Redescription of the brachiopod genus *Globispirifer* Tachibana, 1964 from the lowest Carboniferous of the South Kitakami Belt, NE Japan

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Abstract

In this paper we redescribe the early Tournaisian brachiopod genus *Globispirifer* based on the topotype specimens of the type species *G. nagasakaensis* from the basal part of the Karaumedate Formation of the Nagasaka area, South Kitakami Belt, northeast Japan. The genus *Globispirifer* possesses a pair of well-developed dental plates and crural plates, and thus is unsuitable for the family Martiniidae but fits well within the family Martiniopsidae. Ontogenetic variations of *G. nagasakaensis* exhibit the followings: (1) the shell outline is subcircular in juveniles and then becomes elongate oval in adults, (2) the dorsal fold is completely absent in juveniles, broadened and highly raised in adults, and (3) the external surfaces of both valves are generally smooth in juveniles and weakly plicated in adults.

Key words: brachiopod, Early Carboniferous, *Globispirifer*, northeast Japan, South Kitakami Belt, Tournaisian.

Introduction

Globispirifer is one of the most distinct spiriferid genera among the Early Carboniferous brachiopods. Although the genus is geographically endemic to the South Kitakami Belt, northeast Japan, its presence at the poorly fossiliferous sediments of the lowest Carboniferous is significant and provides insights into the definition of the Devonian/Carboniferous boundary in the South Kitakami region. However, this genus has been poorly understood since Tachibana (1964) proposed it. When creating *Globispirifer,* Tachibana (1964) did not fully describe the genus probably due to insufficient materials. As a consequence, this genus has long remained

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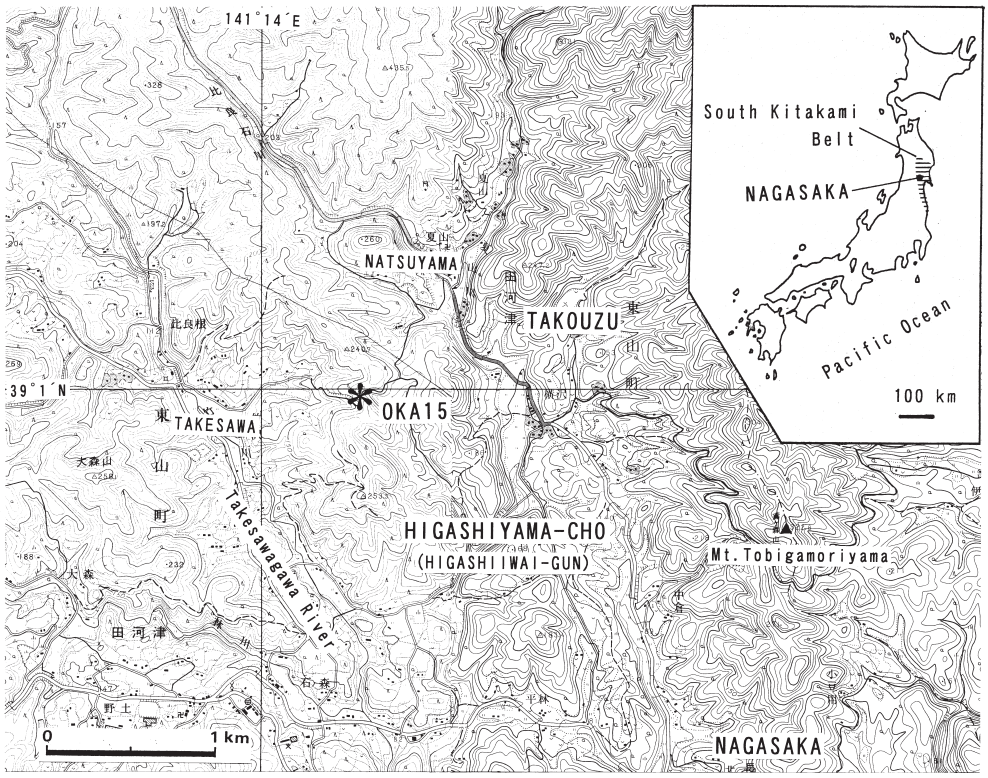

Fig. 1. Map showing the fossil locality OKA15 in the Nagasaka area (using the topographical map of "Maesawa" and "Okita" scale 1: 25,000, published by the Geographical Survey Institute of Japan).

misunderstood.

In 1980s, one of the authors (JT), with help of his students, collected abundant specimens of the type species *Globispirifer nagasakaensis* (Tachibana, 1956) from light greenish grey, fine-grained tuffaceous sandstone of the basal part of the Karaumedate Formation at the locality OKA15, road cutting about halfway between Natsuyama and Takesawa (1 km SW of Natsuyama), Higashiyama-cho, Higashiiwai-gun, Iwate Prefecture, i.e., the Nagasaka area, South Kitakami Belt, northeast Japan (Fig. 1). It should be noted that both our fossil horizon and locality are almost the same as the type locality of the genus *Globispirifer* described by Tachibana (1956).

Together with *G. nagasakaensis*, we also obtained numerous specimens of *Ptychomaletoechia* sp., a rhynchonellid brachiopod species, from the locality OKA15. Although now we cannot give a certain species name to these specimens, they appear to be indistinguishable from the *Ptychomaletoechia* species described by Chen (1995) and Chen and Shi (1999a) from the Devonian/Carboniferous boundary beds of the Tarim Basin, Xinjiang Province, northwest China. In addition, the previous stratigraphical and

palaeontological (brachiopods, ammonoids and plants) data suggest that the underlying Tobigamori Formation is correlated with the Upper Devonian (Famennian)-Lower Carboniferous (lower Tournaisian) and the Karaumedate Formation is assignable to the Lower Carboniferous (lower Tournaisian-upper Visean) (e.g., Yabe and Noda, 1933; Tachibana, 1950, 1952, 1964, 1981; Noda and Tachibana, 1959; Minato et al., 1979; Tazawa, 1980; Ehiro and Takaizumi, 1992; Tajika, 1997). As a result, the basal part of the Karaumedate Formation, bearing *G. nagasakaensis* can be constrained as the earliest Tournaisian in age.

The purpose of this study is to redescribe and emend the genus *Globispirifer* Tachibana, 1964 based on examining the newly obtained materials and the syntype specimens figured by Carter and Gourvennec (2006). A larger number of specimens allow us to observe the ontogenetic variations of *G. nagasakaensis*. All described specimens are registered and housed in the Department of Geology, Faculty of Science, Niigata University.

Systematic descriptions

Order Spiriferida Waagen, 1883
Suborder Spiriferidina Waagen, 1883
Superfamily Martinioidea Waagen, 1883
Family Martiniopsidae Kotlyar and Popeko, 1967

Genus *Globispirifer* Tachibana, 1964

Type species.—*Spirifer* (*Martiniopsis*?) *nagasakaensis* Tachibana, 1956

Diagnosis.—Medium size, biconvex in lateral profile; subcircular to elongate oval in outline; ventral umbo acute, incurved; delthyrium broad, open; suclus absent; dorsal valve varied through growth lineage, subcircular and no median fold in juveniles, elongate oval and having prominent fold in adults; ventral external surface smooth; dorsal external surface smooth in juveniles, but weakly plicated in adults. Ventral interior with blunt teeth supported by broad, divergent dental plates; adminicula distinct and diverging; median myophragm fairly long and high; adductor scars narrow, grooved; diductor scars chevron-shaped, strongly flabellate. Dorsal interior with short, distinct, subparallel crural plates; dorsal adductor scars large, subovate, longitudinally striated.

Remarks.—By selecting *Spirifer* (*Martiniopsis*?) *nagasakaensis* Tachibana, 1956 as the type species, Tachibana (1964, p. 37) created *Globispirifer* without a full description. In Tachibana's definition presence of both dorsal plicae and dental plates and lack of adminicula in both valves characterize the genus. Moreover, *Globispirifer* also resembles externally *Eomartiniopsis* Sokolskaya, 1941 in many aspects. As a consequence, Carter and Gourvennec (2006) assigned this Kitakami genus to the subfamily Eomartiniopsinae of the family

Martiniidae Waagen, 1883. However, the re-examination of the topotype specimens described below reveals that *Globispirifer* possesses distinctive dental adminicula in the ventral valve (Fig. 2) and crural plates in the dorsal valve. Although *Eomartiniopsis* has been treated as a grab-bag genus for smooth, poorly described reticularioids (Carter et al., 1994, p. 340), its type species lacks crural plates or dorsal adminicula. Consequently, *Globispirifer* is rejected to the Eomartiniopsinae. In contrast, both exterior and interior features justify assignment of *Globispirifer* to the family Martiniopsidae.

The most allied genus to *Globispirifer* is *Martiniopsis* Waagen, 1883 (see also Campbell, 1959; Chen, 2004), both genera characterized by well-developed dental plates, distinctive sockets, conspicuous dental adminicula and crural plates. However, *Globispirifer* is differentiated, as compared in the above subfamily, from *Martiniopsis* by the loss of a ventral sulcus and the possession of the variously developed dorsal fold and dorsal external ornamentation. In addition, *Martiniopsis* is usually proportionally transverse and has a deep and broad ventral sulcus that forms a lingual extension near the anterior margin. The flabellate muscle scars and pronounced myophragms of *Globispirifer* are also noteworthy.

Among genera of the Martiniopsidae, *Arektikina* Grunt, 1977 is distinguished from *Globispirifer* by having a more transverse outline, a prominent ventral sulcus and dorsal fold, and weak plicae on both valves. *Nodaea* Tachibana, 1981 established from the same formation possesses a prominent sulcus and fold, capillae on both valves and a pair of short, broad crural plates in the dorsal valve, and thus cannot be confused with *Globispirifer*. The possession of a tiny size, a distinctive ventral sulcus and concentric lamellae distinguishes *Crassumbo* Carter, 1967 from *Globispirifer*. The absence of a ventral sulcus in *Globispirifer*, incorporating with the similar internal structures, also recalls *Rorespirifer* Waterhouse and Piyasin, 1970. However, the Thai genus is distinguished from *Globispirifer* by the loss of a prominent fold on the dorsal valve, capillae on both valves, and the presence of a dorsal median ridge.

Globispirifer also generally resembles the genus *Chiuella* Chen and Shi, 1999b [= *Martiniella* Chu, 1933 of Wang et al. (1964) and Chen and Shi (1999a)] in many details, but this Chinese genus has a ventral sulcus and lacks plicae, dorsal adminicula and median myophragms.

Distribution.—Lower Carboniferous (lower Tournaisian); northeast Japan (South Kitakami Belt).

Globispirifer nagasakaensis (Tachibana, 1956)
Figs. 2, 3.1a-3.9

Martiniella nagasakaensis Tachinana, 1952, p. 358.
Spirifer (*Martiniopsis*?) *nagasakaensis* Tachibana, 1956, p. 13, pl. 1, figs. 5-20.
Globispirifer nagasakensis (Tachibana); Tachibana, 1964, p. 37.
Globispirifer nagasakaensis (Tachibana): Carter and Gourvennec, 2006, figs. 1153.3a-3f.

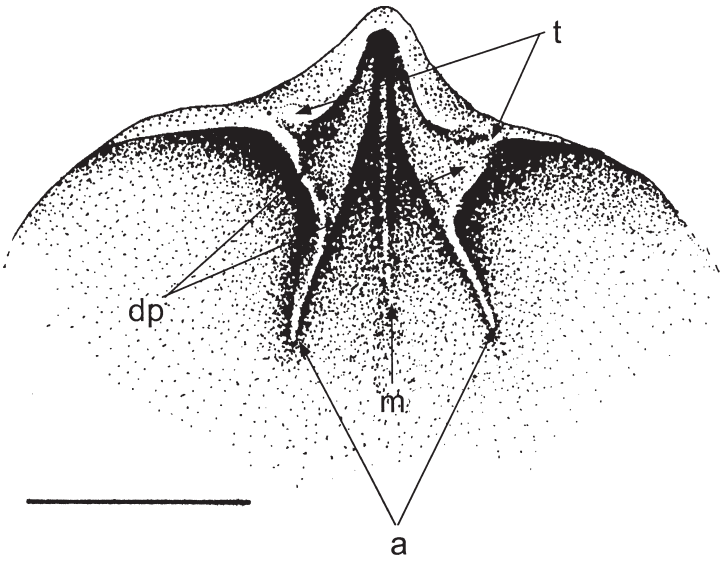

Fig. 2. Reconstruction of ventral interior of *Globispirifer nagasakaensis* (Tachibana), based on the specimen NU-B745. a: adminicula, dp: dental plate, m: myophragm, t: teeth. Scale bar represents 10 mm.

Material.—Twenty-eight specimens from locality OKA15: (1) external and internal moulds of a ventral valve, NU-B739; (2) external moulds of five ventral valves, NU-B740-744; (3) internal moulds of twenty ventral valves, NU-B745-764; (4) external moulds of two dorsal valves, NU-B765, 766. In addition, two dorsal valve specimens figured by Carter and Gourvennec (2006, figs. 1153.3d, 3f), from the lower part of the Karaumedate Formation of the Nagasaka area, South Kitakami Belt, are also treated here to describe the shape and external ornament of the dorsal valve.

Description.—Shell medium size for genus, subcircular to elongate oval, occasionally elongate subpentagonal in outline, moderately biconvex in lateral profile, hingeline rather short, with maximum width at midvalve, cardinal extremities rounded; length about 46 mm, width about 37 mm in the largest ventral valve specimen (NU-B745). Ventral valve moderately convex in lateral profile; beak highly raised, curved and overhanging hingeline; interarea triangular, high, slightly convex, and medially occupied by a broad, triangular, open delthyrium; umbo evenly convex, slightly folded anteriorly; lateral slopes gentle; sulcus wholly absent. Dorsal valve moderately convex in lateral profile; fold originating at anterior to beak, increasing in height and width anteriorly, extremely pronounced near anterior margin, and longitudinally separated by two shallow furrows. Ventral external surface generally smooth; dorsal external surface ornamented by variously developed plicae on lateral slopes; plicae rather weak in juveniles and becoming strong and sharp in adults, numbering 4-7 on each lateral slope.

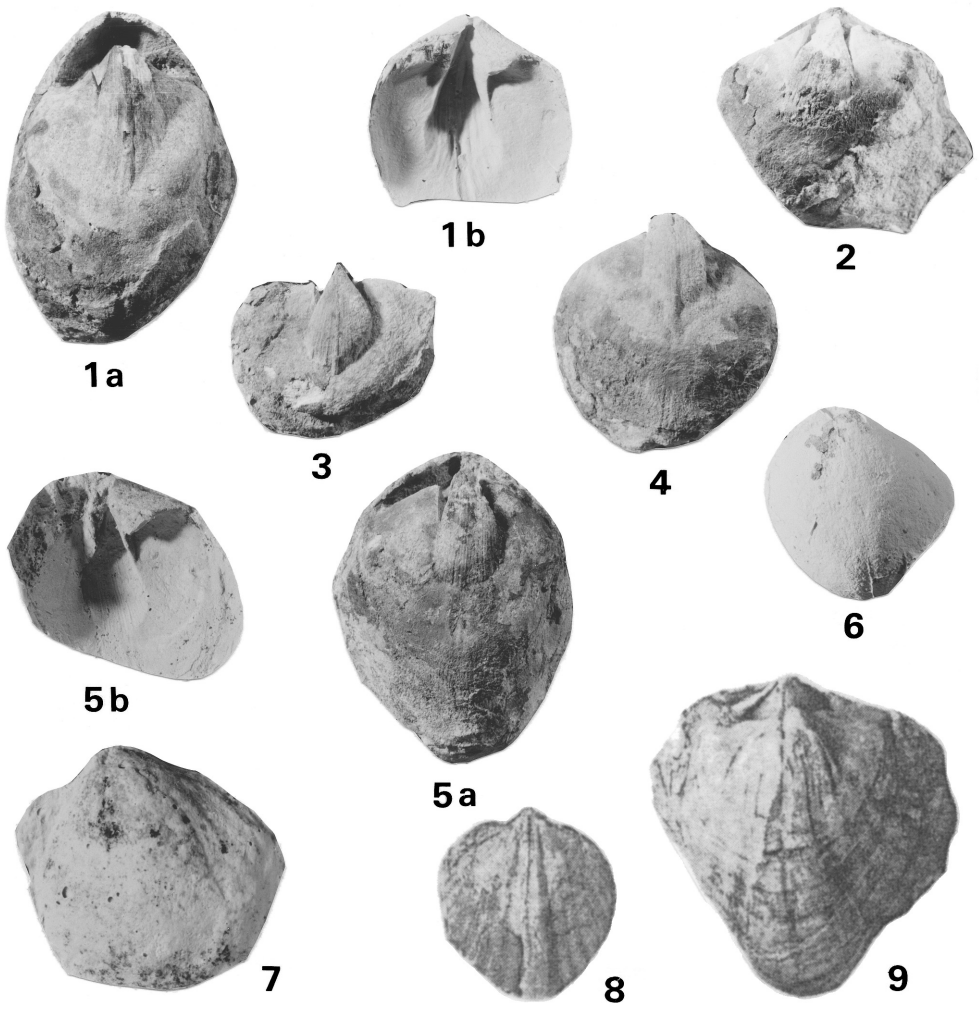

Fig. 3. *Globispirifer nagasakaensis* (Tachibana) from the basal part of the Karaumedate Formation in the Nagasaka area. **1a, 1b:** internal mould and latex cast of a ventral valve, NU-B745, **2-4:** internal moulds of three ventral valves, 2: NU-B747, 3: NU-B756, 4: NU-B748, **5a, 5b:** internal mould and latex cast of a ventral valve, NU-B749, **6:** external latex cast of a ventral valve, NU-B742, **7:** external latex cast of a dorsal valve, NU-B765 (× 2), **8, 9:** external casts of two dorsal valves (after Carter and Gourvennec, 2006). All figures are natural size unless otherwise indicated.

Internally, ventral valve having blunt teeth, supported by a pair of broad and high dental plates; adminicula thin, blade-like, extending forward about one-fourth length of valve, and enclosing oval muscle scars; median myophragm broad, high at posterior region of shell, becoming thinner and lower anteriorly (see Fig. 2); muscle scars well-developed, forming distinctive muscle platforms; adductor scars narrow, situated medially with two shallow grooves on each side of median myophragm; diductor scars prominent, occupying most of

muscle areas, chevron in shape with curved sides, meeting anteriorly with one another; muscle markings strongly flabellate, about 7-10 radial furrows on each scar area. Dorsal internal structure not observed.

Remarks.—Shell outline of *Globispirifer nagasakaensis* varies from subcircular in juveniles (Fig. 3.8) to elongate oval in adults (Fig. 3.1a). The dorsal fold is completely absent in juveniles, lowly raised and broad in some neanic individuals, becomes well-defined but narrow and low in some adults, and eventually broadened and highly raised in gerontic forms. The dorsal external surface is smooth in juveniles, weakly plicated in neanic individuals, and sculptured with coarse plicae in adults.

Distribution.—Same as the genus.

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