Permian lyttoniid brachiopod *Petasmaia* from Akasaka, Mino Belt, central Japan

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**Abstract:** A lyttoniid brachiopod species, *Petasmaia expansa* Cooper and Grant, 1969, is described from the middle member (*Neoschwagerina margaritae* Zone; upper Murgabian) of the Akasaka Limestone within the Mino Belt of central Japan. *Petasmaia* is a rare brachiopod genus, with the only two known species identified so far obtained from the Lower and Middle Permian of West Texas and from the Middle Permian of Akasaka. The presence of *P. expansa* in the Akasaka area suggests that reef-seamount complexes of the Mino Belt, including those of the Akasaka area.

*Petasmaia* is a lyttoniid brachiopod genus characterized by a large and broadly expanded shell with numerous, symmetrically disposed and anteriorly arcuate lateral septa with sharp crests (anguliseptate) in the ventral valve. The genus was proposed by Cooper and Grant (1969) with *Petasmaia expansa* from the Cathedral Mountain Formation (Leonardian), Glass Mountains, West Texas, USA as type species. Among the lyttoniid brachiopod genera, *Leptodus* Kayser, 1883 is readily distinguished from *Petasmaia* by its elongate outline and the lateral septa with blunt crests (solidiseptate) in the ventral valve. *Oldhamina* Waagen, 1883 also has lateral septa with sharp crests like *Petasmaia*, but it differs from the latter by its more strongly arcuate lateral septa in the ventral valve.

The material was collected by the junior author (T. Ono) from black limestone in a limestone quarry of Hanaokayama (Long. 136°34′30″ E, Lat. 35°23′45″ N) in the Akasaka area of Ogaki City, Gifu Prefecture (Fig. 1). The fossil-bearing black limestone is assigned to the middle member of the Akasaka Limestone (Ozawa and Nishiwaki, 1992), and to the *Neoschwagerina margaritae* Zone (upper Murgabian) (Zaw Win, 1999). The specimens described herein are registered with the prefix NU-B, and housed in the Department of Geology, Faculty of Science, Niigata University, Niigata, Japan.

**Systematic descriptions**

**Order** Productida Sarytcheva and Sokolskaya, 1959

**Suborder** Lyttoniidina Williams, Harper and Grant, 2000

**Superfamily** Lyttonioidea Waagen, 1883

**Family** Lyttoniidae Waagen, 1883

**Subfamily** Lyttoniinae Waagen, 1883

**Genus** *Petasmaia* Cooper and Grant, 1969

**Type species** – *Petasmaia expansa* Cooper and Grant, 1969, from the Cathedral Mountain Formation of the Glass Mountains, West Texas, USA.

*Petasmaia expansa* Cooper and Grant, 1969
Figs. 2, 3

*Petasmaia expansa* Cooper and Grant, 1969, p. 10, pl. 2, figs. 15–18; Cooper and Grant, 1974, p. 430, pl. 163, figs. 1–8; pl. 164, figs. 1–16; pl. 165, figs. 1–23; pl. 169, figs. 11–16.

**Material.** –Seven specimens, interior of seven ventral valves, NU-B1727–1733.

**Description.** –Shell large size for genus, transversely wider elliptical in outline, with greatest width at about midlength; length 62 mm, width 97 mm in the largest specimen (NU-B1727). Ventral valve almost flattened in lateral and anterior profiles. Interior of ventral valve with numerous, regularly and symmetrically arranged lateral septa on both sides of a low median septum; lateral septa with sharp crests (see Fig. 3) and broad inter-spaces, being nearly straight to gently arcuate anteriorly and slightly dipping towards the front in lateral profile; total of 13 pairs of septa in the largest specimen.

**Remarks.** –The specimens from Akasaka are abraded and more or less fragmented. However, these specimens can be referred to *Petasmaia expansa* on account of the large, transverse shell and the presence of numerous, regularly arranged lateral septa with sharp crests in the ventral valve.

*Petasmaia* sp. 1 by Cooper and Grant (1974, p. 432) from the uppermost part of the Road Canyon Formation of West Texas, is an indefinite species without detailed description and illustration. Therefore, comparison with that species is difficult.

Recently, Tazawa (in Tazawa and Miyake, 2011, p. 8) described a lyttoniid brachiopod species as *Petasmaia ehiroi* Tazawa in Tazawa and Miyake 2011, from the upper part of the Toyoma Formation (Changhsingian) of Maeda in the Ofunato area, South Kitakami Belt, northeast Japan. However, the Kitakami species should be included into the genus *Oldhamina* because it has strongly arcuate lateral septa in the ventral valve.

**Distribution of Petasmaia**

*Petasmaia* is a rare lyttoniid brachiopod genus comprising only two known species, *Petasmaia expansa* and *Petasmaia* sp. 1. Stratigraphical and geographical distributions of the species are summarized below.

*Petasmaia expansa*: Cathedral Mountain Formation
Petasmaia from Akasaka

Distributions of known species show that the genus Petasmaia is restricted to both West Texas and Akasaka, and absent in Boreal, Gondwanan and typical Tethyan regions (e.g., South China, Iran and Greece). The Permian brachiopod fauna of West Texas comprises nearly 1,000 species in more than 200 genera, with both tropical and anti-tropical elements (Cooper and Grant, 1969). Thus, Petasmaia appears to be one of the tropical elements of the West Texas fauna, and also a tropical Panthalassan element.

Permian brachiopods of Akasaka

Six species of Permian brachiopods are known from Akasaka: Scacchinella gigantea Schellwien, 1900, described by Ando (1986), Okumura and Tomida (2000) and Shen et al. (2006); Leptodus nobilis (Waagen, 1883), described by Tazawa et al. (1998); Coscinophora magnifica Cooper and Grant, 1974, described by Sato (1919), Hayasaka (1925) and Tazawa et al. (1998); Petasmaia expansa, described by Tazawa and Ono (this study); Geyerella sp., described by Hayasaka (1932); and Peltichia akasakensis (Ozawa, 1927), described by Ozawa (1927), Hayasaka (1932) and Shen et al. (1999). Enteletes suessi (Schellwien, 1892) and Enteletes minoensis Hayasaka, 1932, both described by Hayasaka (1932) based on specimens from Akasaka, are junior synonyms of Peltichia akasakensis (Shen et al., 1999, p. 53).

Among the species from Akasaka, C. magnifica and P. expansa are tropical Panthalassan elements, occurring in both West Texas and Akasaka; S. gigantea and L. nobilis are Tethyan elements; and Geyerella sp. is a warm-water element, although its affinities with tropical Panthalassan or Tethyan elements is uncertain. Thus, the Akasaka fauna comprises a mixture of tropical Panthal-
assan and Tetyan elements, and is completely lacking in Boreal (anti-tropical) elements.

In this respect, the Permian brachiopod faunas of British Columbia (Yole, 1963; Logan and McGugan, 1968; Nelson and Nelson, 1985) differ from that of Akasaka, in having much Boreal elements (e.g., Waagenoconcha, Yakovlevia, Megousia, Rhychnopora and Spiriferella) and lacking Coscinopora or Petasmatia, although some Japanese researchers (e.g., Ozawa, 1987; Kobayashi, 1997) have presumed a close faunal relationship between the two regions, based on Permian fusulinid assemblages.

Tazawa and his colleagues (Tazawa and Shen, 1997; Tazawa et al., 1998; Shen et al., 2011) noted that the Permian brachiopod faunas of the Hiyomo, Hatahoko and Akasaka areas of the Mino Belt indicate a close affinity with that of West Texas. Thus, Tazawa and Shen (2010) and Shen et al. (2011) concluded that the Mino reef-seamounts (including the Akasaka Limestone) were located in the equatorial region of mid-Panthalassan between the Palaeotethys and North American Continent in the Early to Middle Permian. At that time, a warm-water current transported the West Texas fauna, excluding the Boreal elements, from east to west. Consequently, the Mino fauna came to be a mixture of the Tethyan and the West Texas elements, and lacking the Boreal elements. The present report of Petasmaia expansa from Akasaka strongly supports the palaeobiogeographical scheme proposed by Tazawa and Shen (2010) and Shen et al. (2011).

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* in Japanese
** in Russian