Jour. Geol. Soc. Japan, Vol. 116, No. 1, p. 51－54, January 2010

Late Carboniferous brachiopod *Plicatiferina* from Nishiamada, Fukui Prefecture, central Japan, and its tectonic implications

Jun-ichi Tazawa, Junko Anso**, Miyuki Umeda** and Toshiyuki Kurihara****

Received July 9, 2009.
Accepted October 2, 2009.
* Department of Geology, Faculty of Science, Niigata University, Niigata 950-2181, Japan
** Fukui City Museum of Natural History, 147 Asuwakami, Fukui 918-8006, Japan
*** Graduate School of Science and Technology, Niigata University, Niigata 950-2181, Japan

Corresponding author; J. Tazawa,
tazawa@geo.sc.niigata-u.ac.jp

Abstract: A new occurrence of the Late Carboniferous productoid brachiopod species, *Plicatiferina borealica* Kalashnikov, is described from a sequence of alternating metamorphosed limestone and subordinate metamorphosed felsic tuff, mudstone and sandstone at Nishiamada, Fukui Prefecture, central Japan. *Plicatiferina* is a typical Boreal-type genus, distributed in the Upper Carboniferous and lowest Permian of Arctic Canada, Arctic Russia, and the northern and southern Urals. The fossilbearing sequence at Nishiamada is assigned to the Late Carboniferous (Kasimovian?), and is correlated with the Unazuki metamorphic rocks of the Hida Belt, central Japan. The occurrence of a Boreal-type brachiopod at Nishiamada suggests that the original calcareous and volcaniclastic sediments of the Unazuki metamorphic rocks were deposited in a shallow sea on and around the eastern North China (Sino-Korea) during the Late Carboniferous.

Keywords: brachiopod, Late Carboniferous, Nishiamada, *Plicatiferina*, Unazuki metamorphic rocks

Introduction

Umeda et al. (2008, fig. 4.D) reported a poorly preserved brachiopod fossil as Brachiopoda gen. et sp. indet. from a metamorphosed sequence of alternating limestone and felsic tuff, mudstone and sandstone in the middle reaches of the Asuwagawa River, Nishiamada, located 16 km SE of Fukui City, central Japan (Fig. 1.B). The brachiopod specimen was subsequently studied by the first author of the present paper (J. Tazawa) and identified as *Plicatiferina borealica* Kalashnikov, 1980. In this paper we describe the brachiopod from Nishamada, and discuss the age and tectonic setting of the host rocks.

Carboniferous brachiopod from Nishiamada

The brachiopod specimen from Nishiamada is represented by a fragmented external mould of ventral valve, preserved in dark greyish brown siltstone. Despite the poor state of preservation, the specimen can be assigned to a productoid brachiopod species, *Plicatiferina borealica* Kalashnikov, as described by Kalashnikov (1980) from the Upper Carboniferous (Kasimovian) of Novaya Zemlya and Vaygach Island, Arctic Russia. This is the first record of the genus *Plicatiferina* from Japan.

1. Species description

The supra-generic classification follows Brunton et al. (2000). The described specimen is registered and housed in the Fukui City Museum of Natural History in Fukui, Japan.

Order Productida Sarytcheva and Sokolskaya, 1959
Suborder Strophalosiidina Schuchert, 1913
Superfamily Strophalosioidea Schuchert, 1913
Family Araksalosiidae Lazarev, 1989
Subfamily Quadratiinae Lazarev, 1989
Genus *Plicatiferina* Kalashnikov, 1980

Plicatiferina borealica Kalashnikov, 1980

Figs. 2.A-2.C.

Plicatiferina borealica Kalashnikov, 1980, p. 46, pl. 11, figs. 1a, 1b, 2.
Brachiopoda gen. et sp. indet. Umeda et al., 2008, fig. 4.D.

Material.－ One specimen, external mould of a ventral valve, FCMNH-GF7591.

Description.－ Shell small for genus, transversely subrectangular in outline, with greatest width at mid-length of ventral valve; length about 7 mm, width about 14 mm. Ventral valve gently convex in both lateral and anterior profiles, not geniculated; umbo small; ears small, not clearly demarcated from visceral region; sulcus moderately deep and broad. External surface of ventral valve ornamented with strong concentric rugae, numbering eight on lateral slopes.

Remarks.－ The sole specimen from Nishiamada is referred to *Plicatiferina borealica* Kalashnikov, 1980,

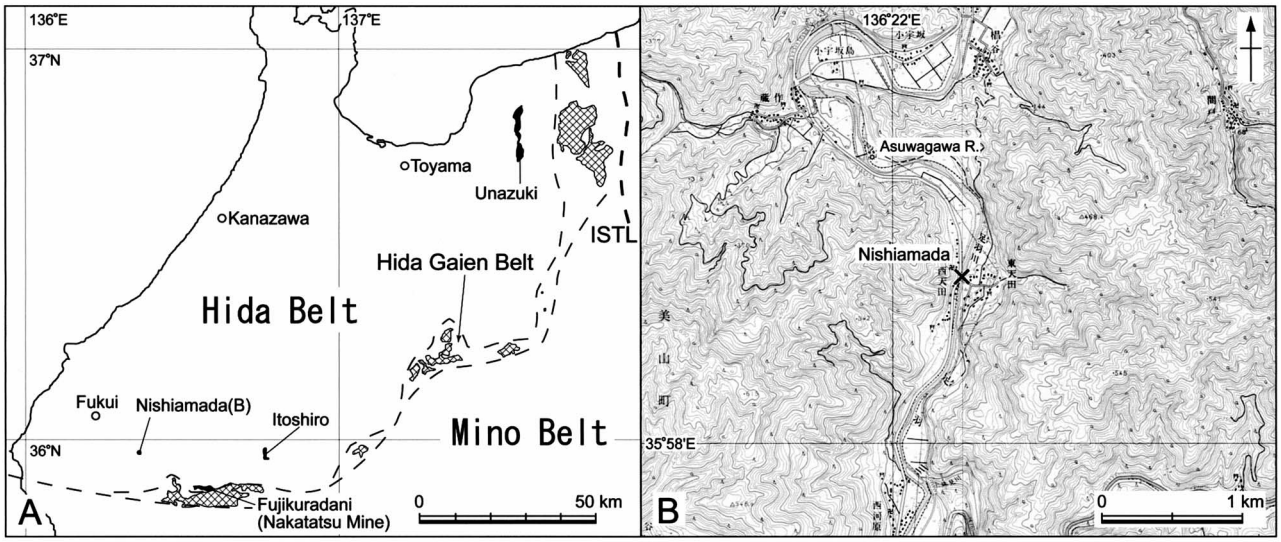

Fig. 1. A: simplified tectonic map of northern central Japan. Black areas indicate distribution of the Unazuki metamorphic rocks (redrawn and adapted from Tazawa, 2004), B: index map showing the fossil locality (×) at Nishiamada, Fukui Prefecture, central Japan (using the topographical maps "Echizen-Ono" and "Kawada" scale 1: 25,000 published by the Geographical Survey Institute of Japan).

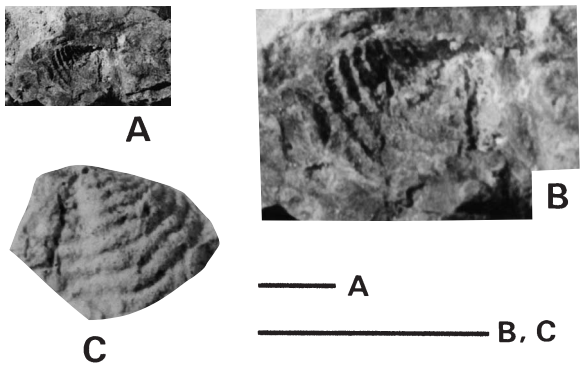

Fig. 2. *Plicatiferina borealica* Kalashnikov from Nishiamada, A, B: external mould of ventral valve, C: latex external cast of ventral valve, FCMNH-GF7591. Scale bars indicate 1 cm.

from the Kasimovian of Novaya Zemlya and Vaygach Island, Arctic Russia, based on its size, shape and external ornament of the ventral valve. The type species, *Plicatiferina pseudoplicatilis* (Stepanov, 1948, p. 33, pl. 6, figs. 3-5), originally described from the Upper Carboniferous (Kasimovian?) of Bashkir, southern Urals, differs from the Nishiamada specimen in its larger size and more numerous and less prominent rugae on the ventral valve. *Plicatiferina kalashnikovi* Carter and Poletaev (1998, p. 117, figs. 3.1-3.4) from the Upper Carboniferous (upper Bashkirian or lower Moscovian) of Ellesmere Island, Arctic Canada, is also a small-sized species of *Plicatiferina*; however, the Canadian species is distinguished from *P. borealica* in having a shallower ventral sulcus and more numerous, finer rugae on the ventral valve.

2. Stratigraphical and geographical distributions of *Plicatiferina*

Five species are assigned to the genus *Plicatiferina*; their stratigraphical and geographical distributions are summarized below, and the latter aspect is shown in Fig. 3. *Plicatiferina chaoi* (Grabau, 1936), from the Middle Carboniferous of China (Guangxi, Guizhou and Xizang), is excluded from the genus *Plicatiferina* based on its much larger size and the ventral valve ornamentation consisting of numerous undulated rugae (see Jin and Liao, 1974, pl. 145, figs. 1, 2), which differ from those of the other *Plicatiferina* species.

Plicatiferina neoplicatilis (Stepanov, 1939): Moscovian-Asselian of the Verkhoyansk Mountains, northern Urals and Bashkiria, southern Urals (Stepanov, 1939; Mironova, 1967; Solomina, 1978; Alexandrov and Einor in Einor, 1979; Kalashnikov, 1980, 1986; Klets, 2005); ***Plicatiferina pseudoplicatilis*** (Stepanov, 1948): Kasimovian-Asselian of Bashkiria, southern Urals (Stepanov, 1948; Mironova, 1967; Garanj et al., 1975; Alexandrov and Einor in Einor, 1979); ***Plicatiferina borealica*** Kalashnikov, 1980: Kasimovian of Novaya Zemlya and Vaygach Island, Arctic Russia (Kalashnikov, 1980), and Upper Carboniferous (Kasimovian ?) of Nishiamada, central Japan (this study); ***Plicatiferina* sp.** cf. *P. neoplicatilis* (Stepanov, 1939): Middle Carboniferous of Pay Khoy, Arctic Russia (Lazarev, 1990); ***Plicatiferina kalashnikovi*** Carter and Poletev, 1998: upper Bashkirian or lower Moscovian of Ellesmere Island, Arctic Canada (Carter and Poletaev, 1998).

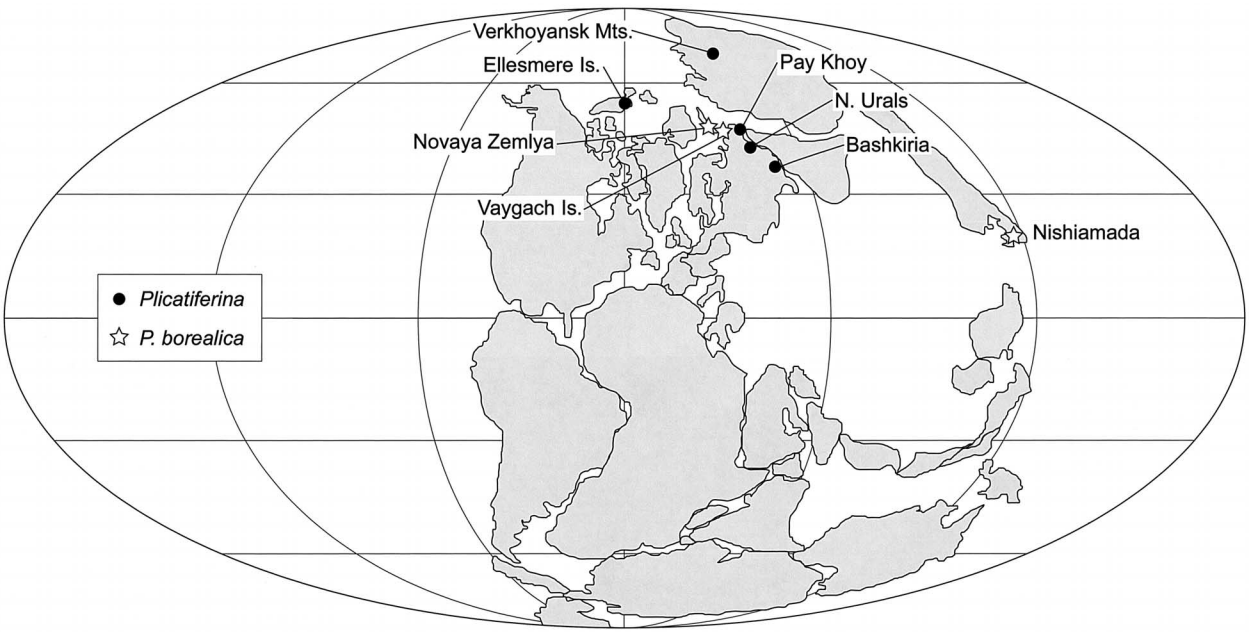

Fig. 3. Geographical distribution of *Plicatiferina* in the Late Carboniferous to earliest Permian. Base map is made from Scotese (1994).

Discussion

Plicatiferina is a typical Boreal-type genus, reported from the Upper Carboniferous (Bashkirian?-Kasimovian) and lowest Permian (Asselian) of Arctic Canada and northern and western Russia. *Plicatiferina borealica* is known only from the Kasimovian of the Arctic Russia. The fossil-bearing limestone at Nishiamada is associated with subordinate felsic tuff, mudstone and sandstone, and contains chert nodules (Umeda et al., 2008; Umeda and Anso, 2008). These rocks are metamorphosed, getting schistosity. Based on lithological and fossil evidence, the metamorphosed limestone at Nishiamada is assigned to the Upper Carboniferous (Kasimovian?) and is correlated with the Upper Carboniferous metamorphosed limestones of the Unazuki metamorphic rocks, found at Unazuki, Toyama Prefecture (Hiroi, 1978; Hiroi et al., 1978), Itoshiro, Gifu Prefecture (Konishi, 1954; Hiroi, 1981), and Fujikuradani (Nakatatsu Mine), Fukui Prefecture (Yamada, 1967; Ishiwatari, 2006) (see Fig. 1.A), central Japan.

In the Late Carboniferous palaeobiogeography of China, Boreal-type brachiopods occur from the Junggar-Xingan (Hinggan), Tianshan-Jilin, and North China-Qilian provinces; and these provinces are closely related to North America and Siberia (Yang, 1994). Therefore, the occurrence of *Plicatiferina* at Nishiamada suggests that the original calcareous and volcaniclastic sediments of the Unazuki metamorphic rocks were deposited in a shallow sea on and around the eastern North China (Sino-Korea) during the Late Carboniferous. This conclusion nearly accords with Arakawa et al. (2000), in which they mentioned two possibilities for the Palaeozoic to early Mesozoic history of the Hida Belt including the Unazuki metamorphic rocks: (1) the Hida Belt was formed at the eastern margin of North China, or (2) it evolved as a part of the East-Central Asian Orogenic Belt (ECAOB).

Acknowledgements

We are greatly indebted to Isamu Hattori of Fukui University for useful advice and encouragement in the course of this study. We thank Shigeru Otoh of Toyama University and Yoshikuni Hiroi of Chiba University for their critical review of the manuscript by which this paper is greatly improved.

References

Arakawa, Y., Saito, Y. and Amakawa, H., 2000, Crustal development of the Hida belt, Japan: Evidence from Nd-Sr isotopic and chemical characteristics of igneous and metamorphic rocks. *Tectonophysics*, **328**, 183-204.

Brunton, C. H. C., Lazarev, S. S., Grant, R. E. and Jin, Y., 2000, Productidina. *In* Williams, A. et al., *Treatise on invertebrate paleontology, Part H Brachiopoda revised, Vol. 3: Linguliformea, Craniiformea, and Rhynchonelliformea (part)*. Geol. Soc. Amer., Boulder and Univ. Kansas, Lawrence, 424-609.

Carter, G. L. and Poletaev, V. I., 1998, Atokan (Late Bashkirian or Early Moscovian) brachiopods from the Hare Fiord Formation of Ellesmere Island, Canadian Arctic Archipelago. *Annal. Carnegie Mus.*, **67**, 105-180.

Einor, O. L., 1979, *Atlas fauny i flory srednego-pozdnego karbona Bashkirii* [*Atlas of the Middle to Late Carboniferous fauna and flora of Bashkir*]. Nedra, Moscow, 204 p. ****

Garanj, I. M., Guseva, S. N., Devingtal, V. V., Donakova, L. M., et al., 1975, Brakhiopody. *In* Stepanov, D. L., Krylova, A. K., Grozdilova, L. P.,

Pozner, V. M. and Sultanaev, A. A., eds., *Paleontologicheskiy atlas kamennougolnykh otlozheniy Urala* [*Palaeontological atlas of the Carboniferous formations of the Urals*]. Nedra, Leningrad, 154-248. ****

Grabau, A. W., 1936, Early Permian fossils of China, Pt. 2. Fauna of the Maping Limestone of Kwangsi and Kweichow. *Palaeont. Sinica, Ser. B,* **8**, 1-441.

Hiroi, Y., 1978, Geology of the Unazuki district in the Hida Metamorphic Terrain, central Japan. *Jour. Geol. Soc. Japan,* **84**, 521-530. *1

Hiroi, Y., 1981, Subdivision of the Hida metamorphic complex, central Japan, and its bearing on the geology of the Far East in pre-Sea of Japan time. *Tectonophysics,* **76**, 317-333.

Hiroi, Y., Fuji, N. and Okimura, Y., 1978, New fossil discovery from the Hida metamorphic rocks in the Unazuki area, central Japan. *Proc. Japan Acad., Ser. B,* **54**, 268-271.

Ishiwatari, A., 2006, §1.6 Chloritoid schist of the Nakatatsu Mine: Tectonic relationship between the Hida-Unazuki Belt and the Hida Gaien Belt. *In* Geological Society of Japan, ed., *Regional Geology of Japan,* 4 *Chubu area*, 150-151. **

Jin, Y. and Liao, Z., 1974, §3. (6) 1. Carboniferous Brachiopoda. *In*, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, ed., *Handbook of Geology and Palaeontology of Southwest China*. Science Press, Beijing, 275-283. *****

Kalashnikov, N. V., 1980, *Brakhiopody verkhnego paleozoya Evropeyskogo Severa SSSR* [*Upper Palaeozoic brachiopods from the European northern USSR*]. Nauka, Leningrad, 134 p. ****

Kalashnikov, N. V., 1986, Brakhiopody. *In* Gorskii, V. P. and Kalmykova, M. A., eds., Atlas kharakternykh kompleksov permskoi fauny i flory Urala: Russkoi Platformy [Atlas of characteristic Permian fauna and flora of the Urals: Russian Platform]. *Tr. Vsesoyuz. Nauch.-Issledovatel. Geol. Inst.* (*VSEGEI*) [*Trans. All Soviet Union Geol. Res. Inst.*], **331**, 29-30, 89-94. ****

Klets, A. G., 2005, *Upper Paleozoic of marginal seas of Angarida*. Acad. Pub. House, Novosibirsk, 240 p. ***

Konishi, K., 1954, Note on the Moscovian (?) deposits at Itoshiro-mura, Fukui, Japan. *Jour. Geol. Soc. Japan,* **60**, 7-17. *1

Lazarev, S. S., 1989, Systematics of Devonian brachiopods of suborder Strophalosiidina. *Paleont. Zhur* (*Paleont. Jour.*), no. 2, 27-39.***

Lazarev, S. S., 1990, *Evolution and System of Productids*. Nauka, Moscow, 171p. ***

Mironova, M. G., 1967, *Pozdnekamennougolnye brakhiopody Bashkirii* [*Late Carboniferous brachiopods of Bashkir*]. Leningrad Univ. Press, Leningrad, 62p.****

Sarytcheva, T. G. and Sokolskaya, A. N., 1959, On the classification of pseudopunctate brachiopods. *Comptes Rendus* (*Doklady*), *Acad. Sci. USSR,* **125**, 181-184. ***

Schuchert, C., 1913, Class 2. Brachiopoda. *In* Zittel, K.A., ed., *Text-book of Palaeontology, vol. 1, part 1. 2nd ed.*, MacMillian & Co., London, 355-420.

Scotese, C. R., 1994, Paleogeographic map. Late Carboniferous (Westphalian). *In* Klein, G.D., ed., Pangea: Paleoclimate, tectonic, and sedimentation during accretion, zenith, and breakup of a supercontinent. *Geol. Soc. Amer. Spec. Pap.* **288**, Geol. Soc. Amer., Boulder, Colorado, 5.

Solomina, R. V., 1978, Nekotorye sredne-verkhnekamennougolnye brakhiopody Severnogo Verkhoyanya. *In* Dubatorov, V. N. and Yuferev, O.V., eds., Biostratifrafiya i paleobiogeografiya devona i karbona Aziatskoy chasti SSSR [Biostratigraphy and palaeobiogeography of Devonian and Carboniferous of the Asian regions of the USSR], *Tr. Inst. Geol. Geofiz.* [*Trans. Inst. Geol. Geophys.*], **386**, 99-123. ****

Stepanov, D. L., 1939, On the stratigraphic value of the Upper Carboniferous and Lower Permian brachiopods. *Comptes Rendus* (*Doklady*), *Acad. Sci. USSR,* **25**, 755-758. ***

Stepanov, D. L., 1948, Verkhnekamennougolnye brakhiopody Bashkirii. *Tr. Vsesoyuz. Neftyan. Nauch.-Issledovatel. Geologorazved. Inst.* (*VNIGRI*) [*Trans. All Soviet Union Petrol. Geol. Prospect. Inst.*], **22**, 1-64. ****

Tazawa, J., 2004, Palaeozoic and Mesozoic tectonics of the Hida Gaien Belt, central Japan: Overview. *Jour. Geol. Soc. Japan,* **110**, 567-579.*

Umeda, M. and Anso, J., 2008, Additional data on fossil-bearing limestone and garnet-bearing clastic rocks exposed at Nishiamada of Fukui City, central Japan. *Bull. Fukui City Mus. Nat. Hist.*, no. 55, 63-68.*

Umeda, M., Anso, J. and Hattori, I., 2008, Fossil-bearing limestone and garnet-bearing clastic rocks found at Nishiamada in Fukui City, central Japan and their significance. *Jour. Geol. Soc. Japan,* **114**, 587-590.*

Yamada, K., 1967, Stratigraphy and geologic structure of the Paleozoic formations in the upper Kuzuryu River district, Fukui Prefecture, central Japan. *Sci. Rep. Kanazawa Univ.,* **12**, 185-207.

Yang, S., 1994, §7 Carboniferous. *In* Yin, H. ed., *The palaeobiogeography of China, Oxford Biogeography Series No. 3*. Oxford Univ. Press, Oxford, 131-162.

* in Japanese
*1 in Japanese with English abstract
** English translation from the original written in Japanese
*** in Russian
**** English translation from the original written in Russian
***** English translation from the original written in Chinese

用語対比

Asuwagawa	足羽川
Fujikuradani	藤倉谷
Itoshiro	石徹白
Nakatatsu Mine	中竜鉱山
Nishiamada	西天田
Unazuki	宇奈月