An early Carboniferous (late Visean) brachiopod fauna from the Arakigawa Formation of Hongo, Hida Gaien Belt, central Japan, and its tectonic significance

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Abstract
Here we describe an early Carboniferous brachiopod fauna from the middle part of the Arakigawa Formation in the Hongo area, Hida Gaien Belt, central Japan. The Hongo fauna consists of six species in five genera: Pugilis sp., Marginatia sp., Fluctuaria undata (Defrance), Fluctuaria sp., Actinoconchus sp., and Imbrexia sp. The fauna is identified as late Visean in age, thus correlating the middle part of the Arakigawa Formation with the upper Visean. Palaeobiogeographically, the Hongo fauna exhibits affinities with early Carboniferous brachiopod faunas of northwestern China (Xinjiang) and northeastern Japan (South Kitakami Belt). The fauna probably belonged to the North China Province, which covered a broad area between the North China Block and the Siberian Block (i.e., the Central Asian Orogenic Belt, CAOB) during the late Visean. The Hida Gaien Belt, including the Hongo area, was likely located in the CAOB during the late Visean. Similarities between the lithology and fauna of the Arakigawa Formation and those of the Carboniferous formations of the South Kitakami Belt provide positive evidence of a tectonic connection between the Hida Gaien and South Kitakami belts.

Key words: Arakigawa Formation, Brachiopoda, Hida Gaien Belt, Hongo, Visean

Introduction

The Hongo area (i.e., Hongo, Kamitakara-cho, Takayama City, Gifu Prefecture) is the northern half of the Hongo–Arakigawa (Moribu) area in the Hida Gaien Belt, central Japan (Fig. 1). There have been few studies of the Palaeozoic rocks and fossils of this area, although some work has been done on the stratigraphy (Isomi and Nozawa, 1957; Tsukada and Niwa, 2005) and palaeontology (Igo, 1964; Kobayashi and Hamada, 1987). In the present study, we describe an early Carboniferous brachiopod fauna (the Hongo fauna) from the middle part of the Arakigawa Formation (named by Isomi and Nozawa, 1957), and discuss the age and palaeobiogeography of the fauna. The correlation of the Arakigawa Formation and the Carboniferous formations of the South Kitakami Belt, northeastern Japan is also discussed.

Stratigraphy and material

The Carboniferous Arakigawa Formation, consisting of thick marine volcanioclastic rocks and minor limestones, is distributed in the Hongo–Arakigawa area with NEE–SWW to N–S strike and NNW to W dip (Isomi and Nozawa, 1957; Tazawa et al., 2000; Tsukada and Niwa, 2005).

According to unpublished data (K. Suzuki, personal observation), the Arakigawa Formation of the Hongo area (about 1,100 m thick) can be subdivided lithologically into a lower part (green to dark green mafic tuff and lava, with thin sandstone and mudstone intercalations, 210 m thick), a middle part (green mafic to intermediate tuff, together with light greenish grey felsic tuff, limestone, conglomerate, sandstone and mudstone, 450 m thick) and an upper part (laminated tuffaceous elastic rocks and light greenish grey felsic tuff, with some limestone layers, 440 m thick; Fig. 2). The middle part of the Arakigawa Formation includes three fossil horizons (HG1, A and T). The locality T (upper fossil horizon) is isolated structurally from localities HG1 (lower fossil horizon) and A (middle fossil horizon) by a N–S fault. Igo (1964) described an ammonoid, Goniatites sp., from horizon A, and identified the age of the fossil horizon as late Visean. Kobayashi and Hamada
(1987) described a trilobite, Paladin hidensis Kobayashi and Hamada, from horizon T, and pointed out that the Hongo species resembles Paladin (Paladin) maillieuxi (Demanet) from the upper Visean of Belgium.

The brachiopod fossils described herein were collected (by Y. Miyake) from light greenish grey, fine-grained tuffaceous sandstone of the middle part of the Arakigawa Formation at locality HG1 (36°16′26″N, 137°21′49″E) on the Zaike-rindo (a path), about 1 km south of Hongo. The topographic and stratigraphic positions of the localities are shown in Figs. 1 and 2, respectively. The brachiopod specimens are now registered and housed in the Faculty of Science, Niigata University, Niigata (prefix NU-B, numbers 2267–2279).

The Hongo fauna

The brachiopod fauna described herein includes six species in five genera: Pugilis sp., Marginatia sp., Fluctuaria undata (Defrance, 1826), Actinoconchus sp., and Imbrexia sp. Of these brachiopods, Fluctuaria undata is abundant in the Hongo fauna. The only other fossils in the Hongo fauna are scarce bryozoans and crinoids.

Age

The stratigraphic distributions of the brachiopod species of the Hongo fauna are summarized in Fig. 3. Of the brachiopod taxa listed above, Fluctuaria undata is known from the lower Visean–lower Bashkirian (Sarytcheva in Sarytcheva and Sokolskaya, 1952; Muir-Wood and Cooper, 1960; Nalivkin and Fotieva, 1973; Martinez Chacon, 1979). At the generic level, Pugilis has a range of upper Visean to Serpukhovian (Brunton et al., 2000); Marginatia is known from the lower Tournaisian–upper Visean (Sarytcheva in Sarytcheva et al., 1963; Carter, 1999; Brunton et al., 2000; Lazarev et al., 2003; Tazawa, 2017); Fluctuaria has been reported from the lower Visean to Moscovian (Chao, 1927; Winkler Prins, 1968; Brunton et al., 2000); Actinoconchus has a long range of upper Devonian to lower Permian (Alvarez and Rong, 2002); and Imbrexia is known from the lower Tournaisian–upper Visean (Beznossova, 1959; Bublitschenko, 1971; Minato and Kato, 1977; Carter, 2006). In summary, the Hongo fauna is identified as late Visean in age. This conclusion is consistent with the findings of Igo (1964) and Kobayashi and Hamada (1987).
In terms of palaeobiogeography, *Pugilis* has been recorded from the USA, Europe, Russia and northern and southern China, but not from Australia. *Marginatia* and *Fluctuaria* show the world-wide distribution, and many species of the two genera have been reported from central Russia (southern Urals and Kuznetsk Basin), Kyrgyzstan and northwestern China (Xinjiang). *Imbrexia* is known mostly from the USA, central Russia and Kazakhstan, and a few from northwestern China (Xinjiang), northeastern China (Heilongjiang and Jilin), northeastern Japan (South Kitakami Belt) and southwestern China (western Yunnan of the Sibumasu region), but not from southern China (e.g., Hunan, Guangxi and Guizhou). *Actinoconchus* is a cosmopolitan genus.

It is noteworthy that the three genera (*Marginatia, Fluctuaria* and *Imbrexia*) occur together from the Tournaissian–Visean of Xinjiang, northwestern China (Yang, 1964; Zhang et al., 1983) and the South Kitakami Belt, northeastern Japan (Minato and Kato, 1977; Tazawa, 1981, 2006). Moreover, as noted in the section of “Systematic descriptions” of the present paper, *Fluctuaria undata* has been recorded from northeastern Japan (South Kitakami Belt), northern Russia (Verkhoyansk Range and northern Urals), the UK (Scotland, England, Isle of Man and northern Ireland), Germany, Belgium, Spain, Algeria, western Russia (Moscow Basin), central Russia (southern Urals and Kuznetsk Basin), Kazakhstan, Uzbekistan, Kyrgyzstan and northwestern China (Xinjiang and Gansu). To summarize, the Hongo fauna exhibits affinities with the early Carboniferous brachiopod faunas of northwestern China (Xinjiang) and northeastern Japan (South Kitakami Belt).

Tazawa and his collaborators (Tazawa, 2017, 2018; Tazawa and Iryu, 2019; Tazawa and Kurita, 2019) pointed out that the early Carboniferous brachiopod faunas of the South Kitakami Belt exhibited affinities with those of the North China Province of Yang (1980, 1983, 1985), which covered a broad area between the North China Block and the Siberian Block, including Kazakhstan (Altay Mountains), Kyrgyzstan (Tien Shan), northwestern China (Xinjiang), northern China (Inner Mongolia) and northeastern China (Heilongjiang). Therefore, the Hongo fauna probably belonged to the North China Province; and the Hida Gaien Belt including the Hongo area was probably located in the CAOB during the late Visean.

**Discussion: Correlation between the Arakigawa Formation and the Carboniferous formations of the South Kitakami Belt**

Tazawa (1989, 1993, 2000) proposed that the Palaeo-
zoic lithostratigraphy and fossil assemblages of the Hida Gaien Belt in central Japan are similar to those of the South Kitakami Belt in northeastern Japan, and that both belts were originally connected tectonically each other. The Carboniferous formations of both belts are characterized by thick marine volcaniclastic rocks associated with a few limestones and the fossil faunas comprising brachiopods, foraminifers and corals. The result of the present study supports and strengthens the above proposal on the correlation of the Carboniferous formations.

The lower part of the Arakigawa Formation, consisting of thick green to dark green mafic volcanic rocks, is correlated lithologically with the middle part of the Hikoroichi Formation (H, Member of Kawamura, 1983; HK3 Unit of Tazawa, 2018), the lower part of the Odaira Formation (Tazawa and Katayama, 1979; Kawamura, 1985) and the lower part of the Karoyama Formation (Tazawa et al., 1981). The middle part of the Arakigawa Formation, consisting of green mafic to intermediate tuff, light greenish grey felsic tuff, limestone, conglomerate, sandstone and mudstone and comprising the Hongo fauna, can be correlated with the upper part of the Hikoroichi Formation (H, Member of Kawamura, 1983; HK4 Unit of Tazawa, 2018), the middle and upper parts of the Odaira Formation (Tazawa and Katayama, 1979; Kawamura, 1985) and the upper part of the Karoyama Formation (Tazawa et al., 1981). Among five genera of the Hongo fauna, three (Marginatia, Fluctuaria and Imbrexia) are shared with the late Visean brachiopod faunas of the South Kitakami Belt (Minato and Kato, 1977; Tazawa, 1981, 2017). The upper part of the Arakigawa Formation, which is well exposed in the Moribu area (just south of the Hongo area) and consisting mostly of green to light greenish grey tuff with a late Carboniferous (Moscovian) brachiopod Choristites, is correlated with the Nagaiwa Formation bearing choristitid brachiopods (Tazawa, 2010) and its volcanic rock-dominant equivalents (e.g., Senbakaya Formation named by Ehiro, 1977) in the South Kitakami Belt, as stated by Tazawa et al. (2000). Tazawa and Hasegawa (1994) and Tazawa et al. (2000) described late Carboniferous (Kasimovian–Gzhelian) fusulinids (Quaifusulina and Schwagerina) and brachiopod (Karavankina) from the uppermost part of the Arakigawa Formation in the Moribu area. The upper Carboniferous (Kasimovian–Gzhelian) formations are, however, lacking in the South Kitakami Belt owing to the erosion in early Permian (pre-Sakmarian; Minato, 1942; Choi, 1972). In summary, the lithology and fauna of the Arakigawa Formation are similar to those of the Carboniferous formations of the South Kitakami Belt. That is an evidence of the tectonic connection between the Hida Gaien Belt and the South Kitakami Belt.

**Conclusion**

In this study, six species of brachiopod in five genera are described from the middle part of the Arakigawa Formation at Hongo in the Hida Gaien Belt. The species are Pugilis sp., Marginatia sp., Fluctuaria undata (Defrance), Fluctuaria sp., Actinoconchus sp. and Imbrexia sp. A late Visean age is assigned to the Hongo fauna; therefore, the age of the middle part of the Arakigawa Formation is late Visean. Palaeobiogeographically, the Hongo fauna possesses a close affinity with those of northwestern China (Xinjiang) and northeastern Japan (South Kitakami). Thus, the Hongo fauna belonged to the North China Province; and the Hida Gaien Belt including the Hongo area was probably located in the CAOB during the late Visean. The lithological succession and fossil assemblages of the Arakigawa Formation resemble those of the Carboniferous formations of the South Kitakami Belt, northeastern Japan, that is a positive evidence of the tectonic connection between the two belts.

**Systematic descriptions**

(by J. Tazawa)

Order Productida Sarytcheva and Sokolskaya, 1959
Suborder Productidina Waagen, 1883
Superfamily Productoidea Gray, 1840
Family Dictyoclostidae Stehli, 1954
Subfamily Dictyoclostinae Stehli, 1954
Genus **Pugilis** Sarytcheva, 1949

Type species. — *Producta pugilis* Phillips, 1836.

**Pugilis** sp.

(Fig. 4H, I)

**Material.** — Two specimens: (1) external and internal moulds of a ventral valve, NU-B2277; and (2) internal mould of a ventral valve, NU-B2278.

**Remarks.** — These specimens are fragmentarily preserved, but can be assigned to the genus *Pugilis* by the slightly longer, large (length about 48 mm, width more than 40 mm in the larger specimen, NU-B2278), dictyocestid-shaped ventral valve with external ornament consisting of numerous fine rounded costae which are increasing in width and becoming irregular, sinuous and nodose anteriorly. The Hongo species resembles *Pugilis*...
serpukhovensis Sarytcheva, 1949, redescribed by Sarytcheva (in Sarytcheva and Sokolskaya, 1952, p. 142, pl. 40, fig. 200) from the Steshevsky Horizon (lower Serpukhovian) of the Moscow Basin, in size, shape and external ornament of the ventral valve. Pugilis crawfordsvillensis (Weller, 1914, p. 116, pl. 12, figs. 4–7), from the Keokuk Limestone of Indiana, the USA, is also like to the Hongo species in the external characters of the ventral valve. But accurate comparison with the Russian or American species is difficult for the poorly preserved specimens. The type species, Pugilis pugilis (Phillips, 1836), refigured by Muir-Wood and Cooper (1960, pl. 96, figs. 1–7) based on the material from the lower Carboniferous (Visean and Serpukhovian) of the UK (Scotland and England), differs from the present species in the much larger size.

Family Buxtoniidae Muir-Wood and Cooper, 1960
Subfamily Marginatinae Waterhouse, 2002
Genus Marginatia Muir-Wood and Cooper, 1960

Type species. – Productus fernglenensis Weller, 1909.

Marginatia sp.
(Fig. 4F, G)

Material. – Two specimens: (1) external and internal moulds of a conjoined shell, NU-B2267; and (2) external and internal moulds of a dorsal valve, NU-B2268.

Remarks. – These specimens are fragmentarily preserved, but can be assigned to the genus Marginatia by the strongly convex ventral valve with reticulate ornament on the posterior portion and costae only on the trail, and by the flattened visceral disc of the dorsal valve with reticulate ornament. The Hongo species resembles well Marginatia burlingtonensis (Hall, 1858), redescribed by Weller (1914, p. 104, pl. 9, figs. 1–10) from the Burlington Limestone of the Mississippi Valley (Illinois and Iowa), the USA, by the medium, slightly transverse dorsal valve (length about 20 mm, width about 32 mm in the larger specimen, NU-B2268). Accurate comparison is, however, difficult for the poorly preserved material.

Superfamily Linoproductoidea Stehli, 1954
Family Linoproductidae Stehli, 1954
Subfamily Linoproductinae Stehli, 1954
Genus Fluctuaria Muir-Wood and Cooper, 1960

Type species. – Productus undatus Defrance, 1826.

**Fluctuaria undata** (Defrance, 1826) (Fig. 4A–C)

*Productus undatus* Defrance, 1826, p. 354; Koninck, 1847, p. 59, pl. 5, fig. 3; Davidson, 1861, p. 161, pl. 34, figs. 10, 11 only; Gröber, 1909, p. 374, pl. 1, fig. 6; Yanishevsky, 1918, p. 45, pl. 5, fig. 10; pl. 8, fig. 12.

*Striatifera undata* (Defrance). Chao, 1927, p. 114, pl. 9, figs. 7–9.

*Productus (Linoproductus) undatus* Defrance. Paeckelmann, 1931, p. 217, pl. 19, fig. 9; Rotai, 1941, p. 99, pl. 20, fig. 3; Gladchenko, 1955, p. 14, pl. 5, figs. 2, 3.

*Productus (Thomasella) undatus* Defrance. Nalivkin, 1937, p. 64, pl. 10, fig. 16.

*Cancrinella undata* (Defrance). Sarytcheva, 1937, p. 82, 111, pl. 7, figs. 1–6, text-figs. 18–20; Sarytcheva in Sarytcheva and Sokolskaya, 1952, p. 110, pl. 20, fig. 136; Yang, 1964, p. 85, pl. 5, fig. 3.

*Fluctuaria undata* (Defrance). Muir-Wood and Cooper, 1960, pl. 115, figs. 11–20: Sarytcheva in Sarytcheva et al., 1963, p. 229, pl. 37, figs. 6–11, text-figs. 101, 102; Abramov, 1965, p. 43, pl. 4, fig. 12; Nalivkin and Fotieva, 1973, p. 47, pl. 11, figs. 1, 2; Donakova, 1978, p. 212, pl. 1, figs. 11, 12; Martinez Chacon, 1979, p. 223, pl. 25, figs. 8–11; Chen and Shi, 2003, p. 154, pl. 5, figs. 3, 16.

*Productus-Cancrinella-undatus* Defrance. Pareyn, 1961, p. 205, pl. 25, fig. 10.

*Fluctuaria cf. undata* (Defrance). Tazawa et al., 1981, pl. 1, figs. 11–13; Tazawa, 1981, p. 72, pl. 5, fig. 7.

Material. – Four specimens: (1) external and internal moulds of a ventral valve, NU-B2273; (2) external mould of a ventral valve, NU-B2274; and (3) external moulds of two dorsal valves, NU-B2275, 2276.

Description. – Shell small in size for genus, elongate oval in outline, with greatest width at anterior to middle-length; length 14 mm, width 9 mm in the largest specimen (NU-B2273). Ventral valve moderately convex at posterior portion and gently convex anteriorly; umbo small; ears small, flattened; sulcus absent. Dorsal valve gently concave; fold absent. External surface of both valves ornamented with numerous, fine, irregular and rounded costellae and strong rugae; numbering 4–5 costellae in 2 mm, 3–4 rugae in 5 mm at anterior portion of ventral valve.

Remarks. – These specimens are referred to *Fluctuaria undata* (Defrance, 1826), refigured by Muir-Wood and Cooper (1960, pl. 115, figs. 11–20) from the Visean of Belgium, in size, shape and external ornament of
Fig. 4. Brachiopods of the Hongo fauna (1). (A–C) *Fluctuaria undata* (Defrance): external latex cast (A₁, A₂) and internal mould (A₃) of ventral valve, NU-B2273, external latex cast (B₁, B₂) of ventral valve, NU-B2274, and external latex cast (C₁, C₂) and external mould (C₃) of dorsal valve, NU-B2275. (D–E) *Fluctuaria* sp.: external latex cast (D₁, D₂) of ventral valve, NU-B2271, and external latex cast (E₁, E₂) of ventral valve, NU-B2272. (F, G) *Marginatia* sp.: posterior (F₁, F₂) and anterior (F₃) views of internal mould of ventral valve, NU-B2267, and external latex cast (G₁, G₂) and external mould (G₃) of dorsal valve, NU-B2268. (H, I) *Pugilis* sp.: external latex cast (H₁, H₂) of ventral valve, NU-B2277, and internal mould of ventral valve, NU-B2278. Scale bars are 1 cm.
both the ventral and dorsal valves. *Fluctuaria campbelli* Roberts (1964, p. 184, pl. 4, figs. 5–13), from the middle Visean of Greenhills, New South Wales, eastern Australia, differs from *F. undata* in having more numerous finer costellae on the ventral valve. *Fluctuaria cf. undata* (Defrance, 1826), described by Tazawa (1981, p. 72, pl. 5, fig. 7) from the Karoyama Formation (upper Visean) of Nisawa, South Kitakami Belt, northeastern Japan, is deemed to be conspecific with the present species. The shells described by Yang (1978, p. 113, pl. 30, fig. 3) as *Fluctuaria undata* (Defrance) from the upper Visean of Xizang (Tibet), are also not referred to the present species in being much smaller size and less transverse outline.

**Distribution.**—Lower Visean–lower Bashkirian: northeastern Japan (South Kitakami Belt), central Japan (Hida Gaien Belt), northern Russia (Vorkhoyans Range and northern Urals), UK (Scotland, England, Isle of Man and northern Ireland), Germany, Belgium, Spain, Algeria, western Russia (Moscow Basin), central Russia (southern Urals and Kuznetsk Basin), Kazakhstan, Uzbekistan, Kyrgyzstan and northwestern China (Xinjiang and Gansu).

*Fluctuaria sp.*

(Fig. 4D, E)

**Material.**—Two specimens, fragmentarily preserved external and internal moulds of two ventral valves, NU-B2271, 2272.

**Remarks.**—These specimens are assigned to the genus *Fluctuaria* by the external ornament of the ventral valve consisting of numerous fine costellae and strong, broad and somewhat irregular rugae. The Hongo specimens resemble the shells, described by Abramov (1970, p. 124, pl. 15, figs. 3, 4) as *Fluctuaria undata* (Defrance, 1826), from the Serpukhovian of Sette-Daban in the southern Vorkhoyans Range, northern Russia, in the large size (length more than 35 mm, width more than 28 mm in the better preserved specimen, NU-B2271) and in having broad rugae (numbering 1–2 in 5 mm) on the ventral valve. *Fluctuaria undata* (non Defrance), described by Galitskaya (1977, p. 134, pl. 47, fig. 1 only) from the Serpukhovian of northern Kyrgyzstan, is deemed to be conspecific with the present species in size, shape and external ornament of the ventral valve. The type species, *Fluctuaria undata* (Defrance, 1826), is easily distinguished from the Hongo species in the much smaller size and in having narrower rugae on the ventral valve. The Hongo species is probably a new species, but the preservation of the material is not adequate for the establishment.

Order Athyridida Boucot, Johnson and Staton, 1964
Suborder Athyrididina Boucot, Johnson and Staton, 1964
Superfamily Athyridoidea Davidson, 1881
Family Athyrididae Davidson, 1881
Subfamily Athyridinae Davidson, 1881
Genus *Actinoconchus* M. Coy, 1844

**Type species.**—*Actinoconchus paradoxus* M. Coy, 1844.

*Actinoconchus sp.*

(Fig. 5C)

**Material.**—One specimen, external and internal moulds of a conjoined shell, NU-B2279.

**Remarks.**—This specimen can be assigned to the genus *Cleiothyridina* by the large, gently biconvex athyridid-shaped shell, which is ornamented by dense growth lamellae and provided with flat, broad and radially striated frill. The Hongo species most resembles *Actinoconchus planosulcatus* (Phillips, 1836), redescribed by Brunton (1980, p. 224, figs. 13, 14) from the upper Visean of Yorkshire, England, in shape, but differs from the British species in its much larger size (length more than 38 mm, width more than 45 mm). *Actinoconchus expansus* (Phillips, 1836), redescribed by Brunton (1980, p. 222, fig. 10) as *Actinoconchus expansus expansus* (Phillips) from the lower Visean of Bolland, Yorkshire, is also large-sized species, but differs from the Hongo species in absence of fold-sulcus. The present species may be a new species of *Actinoconchus*, but the poorly preserved specimen precludes that determination.

Order Spiriferida Waagen, 1883
Suborder Spiriferidina Waagen, 1883
Superfamily Spiriferoidea King, 1846
Family Imbrexiidae Carter, 1992
Genus *Imbrexia* Nalivkin, 1937

**Imbrexia sp.**

(Figs. 5A, B, 6)

**Type species.**—*Spirifer imbrex* Hall, 1858.
Material. – Two specimens: (1) external and internal moulds of a ventral valve, NU-B2269; and (2) external and internal moulds of a dorsal valve, NU-B2270.

Remarks. – These specimens are safely assigned to the genus *Imbrexia* by the medium-sized transverse shell (length about 25 mm, width more than 30 mm in the ventral valve specimen, NU-B2269), with a deep, angular sulcus and external ornament consisting of numerous simple bifurcating costae (numbering 5–6 in 5 mm at midlength of ventral lateral slope) and strongly developed imbricate growth lamellae. The Hongo species most resembles *Imbrexia incertus* (Hall, 1858), redescribed by Weller (1914, p. 335, pl. 41, figs. 6–14) from the Burlington Limestone of the Mississippi Valley, in number of costae on the ventral valve. But the American species is larger in size and more transverse in outline. The type species, *Imbrexia imbrex* (Hall, 1858), redescribed by Carter (1974, p. 687, pl. 1, figs. 1–7; pl. 4, figs. 1–4, text-fig. 3) from the Burlington Limestone of Burlington, Iowa, differs from the present species in having fewer and stronger costae (numbering 4 in 5 mm at midlength). *Imbrexia taidonensis* (Tolmatchoff, 1924,
Fig. 6. Brachiopods of the Hongo fauna (3). *Imbrexia* sp.: external latex cast of enlarged imbricate growth lamellae of ventral valve, NU-B2269.

p. 177, pl. 11, figs. 1, 3), from the upper Tournaisian of the Kuznetsk Basin, central Russia, is similar to the Hongo species in size and shape of the shell, but differs from the latter in having finer and more numerous costae (numbering 7–8 in 5 mm at midlength) on the ventral valve. *Imbrexia* cf. *incipertus* (Hall, 1858), described by Minato and Kato (1977, p. 614, pl. 1, figs. 2–11) from the upper part of the Hikoroichi Formation (= Karyoya Formation by Tazawa et al. 1981) of Nisawa in the South Kitakami Belt, differs from the present species in the larger size and more transverse outline.

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（要 旨）

Tazawa, J., Suzuki, K. and Miyake, Y., 2021, An early Carboniferous (late Visean) brachiopod fauna from the Arakigawa Formation of Hongo, Hida Gaien Belt, central Japan, and its tectonic significance. *J. Geol. Soc. Japan*, 127, 79–90. （田沢純一・鈴木敬介・三宅幸雄. 2021. 飛騨外縁帯本郷の荒城川層から産出した前期石炭紀（ビーゼー期後期）腕足類フォーナとその構造地質学的重要性. 地質雑. 127, 79–90.）

飛騨外縁帯本郷の荒城川層中部から産出した腕足類フォーナ（本郷フォーナ）を記載し、時代と古生物地理について考察した。本郷フォーナは以下の5属6種からなる：*Pugilis* sp., *Marginatia* sp., *Fluctuaria undata*, *Fluctuaria* sp., *Actinoconchus* sp., *Imbrexia* sp. このフォーナは前期石炭紀（ビーゼー期後期）を示し、したがって荒城川層中部は上部ビーゼー階に対比される。古生物地理学的に本郷フォーナは東北日本（南部北上帯）と中国西北部（新疆）の前期石炭紀腕足類フォーナに類縁がある。このことから、ビーゼー期後期には中中国地縁とシベリア地縁の間の広大な地域を占める中国北方区（North China Province）に属していたと推定される。また、ビーゼー期後期に本郷地域を含む飛騨外縁帯は中央アジア造山帯（CAOB）に含まれていたと推定される。岩相層序と化石相において荒城川層は南部北上帯の石炭系に似ているが、それは飛騨外縁帯と南部北上帯の構造的連続を支持する一つの証拠となる。

科学論文では、学説の検証可能性を保証することが重要です。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。見学や採取を行う場合、各自の責任において地権者や関係官庁への連絡と許可の取得の必要があることにお注意下さい。詳しくは、以下のサイトをご覧ください。
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