Middle Permian brachiopods from the Dongujimqinqi area,
Inner Mongolia, China

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Abstract

A small collection of brachiopods is described from the lower Middle Permian Yanchibeishan Formation of the Dongujimqinqi area, eastern Inner Mongolia, China. This fauna consists of the following four species: Kochiprotodictys sp., Linoproductus simensis (Tscherneyschew), Rhynchopora inconstantis Lee and Gu and Licharewia grewingki (Netschajew). The Dongujimqinqi fauna exhibits a strong Boreal-type aspect and suggests an early Middle Permian in age.

Key words: Boreal-type fauna, Brachiopoda, Dongujimqinqi, Inner Mongolia, Middle Permian.

Introduction

Permian brachiopod faunas of Inner Mongolia are important and useful to reconstruct the Permian palaeogeography of east Asia, especially the Sino-Korean and Mongolian blocks and the interspaced area between them. Since the pioneering work of Grabau in 1931, the Permian brachiopods of Inner Mongolia have been described by Lee and Gu (1976), Lee et al. (1980, 1982, 1983, 1985), Liu and Waterhouse (1985), Gu and Zhu (1985) and Duan and Li (1985). However, these taxonomic works were concentrated on the faunas of both the Zhesi (Jisu) and Xiujimqinqi areas, and the other faunas, e.g., the Dongujimqinqi fauna have not been studied enough. The Permian palaeogeography and palaeobiogeography of Inner Mongolia were discussed by Lee and Gu (1984) and Tazawa (1991) on the basis of brachiopod faunas. They considered that the Dongujimqinqi fauna as a Boreal-type fauna. Lee and Gu (1984) mentioned that the Permian faunal provinciality in the Inner Mongolian region was controlled.

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(Manuscript received 30 November, 2000; accepted 21 December, 2000)
by the topography and the sea current in that time, a view also advocated by Shi and Zhan (1996). On the other hand, Tazawa (1991) explained that the faunal provinciality in the Inner Mongolian region was caused by the plate tectonic motion during the Permian, namely the collision of Siberian (Mongolian) and Sino-Korean blocks in late Permian. According to him, the Donggijimqinqi area was a part of continental shelf bordering the southern margin of the Siberian (Mongolian) continent located at the middle paleolatitude of Northern Hemisphere and characterized by the Boreal fauna in the Permian time.

The brachiopod fossils described here were collected by the China-Japan Cooperative Research Group (Leader: K. Ishii) in August 1988, from grey, fine-grained calcareous sandstone of the lower Middle Permian Yanchibeiian Formation (= Gegenaobao Formation of Lee and Gu, 1976) at the point 1638, about 32 km SW of Donggijimqinqi, eastern Inner Mongolia (Fig. 1). The Gegenaobao Formation is correlated with the upper Chihsian (Sheng and Jin, 1994).

In the present study, the following four brachiopod species are recognized and described: Kochipodictus sp., Linopodictus simensis (Tschermschew, 1902), Rhynchopora inconstantis Lee and Gu, 1976 and Licharewia grewingki (Netschajew, 1911). Among them, Kochipodictus sp., Rhynchopora inconstantis and Licharewia grewingki are all Boreal-type elements. Linopodictus simensis has a longer range from Early Carboniferous (Viscian) to Middle Permian (Chihsian). But R. inconstantis was described from the lower Middle Per-
mian (Chihsian) of the Dongujimqinqi area, Inner Mongolia. Furthermore, *L. growingki* has been known from lower Middle Permian of Inner Mongolia and northern Russia. Consequently the Dongujimqinqi fauna is an early Middle Permian (Chihsian) Boreal-type brachiopod fauna.

The brachiopod specimens are housed in the collections of the Department of Geology, Faculty of Science, Niigata University, Niigata, Japan.

**Systematic descriptions**

Order Productida Sarytcheva and Sokolskaya, 1959
Suborder Productidina Waagen, 1883
Superfamily Productioidea Gray, 1840
Family Productidae Gray, 1840
Subfamily Buxtoniinae Muir-Wood and Cooper, 1960
Tribe Buxtoniini Muir-Wood and Cooper, 1960
Genus *Kochiprocessus* Dunbar, 1955

*Kochiprocessus* sp.
Figs. 2A-C.

*Material.*—Two incomplete ventral valves (NU-B167, 168) and an incomplete shell with conjoined valves (NU-B169).

*Description.*—Shell large for genus, more than 60 mm long and about 60 mm wide. Ventral valve moderately convex in lateral and anterior profiles; lateral slopes sharply inclined; sulcus deep and wide, originating from anterior part of visceral disc and developed on trail. Dorsal valve with a shallow concavity; fold inconspicuous. External ornament of both valves consisting of radial rows of numerous elongate spine bases and some irregular and discontinuous rugae. Dorsal interior with a very long fine median septum. Other characters unknown.

*Remarks.*—The present specimens are poorly preserved, but safely assigned to the genus *Kochiprocessus* Dunbar, 1955 on the basis of their size, shape and surface ornament of the shells. These specimens most resemble the shells of *Kochiprocessus* cf. *porrectus* (Kutorga, 1844), described by Grabau (1931, p. 295, pl. 30, figs. 10-12) and Duan and Li (1985, p. 109, pl. 36, figs. 1-4; pl. 37, figs. 1, 2) from the Middle Permian Zhesi Formation of the Zhesi area, Inner Mongolia, in having a rather deep sulcus and steep lateral slopes. The type species, *K. porrectus*, originally described by Kutorga (1844, pl. 10, figs. 3a, b) from the Lower Permian of the Urals, however, has a shallower sulcus, gently inclined lateral slopes, relatively pointed umbonal region and emarginate anterior margin, all of which are different from those of the Inner Mongolian specimens. The Dongujimqinqi specimens may be a new species, although the establishment is difficult for the poorly preserved material.
Superfamily Linoproduotoidea Stehli, 1954
Family Linoproducticidae Stehli, 1954
Subfamily Linoproductinae Stehli, 1954
Genus *Linoproductus* Chao, 1927

*Linoproductus simensis* (Tschemyschew, 1902)

Figs. 2D-J.

1902 *Productus simensis* Tschemyschew, p. 286, 626, pl. 35, figs. 7a-c; pl. 55, figs. 2-5.
1908 *Productus cora var. simensis* Tschemyschew: Gröber, p. 220, pl. 25, figs. 2a, b.
1927 *Linoproductus simensis* (Tschemyschew): Chao, p. 137, pl. 14, figs. 6-8.
1960 *Linoproductus simensis* (Tschemyschew): Volgin, p. 72, pl. 8, figs. 1a-v.
1965 *Linoproductus simensis* (Tschemyschew): Zhao, p. 425, pl. 1, figs. 6, 7.
1971 *Linoproductus simensis* (Tschemyschew): Bamber and Waterhouse, pl. 16, figs. 8, 11.
1974 *Linoproductus simensis* (Tschemyschew): Sergunkova and Zhizhilo, p. 62, pl. 9, figs. 9, 10; pl. 10, figs. 8, 9.
1976 *Linoproductus simensis* (Tschemyschew): Lee and Gu, p. 258, pl. 139, figs. 9-12.
1980 *Linoproductus simensis* (Tschemyschew): Lee et al., p. 376, pl. 152, figs. 11a, b.

*Material.*—Seven incomplete ventral valves (NU-B170-176) and a shell with broken ventral valve and a part of dorsal valve external mould (NU-B177).

*Description.*—Shell small for genus, elongate oval in outline, with greatest width at midvalve; length 34 mm, width 24 mm in the best preserved specimen (NU-B173). Hinge slightly narrower than greatest width of shell; ears small, well demarcated from visceral disc; cardinal extremities obtuse, angular; beak low and thick, strongly incurved to overhanging hinge. Ventral valve strongly convex in lateral profile, most convex at umboval region, visceral disc globose, not geniculated and following a long, tube-shaped trail; umboval and lateral slopes steep; sulcus absent. Dorsal valve moderately concave in lateral profile; having small ears and no fold. External ornament of ventral valve costellate; costellae numbering 10-12 per 5 mm at midvalve, commonly flexuous near frontal margin; rugae developed on ears and lateral slopes of visceral disc, numbering 5-6; spines or spine bases not preserved. External ornament of dorsal valve like those of ventral valve, but costellae being more flexuous; rugae irregularly developed on venter.

*Remarks.*—These specimens are referred to *Linoproductus simensis* (Tschemyschew, 1902), originally described by Tschemyschew (1902, p. 286, 626, pl. 35, figs. 7a-c; pl. 55, figs. 2-5) from the Schwagerina Limestone of the Ural Mountains. The most characteristic tube-like trail can be observed in our specimens (see Fig. 21). *Linoproductus neimongolensis*
Fig. 3. A-H: *Licharevia grewingki* (Netschajew), A: NU-B180, incomplete ventral valve in ventral view, B: NU-B182, incomplete ventral valve in ventral view, C: NU-B179, incomplete ventral valve in ventral view, D-F: NU-B184, incomplete shell in lateral, ventral and posterior views, G: NU-B181, incomplete ventral valve in ventral view, H: NU-B183, incomplete shell in ventral view. All figures are in natural size.

Lee and Gu 1976, from the Lower Permian of the Dongujimqinqi region, Inner Mongolia seems to be conspecific with the present species.

*Linoproducits tenuistriatus* (Verneuil) differs from *L. simensis* in its finer costellae, more prominent rugae, and more flattened trail.

*Distribution.* — Lower Carboniferous (Visean) of Guizhou, south China; southern Tien Shan; Inner Mongolia. Upper Carboniferous (Kasimovian and Gzhelian) of southern Fergana; Inner Mongolia. Lower Permian (Asselian to Artinskian) of northern Yukon Territory; the Ural Mountains; southern Fergana. Middle Permian (upper Chihsian) of Dongujimqinqi, Inner Mongolia.
Order Rhynchonellida Kühn, 1949
Superfamily Rhynchoporoidae Muir-Wood, 1955
Family Rhynchoporidae Muir-Wood, 1955
Genus *Rhynchopora* King, 1865

Figs. 3K-O.


**Material.** — An internal mould of a shell with conjoined valves (NU-B178).

**Description.** — Shell large for genus, elongate subpentagonal in outline, with greatest width at about midvalve; length 28 mm, width 23 mm. Ventral valve gently convex in lateral profile; umbo acute, strongly incurved; sulcus shallow and wide; flanks narrow, highly elevated. Dorsal valve gently convex in lateral profile; umbo bluntly pointed and incurved; lateral slopes steep; fold low, wide, and gently elevated near anterior margin. External surface of both valves costate; costae strong and simple, beginning from beak, numbering 4 on bottom of sulcus, 2 on each sulcal slope and 5 on each flank, 5 on fold, and 6 on each lateral slope; intertroughs narrow. Ventral valve interior with slightly divergent dental plates of about 8 mm long. Dorsal valve interior with large triangular hinge plate; median septum strong, extending for about half length of dorsal valve, supporting a small camarophorium.

**Remarks.** — This specimen is safely assigned to the genus *Rhynchopora* King, 1865 in its rhynchonelliform shell, and having dental plates in the ventral valve and hinge plates and camarophorium supported by a strong median septum in the dorsal valve. The Dongujimqinqi specimen resembles well the shells of *Rhynchopora inconstantis* Lee and Gu, 1976, from the Middle Permian of Dongujimqinqi, Inner Mongolia, in large size, although the shape is longer than the type specimens.

**Distribution.** — Middle Permian (upper Chihsian) of Dongujimqinqi, Inner Mongolia.

Order Spiriferinida Ivanova, 1972
Suborder Spiriferinidina Ivanova, 1972
Superfamily Syringothyridoidea Fredericks, 1926
Family Licharewiidae Slussareva, 1958
Genus *Licharewia* Einor, 1939

*Licharewia grewingki* (Netschajew, 1911)
Figs. 3A-II, 4.
Fig. 4. Transverse serial sections of the ventral valve of *Licharewia growingki* (Netschajew), NU-B179, × 1.5. Numbers indicate distance (in mm) from the umbo.

1911 *Spirifer growingki* Netschajew, p. 81, 149, pl. 10, figs. 1a-d.
1960 *Licharewia growingki* (Netschajew): Slussareva, p. 55, pl. 7, figs. 4-6.
1976 *Licharewia growingki* (Netschajew): Lee and Gu, p. 278, pl. 174, figs. 6a, b; pl. 177, figs. 8a, b.
1998 *Licharewia? growingki* (Netschajew): Kalashnikov, p. 45, pl. 5, figs. 1-3; pl. 6, figs. 1-3; pl. 7, figs. 1a, b; text-fig. 4.

**Material.**—Four incomplete ventral valves (NU-B179-182) and two incomplete shells with conjoined valves (NU-B183, 184).

**Description.**—Shell large for genus, transversely subelliptical in outline, widest at hinge; cardinal extremities blunt, produced; length about 42 mm, width about 81 mm in one adult specimen (NU-B180). Ventral valve beak thick and bluntly acute, moderately incurved; apical angle 115-120°; interarea low, broadly triangular, and slightly concave; flanks gently inclined; sulcus deep, with three fine sulcicostae, originating from beak, and widening and deepening anteriorly. External ornament of both valves costate; each flank of both valves with about 10 strong, simple costae; micro-ornamentation consisting of fine concentric lirae. Ventral interior with a pair of dental plates; dental plates very short, fused within top valve wall in apical cavity, becoming isolated ridges anteriorly; muscle trough deep. Other internal structures not observed.
Remarks.—These specimens are referred to *Licharewia grewingki* (Netschajew, 1911), originally described by Netschajew (1911, p. 81, 149, pl. 10, figs. 1a-d) from the Middle Permian (Kazanian) of the Pinega River region, northern European Russia.

*Licharewia stuckenbergi* (Netschajew, 1900), the type species of this genus, differs from *L. grewingki* in its smaller, more transverse shell, and weaker and more numerous costae on both valves.

*Licharewia schrenckii* (Keyserling, 1846) is distinguished from *L. grewingki* by its higher interarea of the ventral valve.

Distribution.—Middle Permian (upper Chihsian and Maokouan) of Abagqi and Dongujimqinqi, Inner Mongolia. Middle Permian (Lower Kazanian) of the Pinega River region, Pritiman and Kanin Peninsula, northern Russia; Omolon region, northeastern Russia.

Acknowledgements

J. Tazawa wishes to thank Dr. K. Ishii and the other members of the China-Japan Cooperative Research Group who helped him in the field, contributing substantially to the fossil collection and to understanding of the stratigraphy of the Dongujimqinqi region, Inner Mongolia. G.R. Shi wishes to acknowledge the Australian Research Council for financial support to this study (Grant A39701265).

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