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Isogramma (Brachiopoda) from the lower Copacabana Group of the Lake Titicaca region, Bolivia

Masayuki FUJIKAWA*, Takeshi ISHIBASHI** and Jun-ichi TAZAWA***

Abstract

A Late Carboniferous brachiopod *Isogramma paotechowensis* (Grabau and Chao, 1928) is described for the first time from the lower Copacabana Group of Yampupata in the Lake Titicaca region, Bolivia. The occurrence of *I. paotechowensis* suggests that the fossil horizon Yp-26 of the lower Copacabana Group is assigned to Late Carboniferous in age.

Key words: Bolivia, brachiopod, lower Copacabana Group, *Isogramma paotechowensis*, Lake Titicaca region.

Introduction

The brachiopod specimens described in this paper were collected by two of the authors (MF and TI) in September 1998, from tuffaceous sandy shale of the lower Copacabana Group at Yampupata in the Lake Titicaca region, Bolivia, nearby the border with Peru (Fig. 1). The Devonian to Permian formations including the Copacabana Group are exposed in this area. Late Carboniferous and Lower Permian rich faunas are known from the Copacabana Group since d'Orbigny's (1842) work in Bolivia and Central Andes. Many paleontological papers have been published by Newell (1949), Urdininea and Yamagiwa (1980), Arelleno (1983), Maeda and Sakagami (1983), Nagai (1983), Sakagami (1984), Kobayashi and Hamada (1986), Suarez-Riglos et al. (1987), Wilson (1990), Sakagami and Mizuno (1994) and Sakagami (1995a, 1995b). The brachiopod fauna has also been reported by Kozlowski (1914), Chronic (in Newell, 1949), Newell et al. (1953), Branisa (1965), Samtleben (1971), Yanagida (1983), and Sakagami (1984). Recently, Ishibashi and Fujikawa (1999) reported the following

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* Graduate School of Science and Technology, Niigata University, Niigata 950-2181, Japan
** Kashii-dai 2-14-10, Fukuoka 813-0014, Japan
*** Department of Geology, Faculty of Science, Niigata University, Niigata 950-2181, Japan
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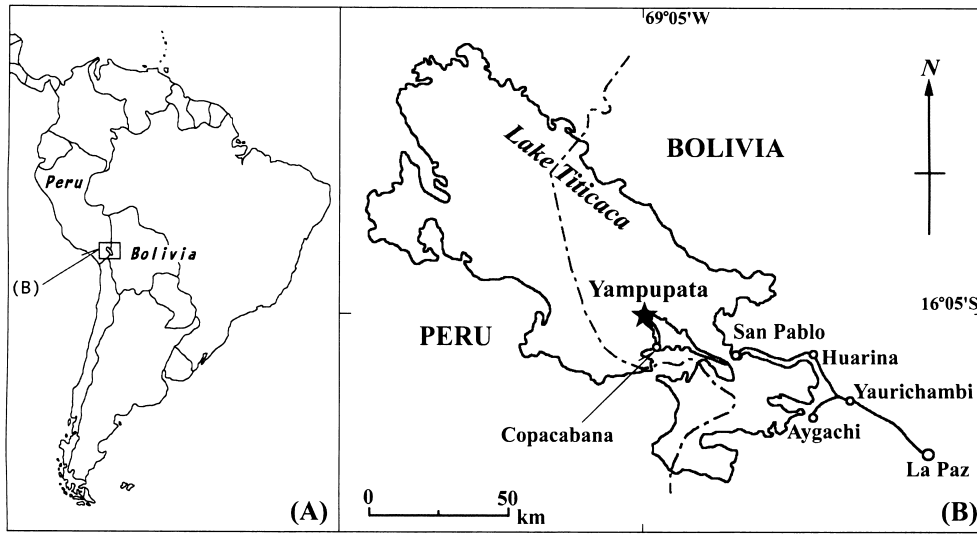

Fig. 1. Index map showing the fossil locality of the Yampupata area in the Lake Titicaca region, Bolivia.

four brachiopod species from the Yampupata area: *Linoproductus* sp., *Isogramma* sp., *Stereochia* sp., and *Neospirifer* sp.

The purpose of this paper is to describe a brachiopod species *Isogramma paotechowensis* (Grabau and Chao, 1928) from the Yampupata area, and to suppose the age of the lower Copacabana Group in this area. Among the authors, MF and JT are responsible for the systematic descriptions, and MF and TI are responsible for the field geology. All the specimens of *I. paotechowensis* are housed in the Department of Geology, Faculty of Science, Niigata University.

Stratigraphy

The Copacabana Group is narrowly distributed in Peru and Bolivia through the Andes, with the strike of NW-SE. This group was recognized by Newell et al. (1953) as the Upper Carboniferous and Lower Permian, consisting of massive limestone and black shale, about 1900 m in the maximum thickness.

The geological map of the Yampupata area has been made by the Geological Survey of Bolivia (GEOBOL) (1978). In the Yampupata area, the Copacabana Group overlies the Devonian Aigachi Formation and the Carboniferous Khasa and Cumana formations, and is covered with unconformity by the Tertiary rocks. The lower part of the Copacabana Group, having a general trend NW-SE, and dipping 40° NE, is estimated more than 340 m in thickness

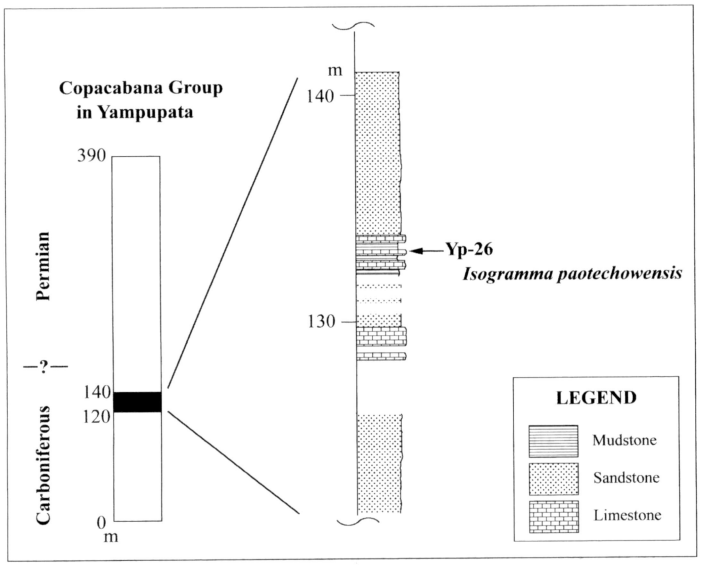

Fig. 2. Columnar section of the lower Copacabana Group at Yampupata, showing the fossil horizon Yp-26, revised from Sakagami (1986).

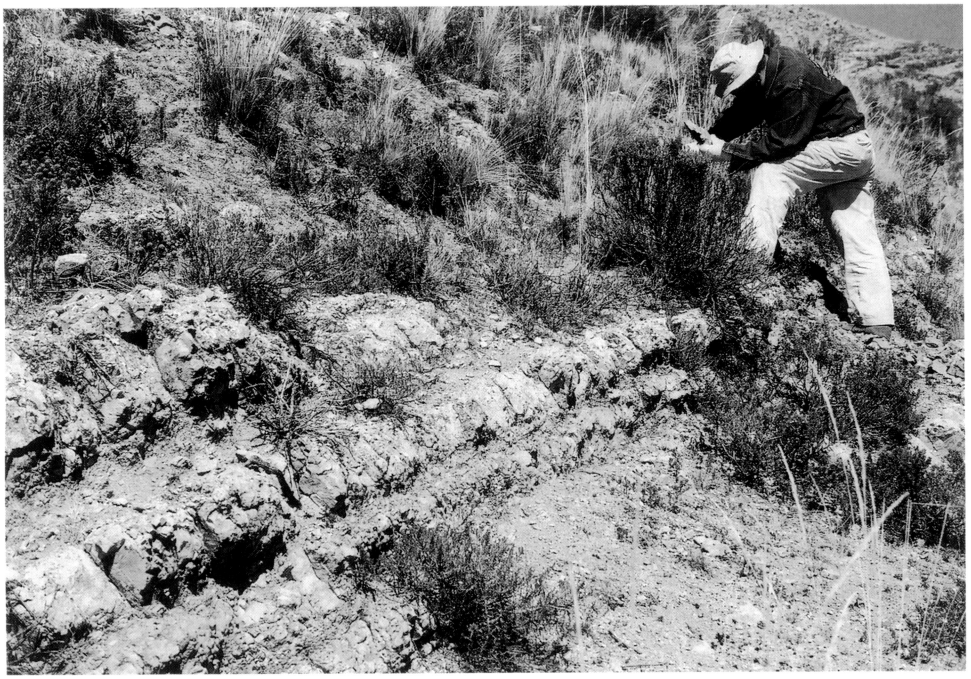

Fig. 3. Outcrop of the lower Copacabana Group (Yp-26) at Yampupata.

(Sakagami, 1986). Fig. 2 shows the columnar section of the lower Copacabana Group at Yampupata. We have collected the brachiopod specimens from pale green tuffaceous sandy shale at the horizon Yp-26 of Sakagami et al. (1985), 130 m above from the base of the Copacabana Group (Fig. 3). Bryozoans, brachiopods, cephalopods, bivalves, and gastropods have been reported from this bed (Sakagami, 1986).

In this area, the Carboniferous–Permian boundary has not settled the precise horizon yet. Sakagami (1986) mentioned that the horizon Yp-26 lies on the 80m above the Carboniferous-Permian boundary. Suarez-Riglos et al. (1987) studied the conodont biostratigraphy of the Copacabana Group in Bolivia, and they proposed that the lowermost Permian *Triticites* Zone and *Triticites nitens* Subzone are really equivalent to the uppermost Carboniferous. This proposal was followed by Sakagami et al. (1991) who examined along some routes, Cuyavi, Yampupata, Ancoraimes, and Matilde, in the Lake Titicaca region. Sakagami and Mizuno (1994) discovered the Middle Pennsylvanian fusulinaceans and conodonts from the fossil horizons Cu-04, 11, 29, 32, 39, 43, 46a, and 46b of the Cuyabi route (Sakagami, 1986) and Yp-10 of the Yampupata route in the lower part of the Copacabana Group. The horizon Cu-46 in the Cuyabi route were referable to Yp-10 (about 45 m below Yp-26) in the Yampupata route from the fusulinacean evidence (Sakagami and Mizuno, 1994).

Consequently, the horizon Yp-26 is referable to Middle Pennsylvanian or later. Meanwhile, *Isogramma paotechowensis,* which was collected at the horizon Yp-26, has only occurred from the Upper Carboniferous of north China and the Carnic Alps. Therefore, we correlate the sampling horizon Yp-26 of the lower Copacabana Group with Late Carboniferous in age. This view does not conflict with the previous study of Sakagami and Mizuno (1994), and is valuable for the argument of the Carboniferous–Permian boundary in the lower Copacabana Group of the Yampupata area.

Systematic paleontology

Order Dictyonellida Cooper, 1956
Superfamily Eichwaldioidea Schuchert, 1893
Family Isogrammidae Schuchert, 1929
Genus *Isogramma* Meek and Worthen, 1870

Isogramma paotechowensis (Grabau and Chao, 1928)
Fig. 4.

Aulacorhynchus paotechowensis Grabau and Chao, in Chao, 1928, p. 33, pl. 1, fig. 27; pl. 4, figs. 1-5.

Isogramma paotechowensis (Grabau and Chao). Aigner and Heritsch, 1931, p. 307, pl. 2, figs. 29-36; pl. 3, figs. 37-44; pl. 4, figs. 45-51; pl. 5, figs. 52, 53, 67-71; Hatai and Omura,

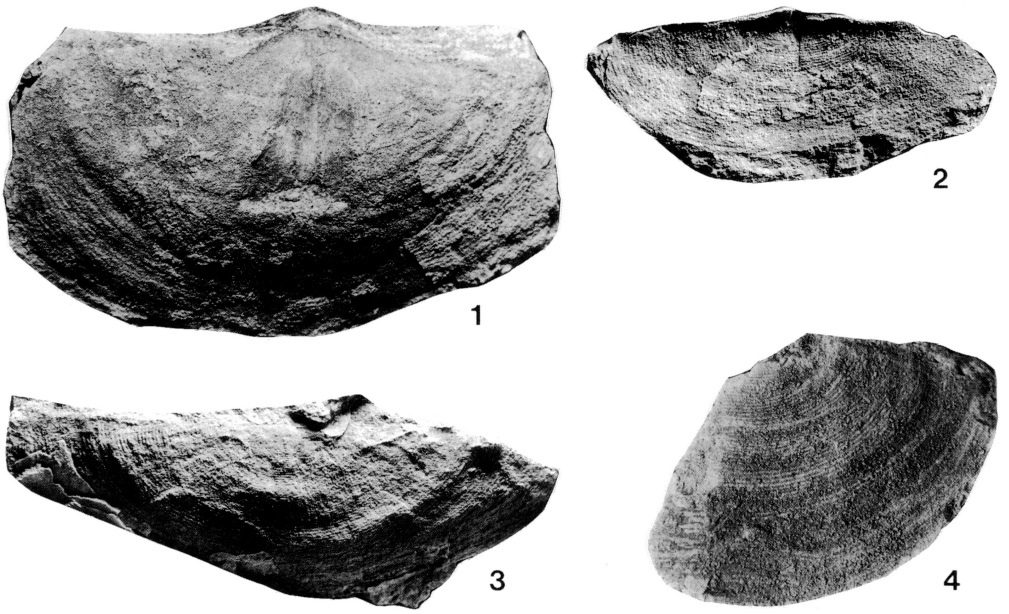

Fig. 4. *Isogramma paotechowensis* (Grabau and Chao, 1928), from the lower Copacabana Group of Yampupata in the Lake Titicaca region, Bolivia. 1: ventral valve, NU-B591. 2: dorsal valve, NU-B593. 3: ventral valve, NU-B592. 4: dorsal valve, NU-B594.

1941, pl. 2, fig. 4; Wang, 1957, p. 160, pl. 92, fig. 14; Wang et al., 1964, p. 354, pl. 37, fig. 38; Lee and Duan, 1985, p. 239, pl. 66, figs. 14, 15, 23.

Isogramma paotechowense (Grabau and Chao). Licharev, in Gorsky, 1939, p. 83, pl. 17, figs. 1, 2.

Isogramma sp. Ishibashi and Fujikawa, 1999, pl., figs. 4-8.

Material.—Six specimens: two ventral valves (NU-B591, NU-B592), a single dorsal valve (NU-B593), and three valve fragments (NU-B594-NU-B596).

Description.—Shell medium size for genus, transversely suboval in outline, with greatest width slightly anterior to hingeline; length 44 mm, width 72 mm in the largest specimen (NU-B591). Ventral valve slightly convex. Dorsal valve slightly concave to almost flattened. External surface of both valves ornamented by fine numerous and regular concentric fila. Fila sharply separated by shallow grooves; numbering 9-12 in 5 mm at mid of ventral valve.

Remarks.—The specimens from Yampupata, Lake Titicaca region have been figured and reported as *Isogramma* sp. by Ishibashi and Fujikawa (1999) without any systematic description. These specimens are identical with *Isogramma paotechowensis* (Grabau and Chao, 1928), originally described by Grabau and Chao (in Chao, 1928) as *Aulacorhynchus paotechowensis*

from the Taiyuan Series of Shanxi, north China in size, shape and external ornament of shell. The number of fila is 10 per 5 mm in the Chinese type specimen (Chao, 1928, pl. 1, fig. 27), and 9-12 per 5 mm in the Bolivian specimens.

The shells, described and figured as *Isogramma paotechowensis*, from the Upper Carboniferous and Lower Permian of Fergana (Volgin, 1957, p. 39, pl. 1, figs. 8-9; Volgin, 1960, p. 41, pl. 2, fig. 6; Sergunkova and Zhizhilo, 1974, p. 68, pl. 12, figs. 1-3), and from the Middle Permian of the southern Kitakami Mountains, northeast Japan (Minato, 1955, p. 29, text-fig. 1; Nakamura, 1970, p. 306, pl. 3, figs. 1, 2; pl. 4, figs. 1, 2), may be not assigned to *I. paotechowensis* in their much larger size and more transverse outline.

Distribution.—Upper Carboniferous of the Carnic Alps; Shaanxi, Shanxi and Hebei, north China; Lake Titicaca region, Bolivia.

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