Isogramma (Dictyonellida, Brachiopoda) from the Middle Carboniferous of Omi, central Japan

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Abstract

A single specimen of *Isogramma millepunctata* (Meek and Worthen, 1870) is described from the *Fusulina-Fusulinella* Zone (Moscovian) of the Omi Limestone in Omi, central Japan. This is the first record of *Isogramma* from the Carboniferous of Japan. The occurrence of *Isogramma* from Omi supports the palaeogeographical reconstruction that the Omi reef-sea mount complex was located at the northern middle latitudinal area of the western Panthalassa in the Middle Carboniferous time.

Key words: central Japan, *Isogramma*, Middle Carboniferous, Omi Limestone, Panthalassa.

Introduction

Isogramma is a brachiopod genus, ranging from the Lower Carboniferous (Visean) to the Middle Permian (Guadalupian). Although about 35 species of this genus have been known from Europe, Russia, China, North America and South America, in Japan, only two species, *Isogramma paotechowensis* (Grabau and Chao, in Chao, 1928) and *Isogramma heritschi* Nakamura, 1970, have been described by Minato (1955) and Nakamura (1970) from the Middle Permian Kanokura Formation of the southern Kitakami Mountains, northeast Japan.

Several years ago, the second author (KS) collected a brachiopod specimen from light grey limestone of the *Fusulina-Fusulinella* Zone (Moscovian) of the Omi Limestone, cropping out at the Higashiyama Quarry, northern slope of Mt. Kurohimeyama in Omi, central Japan (Figs. 1, 2). The brachiopod specimen was sent to the first author (JT) through the third author (KT),

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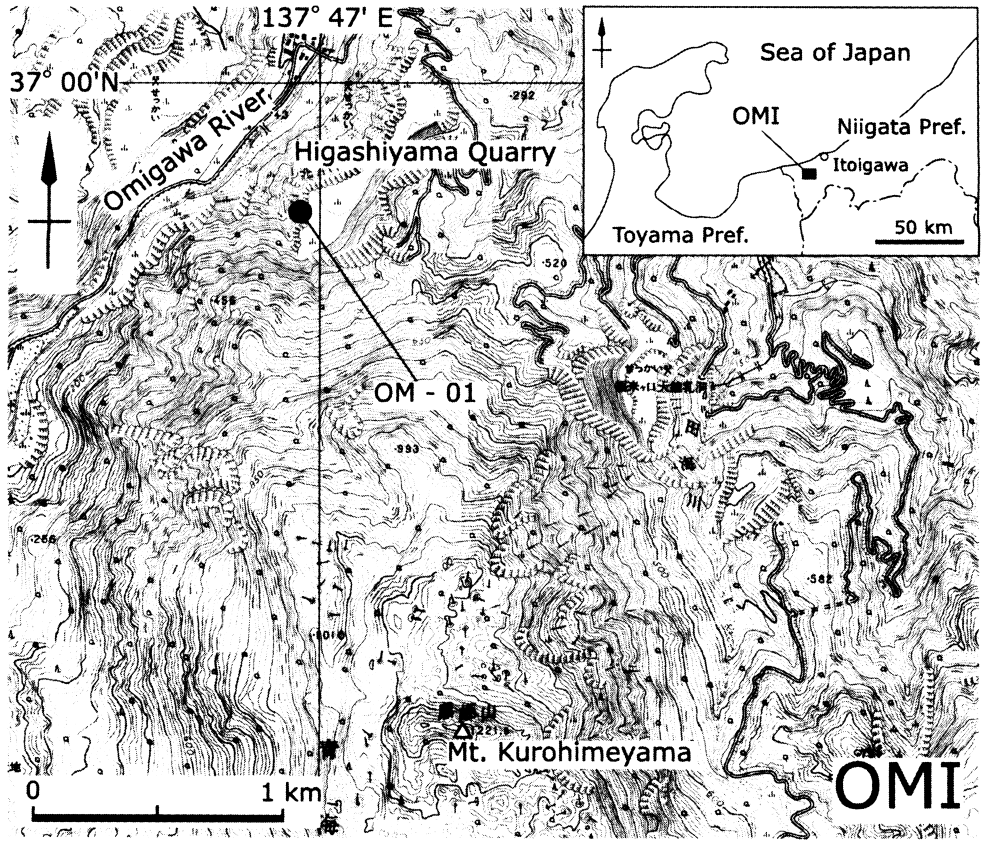

Fig. 1. Index map of the fossil locality (OM-01) in Omi, central Japan

and identified with *Isogramma millepunctata* (Meek and Worthen, 1870), originally described from the Middle Pennsylvanian of Illinois, U.S.A. This is the first record of *Isogramma* from the Carboniferous of Japan.

The Omi Limestone in the Omi area, west of Niigata Prefecture, central Japan is a large limestone-basalt block (12 km×3 km) in the Middle to Upper Permian accretionary complex of the Akiyoshi Belt (Tazawa et al., 2002). It consists of white to light grey, massive limestone of about 1,000 m thick, with the underlying reddish purple to dark green basalt and basaltic tuff of more than 15 m thick (Hasegawa et al., 1969, 1982). The limestone contains many fossils of the Lower Carboniferous (Upper Visean) to the Middle Permian (Capitanian) smaller foraminifers, fusulinoideans, corals, bryozoans, brachiopods, cephalopods, crinoids, conodonts, calcareous algae etc. The limestone-basalt blocks of the Akiyoshi Belt, including the Omi block, are originated in a reef-sea mount complexes at the western Panthalassa in the Early Carboniferous to the Middle Permian time (Kanmera et al., 1990; Sano and Kanmera, 1996).

Fig. 2. Outcrop of the Middle Carboniferous limestone at the Higashiyama Quarry, northern slope of Mt. Kurohimeyama in Omi. Arrows show the fossil locality (OM-01).

The purpose of this paper is to describe the single specimen of *Isogramma millepunctata* (Meek and Worthen) from Omi, and to discuss on its palaeobiogeographical and palaeogeographical significance. The brachiopod specimen is housed in the Fossa Magna Museum, Itoigawa.

Stratigraphical and geographical distributions of *Isogrammma*

The genus *Isogramma* is the most flourishing and abundant in the Middle to Upper Carboniferous. In the Middle Carboniferous, the following 13 species (10 species and 3 species indeterminate) have been described from Europe (Spain, Carnic Alps and Serbia), Russia (Moscow Basin, Donetz Basin and Fergana), Northwest China (Xinjian, Gansu and Shaanxi), North China (Shanxi and Hebei), Northeast China (Liaoning), North America (Nebraska, Illinois, Ohio, Texas and New Mexico) and South America (Bolivia). The present authors add Omi to the above list of the fossil localities. It is noteworthy that the *Isogramma* species have never been found from the Middle Carboniferous of the Boreal region (Greenland, Spitsbergen, Arctic Russia and Arctic Canada), the typical Tethyan region (South China) and the Gondwanan region (Australia).

Isogramma millepunctata (Meek and Worthen, 1870)
Isogramma davidsoni (Barrois, 1882)
Isogramma expansa (De Regny and Gortani, 1905)
Isogramma paotechowensis (Grabau and Chao, in Chao, 1928)
Isogramma manchoukuoensis Hatai and Omura, 1941
Isogramma asymmetrica Ding, in Yang et al., 1962
Isogramma licharevi Aisenverg, 1964
Isogramma serbica Stojamovic-Kuzenko, 1968
Isogramma kesmensis Ilkovsky, 1978
Isogramma coopi Wardlaw, Schindel and Yochelson, 1987
Isogramma cf. *millepunctata*, Licharew, 1936
Isogramma sp., Branisa, 1965
Isogramma sp., Sutherland and Harlow, 1973

Isogramma millepunctata (Meek and Worthen) has been described from the Lower to Upper Pennsylvanian of Nebraska (Dunbar and Condra, 1932), Illinois (Meek and Worthen, 1870) and Ohio (Morningstar, 1922; Sturgeon and Hoare, 1968), the Middle and Upper Carboniferous of southern Fergana (Licharew, 1936; Volgin, 1957, 1960), and the Middle Carboniferous of north Xinjian, Northwest China (Wang and Yang, 1998) and Omi, central Japan (this study) (Fig. 3). Nakamura (Nakamura, 1970; Nakamura et al., 1985) pointed out that the geographical distribution of *Isogramma* in the Permian is restricted only along the

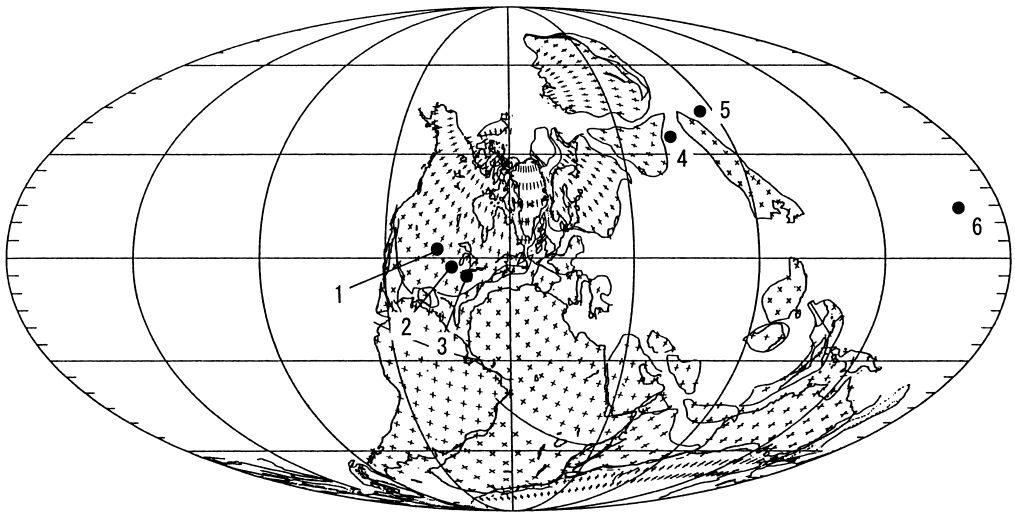

Fig. 3. Geographical distribution of *Isogramma millepunctata* in the Middle Carboniferous (plotted on the base map by Scotese and McKerrow, 1990). 1: Nebraska, 2: Illinois, 3: Ohio, 4: southern Fergana, 5: north Xinjian, 6: Omi.

northern margin of the Tethyan Province, and excluded any other regions, such as South China and the Salt Range, Pakistan. Consequently, *Isogramma* is an antitropical genus in the Middle Carboniferous to the Middle Permian, and it is distributed mainly in the transitional zone of the Northern Hemisphere, except for the occurrence from the Upper Carboniferous to the Lower Permian of Bolivia (Branisa, 1965; Fujikawa et al., 2003).

The Akiyoshi-type reef-seamount complexes including that of Omi were born in the Early Carboniferous (Late Visean) at the low latitudinal (about 14° N) area in the Panthalassa (Fujiwara, 1967), and accreated to the "Proto-Japan" at the eastern margin of North China which was located in the middle latitudinal area of the Northern Hemisphere, probably being about 25-30° N in the Middle to Late Permian (Tazawa, 2000). Therefore, it is concluded that the Omi block was located at the northern middle latitude (about 20° N) of the western Panthalassa in the Middle Carboniferous (see Fig. 3). The antitropical nature of *Isogramma* supports the above reconstruction.

Description of species

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

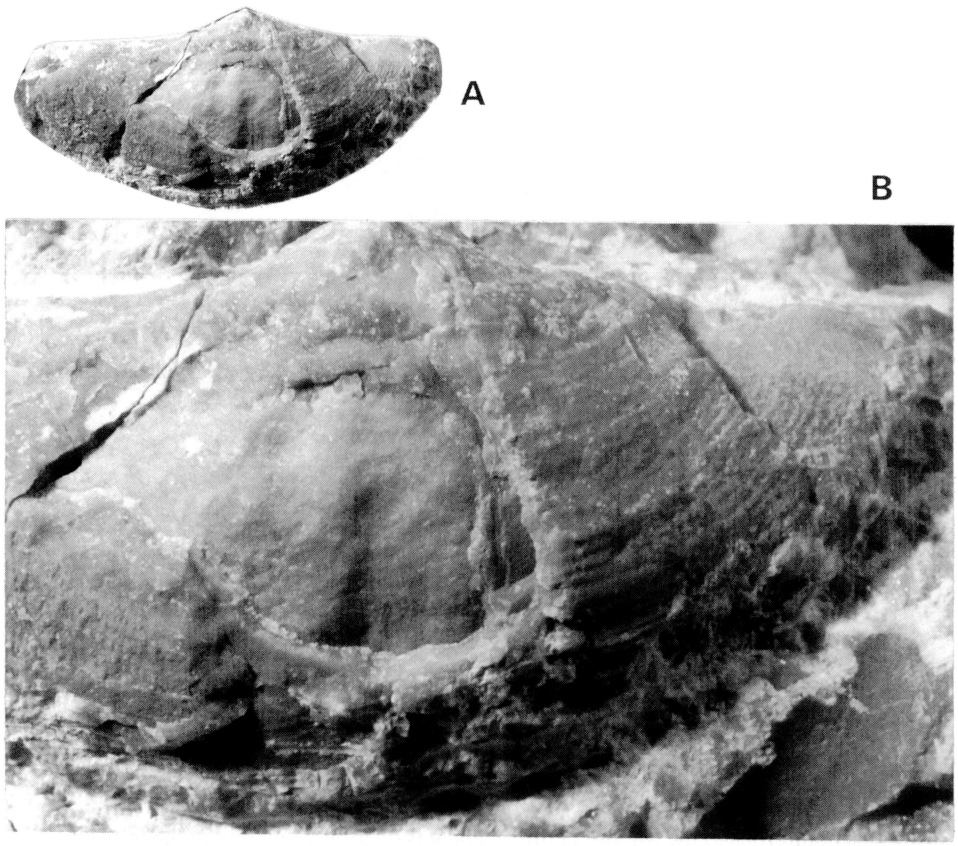

Fig. 4. A ventral valve specimen (FMM1320) of *Isogramma millepunctata* (Meek and Worthen) from the Middle Carboniferous of the Omi Limestone at the Higashiyama Quarry (Loc. OM-01). A: natural size, B: X 3.

Isogramma millepunctata (Meek and Worthen, 1870)
Figs. 4A, 4B.

Chonetes? *millepunctata* Meek and Worthen, 1870, p. 35.

Aulacorhynchus millepunctatus (Meek and Worthen): Morningstar, 1922, p. 180, pl. 7, fig. 12.

Isogramma millepunctata (Meek and Worthen): Aigner and Heritsch, 1931, pl. 1, figs. 23-27; Dunbar and Condra, 1932, pars, p. 282, pl. 42, figs. 18-20 only; Licharew, 1936, pl. B, figs. 4a, 4b; Hatai and Omura, 1941, pl. 2, figs. 1, 2; Volgin, 1957, p. 37, pl. 1, figs. 1-7; Volgin, 1960, p. 41, pl. 2, figs. 3-5; Sturgeon and Hoare, 1968, p. 25, pl. 2, figs. 15, 16; Wang and Yang, 1998, p. 66, pl. 24, fig. 3.

Material.—One specimen, from locality OM-01, incomplete ventral valve, FMM1320.

Description.—Shell medium size for genus, transversely semielliptical in outline; hinge nearly straight, a little less than greatest width, latter occurring slightly anterior to hinge line; length 27 mm, width about 60 mm. Ventral valve slightly convex in lateral and anterior profiles. External surface of ventral valve ornamented by numerous fine, regular concentric fila, numbering 11 in 5 mm at about midvalve. Umbonal plate obscure.

Remarks.—This specimen can be referred to *Isogramma millepunctata* (Meek and Worthen, 1870), originally described from the Middle Pennsylvanian of Marion County, Illinois, by its size, shape and external ornament of the ventral valve.

Isogramma paotechowensis (Grabau and Chao, in Chao, 1928) from the Taiyuan Series of Shanxi, North China and *Isogramma davidsoni* (Barrois, 1882) from the Middle Carboniferous of Asturias, northwest Spain are somewhat similar to *I. millepunctata* in size and external ornament of the ventral valve, but the former two species differ from the present species in their longer shape and having not straight hinge on the ventral valve.

Distribution.—Lower to Upper Pennsylvanian of North America (Nebraska, Illinois and Ohio); Middle and Upper Carboniferous of southern Fergana; Middle Carboniferous of north Xinjian, Northwest China and Omi, central Japan.

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