral valve, KCG002 (paratype).

Diagnosis.—Large *Gypospirifer* with narrow, deep ventral sulcus and narrow, high dorsal fold, and ornamented with relatively fine costae (10–11 in 10 mm at midlength of ventral valve) on both valves.

Description.—Shell large size for genus, transversely semielliptical in outline, with greatest width at hinge; length 49 mm, width about 65 mm in the better preserved dorsal valve specimen (KCG001). Ventral valve moderately convex in lateral profile, most convex at umbonal region; umbo strongly incurved; interarea high for genus, slightly concave; sulcus narrow and deep, originating at umbo and rapidly widening anteriorly. Dorsal valve gently convex in lateral profile; fold narrow and high. External surface of ventral valve ornamented with numerous fine costae and concentric ornament of a few, strong, irregular rugae and very fine growth lines; costae subridged and subtly fasciculate; numbering 10–11 costae in 10 mm at about midlength. External ornament of dorsal valve similar to that of opposite valve. Ventral interior with a pair of thick, short dental plates and a deeply impressed, large, elongate ovate muscle field. Dorsal interior with a pair of widely divergent hinge sockets and small, striated cardinal process.

Remarks.—Shells of *Gypospirifer kobiyamai* sp. nov. were first figured by Kobiyama (1956) from the Takakurayama Formation of the Takakurayama area, Abukuma Mountains, northeast Japan as *Spirifer fasciger* var. *simplex* Grabau, 1936, and subsequently described by Hayasaka (1960) from the lower Kanokura Formation of Tagara and Takayashiki in the Kesennuma area as *Neospirifer fasciger* (Keyserling, 1846). The neospiriferid species, *Neospirifer simplex* and *Neospirifer fasciger* are, however, readily distinguished from *G. kobiyamai* by their much smaller dimensions.

Gypospirifer kobiyamai sp. nov. most resembles *Gypospirifer gryphus* Cooper and Grant (1976, p. 2211, pl. 591, figs. 1–5), from the Graham Formation of west Texas, in size and shape of the shell, but the Texas species differs from the present new species in having shallower sulcus and coarser costae on the ventral valve.

Gypospirifer volatilis Duan and Li (1985, p. 127, 207, pl. 48, figs. 1, 2; pl. 49, figs. 1, 2), from the Zhesi (Jisu) Formation of Zhesi, Inner Mongolia, north China, differs from *G. kobiyamai* in having much broader and higher fold on the dorsal valve.

Distribution.—Middle Permian (Wordian) to Upper Permian (Lopingian): northeast China (Heilongjiang), eastern Russia (South Primorye), northeast Japan (Kesennuma and Takakurayama in the South Kitakami Belt), central Japan (Moribu in the Hida Gaien Belt) and southwest Japan (Mizukoshi, central Kyushu, western extension of the Hida Gaien Belt).

Order Spiriferinida Ivanova, 1972
Suborder Cyrtinidina Carter and Johnson, 1994
Superfamily Cyrtinoidea Fredericks, 1911
Family Cyrtinidae Fredericks, 1911

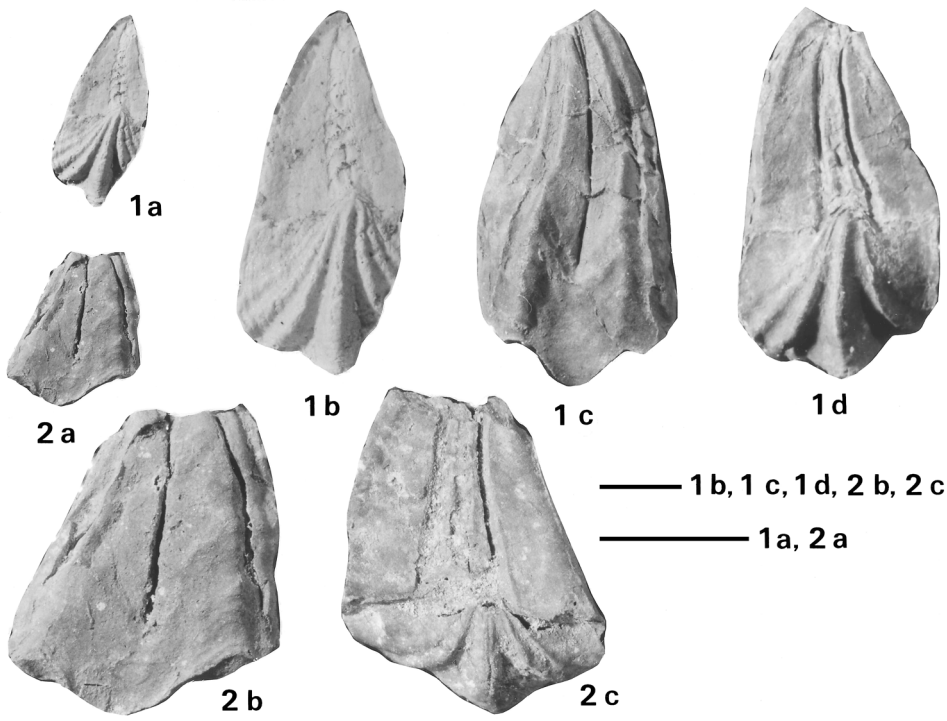

Fig. 3. 1, 2: *Licharewina arakii* (Hayasaka), 1a, 1b, 1c, 1d: external latex cast of dorsal valve with interarea of ventral valve, internal mould of ventral valve, and internal mould of dorsal valve with interarea of ventral valve, KCG004, 2a, 2b, 2c: internal mould of ventral valve, and internal mould of dorsal valve with interarea of ventral valve, KCG006. Scale bars represent 1 cm.

Genus *Licharewina* Kotlyar, Zakharov and Polubotko, 2004

Type species.—*Licharewina praetriassica* Kotlyar, Zakharov and Polubotko, 2004.

Licharewina arakii (Hayasaka, 1963a)
Figs. 3.1, 3.2

Geyerella arakii Hayasaka, 1963a, p. 481, figs. 2, 3.

Material.—Two specimens from localities AR2 and AR4: (1) internal mould of a conjoined shell, with external mould of the dorsal valve and interarea of the ventral valve, KCG004; (2) internal mould of a conjoined valve, KCG006.

Description.—Shell large size for genus, elongate subtrigonal in outline; hinge straight, wide, slightly shorter than greatest width which occurring at about four-fifths length from

umbo, in another way, at about midlength of dorsal valve; length about 27 mm, width 19 mm in the better preserved specimen (KCG004). Ventral valve highly pyramidal and slightly bent; interarea very high, flat to slightly concave, with narrow delthyrium covered by imbricated plates; sulcus narrow and deep. Dorsal valve gently convex in lateral profile; fold narrow and high. External surface of dorsal valve ornamented by simple, strong costae with subangular crests, counted 3 on each lateral slope. Ventral interior with a long, thin median septum, extending to about three-quarters length of valve and short, strong, subparallel dental plates. Internal surface of both valves covered by numerous very fine pustules (indicate punctate shell).

Remarks.—*Licharewina arakii* (Hayasaka, 1963a) was first described by Hayasaka (1963a) as *Geyerella arakii* Hayasaka, 1963a, from the lower Kanokura Formation of Omotematsukawa (Anabuchi) in the Kesennuma area, South Kitakami Belt. In the present paper, the genus is changed to *Licharewina* from *Geyerella*, on the basis of its external and internal characters, highly pyramidal and slightly bent ventral valve, very high interarea with delthyrium covered by imbricated plates, and in having some simple strong costae, but lacking concentric rugae or growth lines on the both ventral and dorsal valves.

The type species, *Licharewina praetriassica* Kotlyar, Zakharov and Polubotko (2004, p. 522, figs. 6.13–6.20), from the Upper Permian (Changhsingian) of the northwestern Caucasus Mountains, differs from the present species in its much smaller size.

Licharewina josephinae (Gemmellaro, 1899), redescribed and refigured by Shen and Clapham (2009, p. 732, pl. 6, figs. 1–15), from the Episkopi Formation (Wuchiapingian) of Hidra Island, Greece, differs from *L. arakii* in its smaller size and less pyramidal outline of the shell.

Distribution.—Middle Permian (Wordian): northeast Japan (Kesennuma in the South Kitakami Belt).

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