Delepinea and *Daviesiella* (Chonetoidea, Brachiopoda) from the Lower Carboniferous of Omi, central Japan

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Abstract

Two species of large chonetid brachiopod, *Delepinea sinuata* Yanagida, 1968 and *Daviesiella omiensis* Tazawa, sp. nov., are described from the Lower Carboniferous (lower Upper Visean, Asbian) basaltic tuff of the lowest part of the Omi Limestone in the Omi area, central Japan. *Daviesiella* is described for the first time from the Japanese Carboniferous. The age and palaeobiogeography of the brachiopod fauna are discussed, and the stratigraphical and geographical distributions of both *Delepinea* and *Daviesiella* are documented.

Key words: basaltic tuff, central Japan, *Daviesiella, Delepinea*, Lower Carboniferous, Omi.

Introduction

Delepinea and *Daviesiella* are conspicuous and well-known large chonetid brachiopods. Since being reported by Sowerby (1823) and Davidson (1863) from the Lower Carboniferous (Visean) of Britain, many species of these two genera have been described from the Lower Carboniferous, mostly the Visean, of western Europe, northern Africa, Russia, Iran, central Asia, China, Japan and Australia. In Japan, the following three *Delepinea* species have been known from two localities: *Delepinea sayamensis* Yanagida and *Delepinea sinuata* Yanagida from the Upper Visean of Akiyoshi, southwest Japan (Yanagida, 1968), and *Delepinea* cf. *sayamensis* Yanagida from the Upper Visean of Omi, central Japan (Tazawa et al., 1983). On

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(Manuscript received 5 January, 2005; accepted 8 February, 2005)

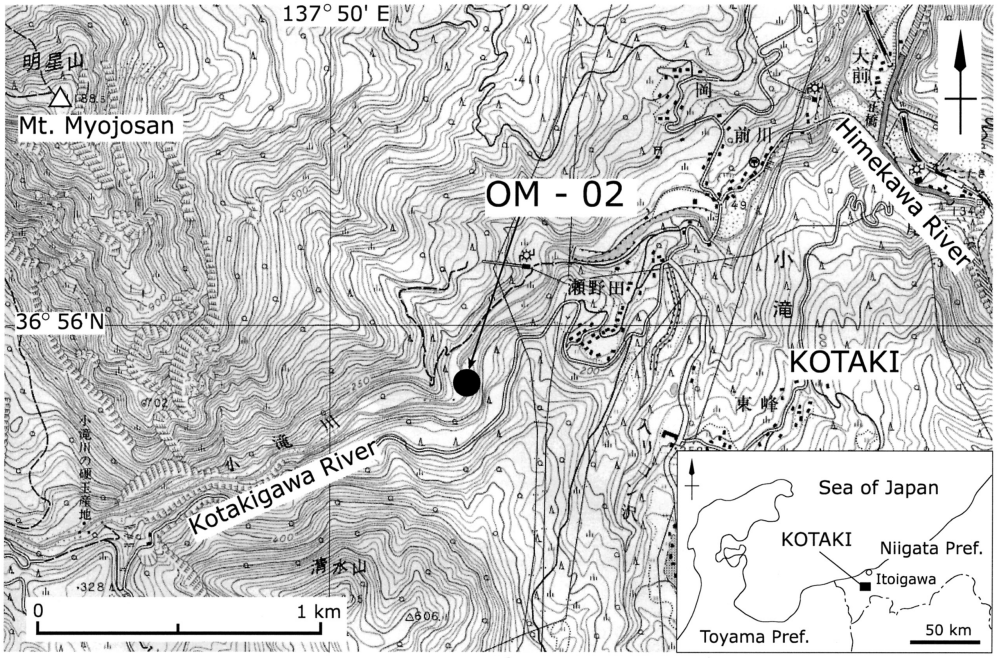

Fig. 1. Index map of the fossil locality (OM-02) in Omi, central Japan.

the other hand, none of the *Daviesiella* species has been known until now. This is the first record of *Daviesiella* from the Japanese Carboniferous.

In the Omi area, reddish purple to dark green basaltic tuff is distributed along the northeastern margin of the limestone blocks, Itagamine, Kurohimeyama and Myojosan blocks (Tazawa et al., 2002). The basaltic tuff is more than 15 m thick, and it is conformably overlain by about 1,000 m thick, white to light grey, massive limestone of Early Carboniferous (Late Visean) to Middle Permian (Capitanian) (Hasegawa et al., 1982). Several years ago, the second author (KS) collected some brachiopod specimens from a large float of reddish purple basaltic tuff at the foot of the southern cliff of Mt. Myojosan, i.e., the locality OM-02, middle stream of the Kotakigawa River, Kotaki in the Omi area, central Japan (Fig. 1). Recently, the brachiopod specimens were sent to the first author (JT) through the third author (KT) for taxonomic study. Now it is revealed that the brachiopod material consists of each single species of both *Delepinea* and *Daviesiella*.

In this paper we describe the specimens of *Delepinea* and *Daviesiella* from Kotaki in the Omi area, and discuss the age and palaeobiogeography of this fauna. The brachiopod specimens described herein are registered and housed in the Fossa Magna Museum, Itoigawa.

Distribution of *Delepinea* and *Daviesiella*

The genus *Delepinea* was proposed by Muir-Wood (1962, p. 99) with *Productus comoides* Sowerby, 1823, as type species. The following twenty-five species of this genus have been described from the Upper Tournaisian to Serpukhovian, mostly from the Lower to the Upper Visean, of western Europe, northern Africa, Russia, Iran, central Asia, China, Japan and Australia (Fig. 2).

Delepinea comoides (Sowerby, 1823): Upper Visean of Scotland (Brand, 1970); Lower-Upper Visean of England (Sowerby, 1823; Garwood, 1916; George, 1930; Muir-Wood, 1962) and Belgium (Delépine, 1928); Tournaisian-Visean of Germany (Sommer, 1909; Paeckelmann, 1930); Upper Visean of the Elburz, northern Iran (Rivière, 1934; Gaetani, 1968); Middle-Upper Visean of the Moscow Basin (Russian Platform) (Sokolskaya, 1950; Sarytcheva and Sokolskaya, 1952; Garanj et al., 1975); Serpukhovian of the Donetz Basin (Donbass) (Garanj et al., 1975); Tournaisian-Visean of the Urals (Lapina, 1957; Kalashnikov, 1974; Garanj et al., 1975; Nalivkin, 1979; Donakova, 1980); Upper Tournaisian-Lower Visean of northern Kirgiz (Galitzkaja, 1977); Tournaisian-Visean of Xinjiang, northwest China (Zhang et al., 1983); Visean of Sichuan, south China (Tong, 1978); Upper Visean of Guizhou and Guangdong, south China (Yang et al., 1977; Yang, 1978; Feng and Jiang, 1978; Yang et al., 1983; Wang et al., 1990); Middle-Upper Visean of Ussuri, eastern Russia (Nalivkin and Fotieva, 1973).

Delepinea aspinosa (Dun, 1902): Middle-Upper Visean of New South Wales, east Australia (Dun, 1902; Campbell and Roberts, 1964).

Delepinea destinezi (Vaughan, 1915): Middle Visean of Ireland (Simpson, 1953; Brunton 1966a, b); Middle Visean of Wales (Vaughan, 1915; Muir-Wood, 1962); Lower-Middle Visean of Belgium (Vaughan, 1915; Delépine, 1928); Lower Visean of Morocco (Muir-Wood, 1962).

Delepinea carinata (Garwood, 1916): Lower Visean of England, Wales and the Isle of Man, Britain (Garwood, 1916; Cope, 1935; Muir-Wood, 1962); Lower Visean of Belgium (Muir-Wood, 1962).

Delepinea gigantea (Fredericks, 1926): Middle Visean of the Donetz Basin (Donbass) (Garanj et al., 1975); Upper Tournaisian-Lower Visean of the Urals (Fredericks, 1926; Garanj et al., 1975; Nalivkin, 1979).

Delepinea rhenana (Paeckelmann, 1930): Visean of Ratingen, Germany (Paeckelmann, 1930).

Delepinea ratingensis (Paeckelmann, 1930): Visean of Ratingen, Germany (Paeckelmann, 1930).

Delepinea munsteri (Paeckelmann, 1930): Visean of Trogenau, Germany (Paeckelmann, 1930).

Delepinea franconicus (Paeckelmann, 1930): Visean of Trogenau, Germany (Paeckelmann, 1930).

Delepinea megaera (Paeckelmann, 1930): Visean of Ratingen, Germany (Paeckelmann, 1930).

Delepinea piedboeufi (Paeckelmann, 1930): Visean of Ratingen, Germany (Paeckelmann, 1930).

Delepinea silesiaca (Paeckelmann, 1930): Lower Visean of Schlesien, Germany (Paeckelmann, 1930); Upper Visean of Taimyr, northern Russia (Dedok and Tschernjak, 1960).

Delepinea cannindahensis (Maxwell, 1961): Upper Visean of Queensland, east Australia (Maxwell, 1961).

Delepinea gloucesterensis Campbell and Roberts, 1964: Middle-Upper Visean of New South Wales, east Australia (Campbell and Roberts, 1964).

Delepinea uttingi Thomas, 1965: Visean of the Bonaparte Gulf Basin, northwest Australia (Thomas, 1965; Roberts, 1971).

Delepinea sayamensis Yanagida, 1968: Upper Visean of Akiyoshi, southwest Japan (Yanagida, 1968; Yanagida et al., 1971).

Delepinea sinuata Yanagida, 1968: Upper Visean of Akiyoshi, southwest Japan (Yanagida, 1968; Yanagida et al., 1971) and Omi, central Japan (this study).

Delepinea subcarinata Jin and Liao, 1974: Lower Visean of Guizhou, south China (Jin and Liao, 1974; Wu et al., 1974; Yang, 1978); Upper Visean of Yunnan, southwest China (Jiang, 1997).

Delepinea depresa Jin and Liao, 1974: Upper Visean-Serpukhovian of Qinghai, northwest China (Jin et al., 1979) and Hunan, south China (Liu et al., 1982); Upper Visean of Guizhou, south China (Jin and Liao, 1974; Wu et al., 1974; Yang, 1978); Tournaisian-Visean of Xizang (Tibet), southwest China (Jin et al., 1985).

Delepinea nalivkini Garanj, 1975: Lower Visean of the Urals (Garanj et al., 1975).

Delepinea transversa Yang, 1978: Upper Visean-Serpukhovian of Hubei, Hunan and Guizhou, south China (Yang, 1978; Feng and Jiang, 1978; Feng, 1981; Liu et al., 1982; Yang, 1984).

Delepinea sinensis Yang, 1978: Lower-Upper Visean of Guizhou, south China (Yang, 1978; Feng and Jiang, 1978).

Delepinea dawanrenensis Shan and Zhao, 1981: Upper Visean-Serpukhovian of Hunan, south China (Shan and Zhao, 1981).

Delepinea subeiensis Ding, 1983: Upper Visean-Serpukhovian of Gansu, northwest China (Ding and Qi, 1983).

Delepinea sinus Jiang, 1987: Middle Visean of Sichuan, south China (Yang and Jiang, 1987); Upper Visean of Yunnan, southwest China (Jiang, 1997).

The genus *Daviesiella* was erected by Waagen (1884, p. 613), and subsequently revised by Muir-Wood (1962, p. 96), with *Productus llangollensis* Davidson, 1862 as type species. The following four *Daviesiella* species have been described from the Lower to the Upper Visean, mostly from the Middle Visean, of Britain, northern Kirgiz, northwest China and Japan (Fig. 2).

Daviesiella llangollensis (Davidson, 1863): Middle-Upper Visean of England and Wales (Davidson, 1863; Jackson, 1922; Cope, 1940; Muir-Wood, 1962); Lower Visean of northern Kirgiz (Galitzkaja, 1977); Visean of Xinjiang, northwest China (Zhang et al., 1983).

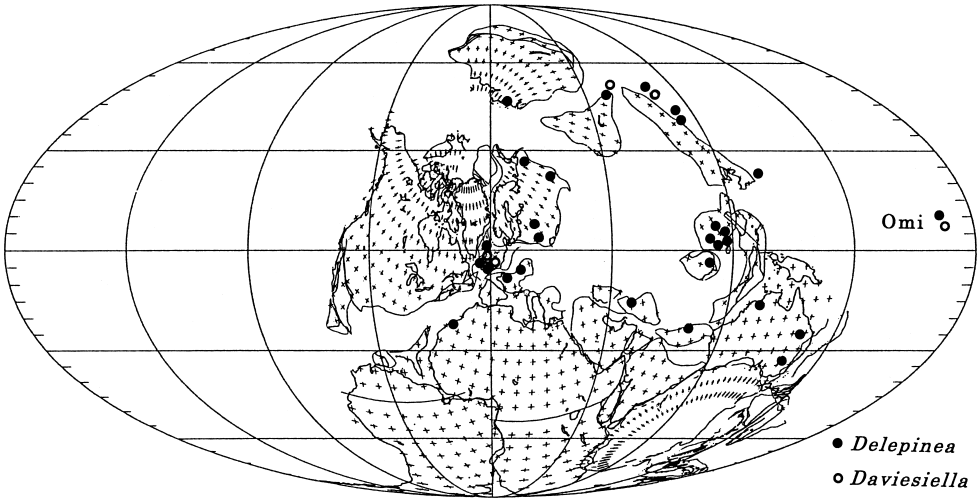

Fig. 2. The geographical distribution of *Delepinea* and *Daviesiella* in the Early Carboniferous (Visean) time, protted on the base map by Scotese and McKerrow (1990).

Daviesiella derbiensis Cope, 1940: Middle Visean of England (Cope, 1940; Muir-Wood, 1962).
Daviesiella notota Cope, 1940: Lower-Middle Visean of England (Cope, 1940).
Daviesiella omiensis Tazawa, sp. nov.: Upper Visean of Omi, central Japan (this study).

Discussion

The reddish purple basaltic tuff of Kotaki (OM-02) is equivalent to the same rocks of the middle Omigawa River, about 9 km NW of Kotaki; the latter contains fossils of some brachiopods, *Rhipidomella* sp. and *Delepinea* cf. *sayamensis* Yanagida (Tazawa et al., 1983). These *Delepinea*-bearing basaltic tuffs of Omi can be correlated with the upper part of thick basic pyroclastic rocks of Akiyoshi, i.e., the uppermost part of the *Endostaffella* sp. A Zone (Okimura, 1966), characterized by the *Delepinea sayamensis-Delepinea sinuata-Orthotetes* aff. *australis* Assemblage (Yanagida, 1987). Yanagida and his colleague (Yanagida, 1968, 1987; Yanagida et al., 1971) considered the age of the fossil zone to be the Middle Visean on the basis of the brachiopod assemblage. However, *Delepinea sinuata* is very close to *Delepinea cannindahensis* (Maxwell) from the Upper Visean of Queensland, east Australia. *Orthotetes* aff. *australis* is closely related to *Orthotetes australis* (Campbell) from the Middle-Upper Visean of east Australia. We now accept and follow the Tazawa's opinion (Tazawa et al., 1983) that the *Delepinea*-bearing bed of the basic pyroclastic rocks in the Omi and Akiyoshi areas are correlated with the Upper Visean, probably the lower Upper Visean

(Asbian).

The palaeomagnetic data for the reddish purple basaltic tuff of Akiyoshi (Fujiwara, 1967) indicate that the Akiyoshi-Omi seamounts were probably located at the lower to middle northern palaeolatitude, about 14° N, on the Panthalassa in the latest Early Carboniferous (Tazawa, 2000). The genus *Delepinea* is widely distributed in the Tethyan, Panthalassan, sub-Arctic and peri-Gondwanan regions, although *Daviesiella* is restricted to the Northern Hemisphere. Both *Delepinea and Daviesiella* are coexisted in the sub-Arctic region (northwest China and central Asia) and Britain. The Omi fauna probably connected with the brachiopod faunas of the sub-Arctic region, particularly, northwest China (Xinjiang) and central Asia (Kirgiz). Furthermore, the occurrence of *Delepinea sinuata* in Omi, and *Delepinea cannindahensis* in Queensland suggests that there was some faunal relationship between Omi and eastern Australia in the late Early Carboniferous (early Late Visean) time.

Systematic descriptions

Order Productida Sarytcheva and Sokolskaya, 1959
Suborder Chonetidina Muir-Wood, 1955
Superfamily Chonetoidea Bronn, 1862
Family Rugosochonetidae Muir-Wood, 1962
Subfamily Delepineinae Muir-Wood, 1962
Genus *Delepinea* Muir-Wood, 1962

Delepinea sinuata Yanagida, 1968
Figs. 3A, 3B.

Delepinea sinuata Yanagida, 1968, p. 333, pl. 34, figs. 2, 3; text-figs. 6-8; Yanagida et al., 1971, pl. 9, figs. 2-4.

Material.—One specimen, from locality OM-02, an incomplete ventral valve, FMM1342.

Description.—Shell small size for genus, transversely subelliptical in outline, with greatest width at or near hinge; length about 40 mm, width about 87 mm in the single ventral valve specimen (FMM1342). Ventral valve slightly convex in lateral profile, most convex at umbonal region; sulcus broad and shallow, originating at about a quarter length from posterior margin, and bounded by a pair of low, wide and rounded folds on both sides of sulcus. External ornament of ventral valve consisting of numerous costellae, numbering 24-26 per 10 mm at 10 mm from anterior margin of valve.

Remarks.—This specimen is relatively small in size, and seem to be an immature shell of *Delepinea sinuata* Yanagida, 1968, originally described by Yanagida (1968, p. 333) from the Upper Visean basaltic tuff of Akiyoshi, southwest Japan. *D. sinuata* is characterized by its

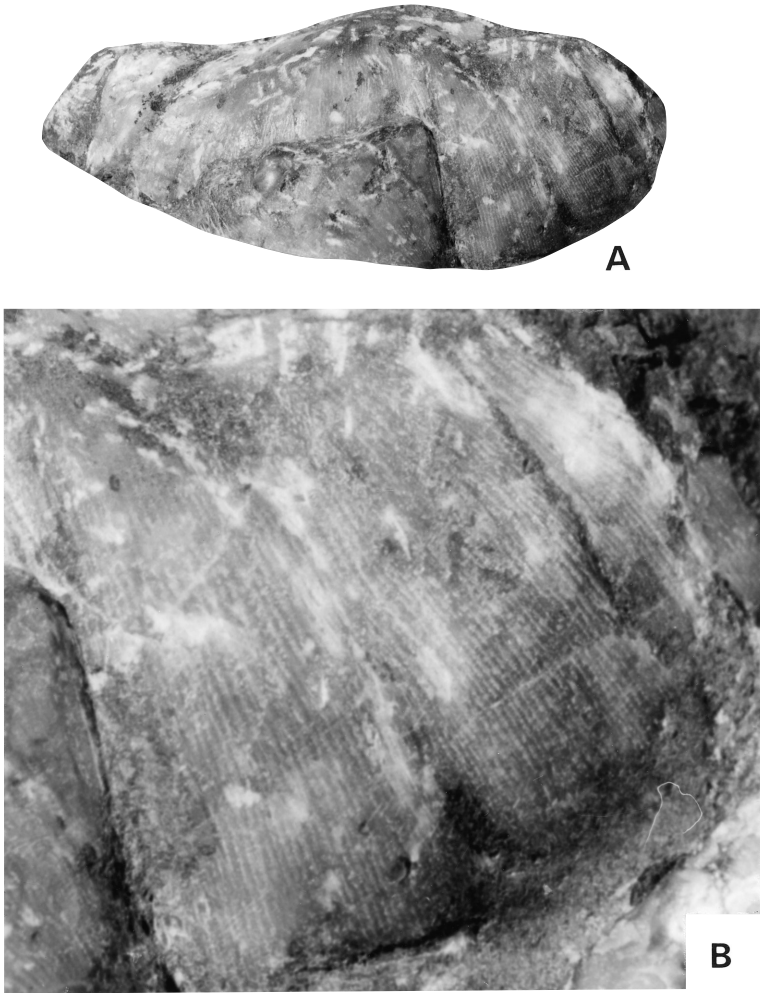

Fig. 3. *Delepinea sinuata* Yanagida. A ventral valve specimen, from the Upper Visean basaltic tuff of Omi, FMM1342, A: ventral view (× 1), B: enlarged of shell surface, showing numerous costellae (× 3).

transverse outline, broad and shallow ventral sulcus, and low rounded folds on both sides of the sulcus. It is noteworthy that *D. sinuata* externally resembles well *Delepinea cannindahensis* (Maxwell, 1961), described by Maxwell (1961, p. 86, pl. 19, figs. 16-19) from the Upper Visean of the Yarrol area, Queensland, east Australia.

Delepinea cf. *sayamensis* Yanagida, 1968, described and figured by Tazawa et al. (1983, p. 281, figs. 2.4-2.6) from the Upper Visean reddish purple basaltic tuff of Omi (middle Omigawa River), is clearly distinguished from the present species by its ventral valve lacking

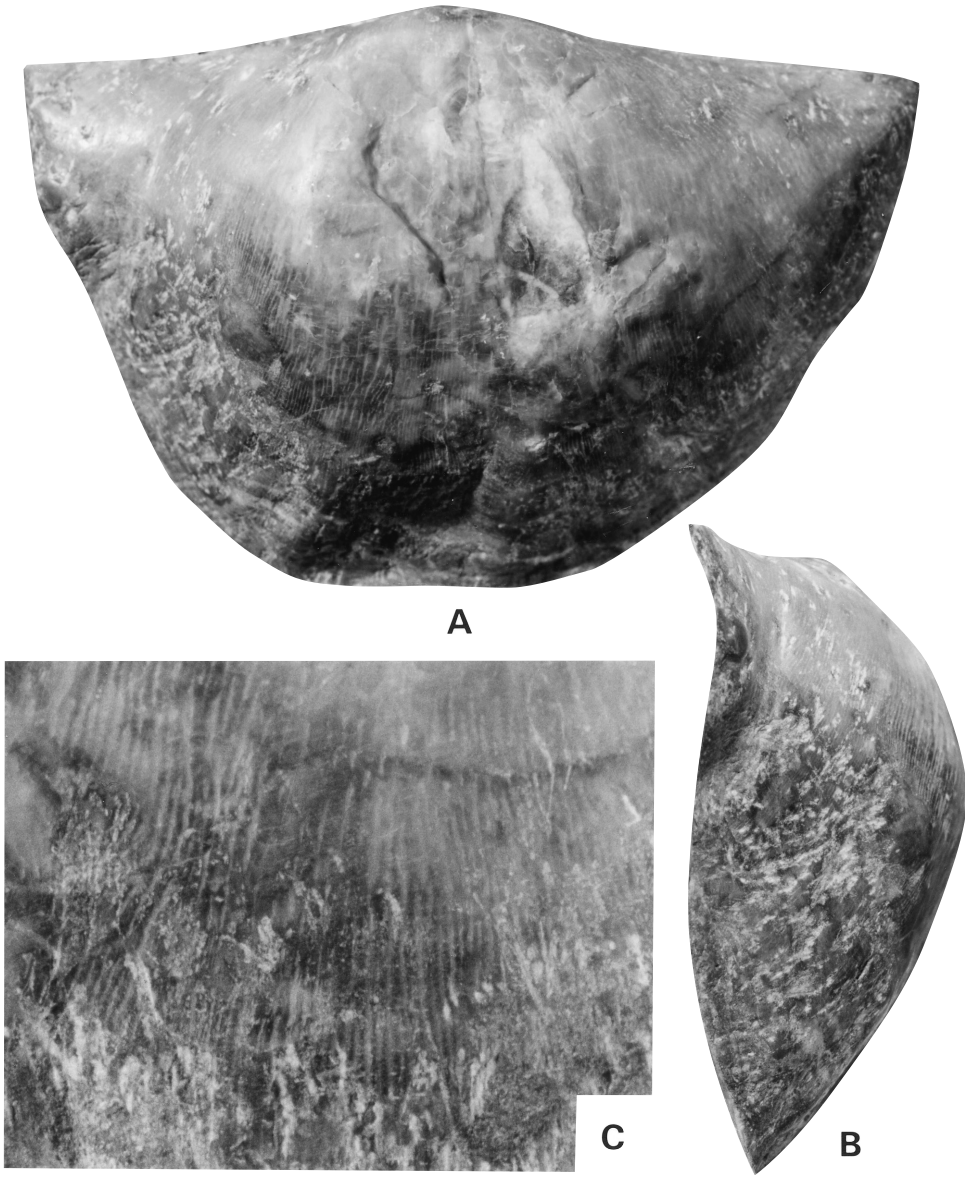

Fig. 4. *Daviesiella omiensis* Tazawa, sp. nov. A ventral valve specimen, from the Upper Visean basaltic tuff of Omi, FMM1341, A: ventral view (× 1), B: lateral view (× 1), C: enlargement of shell surface, showing numerous costellae (× 3).

sulcus, and in having coarser costellae, numbering 16-17 per 10 mm.

Distribution.—Lower Carboniferous (Upper Visean); Akiyoshi, southwest Japan and Omi, central Japan.

Family Daviesiellidae Sokolskaya, 1960
Genus *Daviesiella* Waagen, 1884

Daviesiella omiensis Tazawa, sp. nov.
Figs. 4A-4C.

Material.—One specimen (holotype), from locality OM-02, a ventral valve, FMM1341.

Diagnosis.—Large *Daviesiella*, with prominent ears and shallow sulcus on ventral valve.

Description.—Shell large size for genus, transversely semicircular in outline, with greatest width at hinge; length 82 mm, width 123 mm in the holotype (FMM1341). Ventral valve moderately and unevenly convex in lateral profile, strongly convex on umbonal slope and slightly convex on anterior half of valve; interarea and pseudodeltidium invisible; umbo small; ears large, prominent, but not clearly differentiated from visceral part; sulcus narrow and shallow on anterior half of valve. External ornament of ventral valve consisting of numerous costellae; numbering 18-20 per 10 mm at 10 mm from anterior margin of valve.

Interior of ventral valve and both exterior and interior of dorsal valve are unknown.

Remarks.—This specimen can be assigned to the genus *Daviesiella* by its strongly inflated ventral valve, lacking developed interarea, and ornamented with numerous costellae. The specimen of Omi seems to be a new species of *Daviesiella* in having shallow sulcus and prominent ears on the ventral valve. The new species is named *Daviesiella omiensis*, for its locality Omi, west of Niigata Prefecture, central Japan.

Daviesiella derbiensis Cope, 1940, described by Cope (1940, p. 208) from the Middle Visean of Derbyshire, central England resembles the present species in having shallow ventral sulcus, but the former differs from the latter in its less transverse outline.

Daviesiella llangollensis (Davidson, 1863), the type species of *Daviesiella*, originally described by Davidson (1863, p. 277) from the Lower Carboniferous (Upper Visean) of Llangollen, Denbighshire, northern Wales, differs from *D. omiensis* in having smaller ears and lacking sulcus on the ventral valve.

Distribution.—Lower Carboniferous (Upper Visean) of Omi, central Japan.

Acknowledgements

We thank I. Niikawa (Niigata University) for critical reading of the manuscript; A.M. Popov (Far Eastern Geological Institute, Vladivostok) and Z.Q. Chen (The University of Western Australia) for sending copies of some references; Y. Hasegawa (Emeritus professor of Niigata University) for discussion on the geology of the Omi area.

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