Brachiopods from the Upper Permian Takakurayama Formation, Abukuma Mountains, northeast Japan

Jun-ichi TAZAWA*

Abstract

A brachiopod fauna, consisting of 26 species in 20 genera, is described from the Upper Permian (Lopingian) Takakurayama Formation of the Takakurayama area in the Abukuma Mountains, South Kitakami Belt, northeast Japan. This fauna includes two new species, *Chonetinella iwakiensis* and *Chonetinella transversa*. The Takakurayama fauna is a Boreal-Tethyan mixed fauna and allied with the Middle to Late Permian brachiopod faunas of North China (Inner Mongolia), Northeast China (Heilongjiang and Jilin), eastern Russia (South Primorye), northeast Japan (southern Kitakami Mountains in the South Kitakami Belt), central Japan (Moribu in the Hida Gaien Belt) and southwest Japan (Mizukoshi in the Hida Gaien Belt). These regions were probably located within a large continuous sedimentary basin on continental shelf or slope bordering the northern and eastern margins of North China in the Middle to Late Permian.

Key words: Abukuma Mountains, Boreal-Tethyan mixed fauna, Brachiopoda, Takakurayama, Upper Permian.

Introduction

The Takakurayama area, Iwaki City, Fukushima Prefecture in the Abukuma Mountains, South Kitakami Belt, northeast Japan is one of the famous Permian fossil localities in Japan (Fig. 1). On the brachiopods, 21 species have hitherto been described by Yanagisawa (1967) and Nakamura (1972), and 26 species have been listed by Kobiyama (1956) and Koizumi (1979). However, most of the Permian brachiopods from the Takakurayama area need to be revised in light of new taxonomy.
In the period of 1986-2005, I surveyed in the Takakurayama area and collected a large number of Permian brachiopod fossils with the help of two students (at that time) N. Kaneko and S. Hasegawa; and we clarified the Permian stratigraphy of this area (Tazawa et al., 2005). The brachiopod fossils occur from sandy shale or calcareous shale of three horizons in the lower and upper parts of the Takakurayama Formation. In this paper, the Permian brachiopods of 26 species in 20 genera, including two new species *Chonetinella iwakiensis* and *Chonetinella transversa*, are described.

All of the brachiopod specimens described in this paper are housed in the following institutions, as indicated by the prefixes assigned to the registered specimen numbers: IGPS, Tohoku University Museum in Sendai; NU-B, Department of Geology, Faculty of Science, Niigata University in Niigata.

**Fig. 1.** Index map showing the fossil localities T₁, T₇, and T₈ in the Takakurayama area. Using the topographical map of “Yotsukura” scale 1:25,000 published by the Geographical Survey Institute of Japan.
Stratigraphy

The Takakurayama Formation, named by Onuki (1966), is exposed in the northeastern slope of Mt. Takakurayama, dipping 30-45° W and striking in a general NNE-SSW direction, and occupying the area of about 0.5 km (E-W) × 6 km (N-S). It consists mostly of black shale with subordinate sandstone and conglomerate, more than 805 m in total thickness (Fig. 2). This formation is subdivided into the following three members: the Iriishikura Member, consisting mostly of shale with some sandstone beds, 290 m thick; the Motomura Member, consisting of sandstone and conglomerate with some shale beds, 167 m thick; and the Kashiwadaira Member, consisting mostly of shale with some sandstone and conglomerate beds, 348 m thick, in ascending order. These members are approximately equal to the Iriishikura, Motomura and Kashiwadaira Formations of Yanagisawa and Nemoto (1961), respectively. The brachiopod fossils treated in this paper were collected from sandy shale or calcareous shale of the lower part (Iriishikura Member) and the upper part (Kashiwadaira Member) of the Takakurayama Formation. The locations, horizons and lithology of fossil localities T₁, T₇, and T₈, named by Yanagisawa (1967), are as follows:

T₁: Upperstream of B-sawa (37° 7’59”N, 140° 55’8”E), a tributary of the Sodetamayamagawa River. Dark grey sandy shale of the lower part of the Takakurayama Formation (about 30 m below from the base of the Motomura Member).

T₇: Upperstream of G₂-sawa (37° 8’43”N, 140° 55’8”E), a tributary of the Sodetamayamagawa River. Dark grey sandy shale and calcareous shale of the upper part of the Takakurayama Formation (about 100 m above from the base of the Kashiwadaira Member).

T₈: Midstream of H-sawa (37° 9’5”N, 140° 55’16”E), a tributary of the Sodetamayamagawa River. Dark grey sandy shale of the upper part of the Takakurayama Formation (about 67 m below from the top of the formation).

Lithologically, the black shale of the Takakurayama Formation is similar to that of the Upper Permian Toyoma Formation (Onuki, 1969; Tazawa, 1988) in the southern Kitakami Mountains, and the conglomerate of this formation is correlated with the Usuginu-type conglomerate (Kano, 1971), which is widely distributed in the Upper Permian of Japan.

The Takakurayama fauna

The brachiopod fauna described herein includes the following 26 species assigned to 20 genera (Table 1): *Chonetinella krotovi* (Fredericks, 1925), *Chonetinella iwakiensis* sp. nov., *Chonetinella transversa* sp. nov., *Dyoros* (*Dyoros*) sp., *Haydenella* sp., *Lamnimargus peregrinus* (Fredericks, 1924), *Transennatia gratiosa* (Waagen, 1884), *Costatumulus* cf.

**Age and Correlation**

The Takakurayama fauna contains various brachiopod species of Early Permian (Asselian) to Late Permian (Changhsingian). It is noteworthy that this fauna consists mostly of the Middle Permian (Wordian-Capitanian) species, but it includes some species of Late Permian (Lopingian) elements, such as *Chonetinella transversa* and *Derbyia schellwieni* (see Table 1). Moreover, *Costatumulus cf. tazawai* is close to *Costatumulus tazawai* Shen, Archbold, Shi

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**Fig. 2.** Generalized columnar section of the Takakurayama Formation in the Takakurayama area, showing the horizons of T₁ (with brachiopod, gastropod and cephalopod by Yanagisawa, 1967), T₇ and T₈ and other fossil horizons of fusulinoideans (Murata, 1964; Ueno, 1992). Adapted from Tazawa et al. (2005).
Table 1. Provincial types, fossil localities (T₁, T₇, and T₈), and geographical and stratigraphical distributions of brachiopods of the Takakurayama fauna. Open circle is the Boreal (bipolar) species, and solid circle is the Tethyan species.

<table>
<thead>
<tr>
<th>Species</th>
<th>Takakurayama</th>
<th>Japan</th>
<th>Other regions</th>
<th>Stage</th>
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<tbody>
<tr>
<td>Chonetinella krotovi (Fredericks)</td>
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<tr>
<td>Chonetinella iwakii sp. Tazawa sp. nov.</td>
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<td>Chonetinella transversa Tazawa sp. nov.</td>
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<td>Dyros (Dyrose) sp.</td>
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<td>Haydenella sp.</td>
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<td>Laminarinus sphyricus (Fredericks)</td>
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<td>Transennalia gratiosa (Waagen)</td>
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<td>Costatumulus cf. tazawai Shen, Archbold, Shi &amp; Chen</td>
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<td>Anisanthus ussuricus (Fredericks)</td>
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<td>Terrakes sp.</td>
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<td>Yakulevia mammatiformis (Fredericks)</td>
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<td>Olshamiia cf. ianyangensis Chen</td>
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<td>Derbyia schelliowi Frech</td>
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<td>Derbyia? sp.</td>
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<td>Stenoscisma margaritii (Tschernyschew)</td>
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<td>Rhynchopora sp.</td>
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<td>Hustedia grandicosta (Davidson)</td>
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<td>Martina semiplana Waagen</td>
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<td>Martina latu Grabau</td>
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<td>Martina sp.</td>
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<td>Gypospirifer volatilis Duan &amp; Li</td>
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<tr>
<td>Spiniferella saranae (de Verneuil)</td>
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<td>Spiniferella? sp.</td>
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<td>Alispiniferella litu (Fredericks)</td>
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<td>Eltina tibetana (Deiner)</td>
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<tr>
<td>Cathaysporina sp.</td>
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and Chen from the Upper Permian (Wuchiapingian) of southern Xizang (Tibet); and *Oldhamina* cf. *lianyangensis* resembles *Oldhamina lianyangensis* Chan from the Upper Permian (Changhsingian) of Guangdong, South China.

The brachiopod fossils as like as the other animal and plant fossils, such as bivalves, ammonoids, trilobites and land plants, occur as reworked fossils (Tazawa et al., 2005). Therefore, the age of the fossil-bearing beds is a Late Permian (Lopingian), probably a Wuchiapingian age, although the Takakurayama fauna consists mostly of the Middle to Late Permian elements. A gastropod *Bellerophon* from the locality T1, lower part of the Takakurayama Formation (Yanagisawa, 1967) indicates that this horizon is probably correlated with the *Bellerophon* Zone (Onuki, 1969) of the Upper Permian Toyoma Formation in the southern Kitakami Mountains.

Consequently the age of the whole of the Takakuraya Formation is assigned to be Late Permian (Lopingian), although previous authors considered that the whole Takakurayama Group (=Takakurayama Formation) is correlated with the Lower to Middle Permian (Yanagisawa and Nemoto, 1961), the Middle Permian (Onuki, 1966; Ueno, 1992) and the Lower to Upper Permian (Yanagisawa, 1967).

**Palaeobiogeography**

The Takakurayama fauna contains many Boreal type (including bipolar or antitropical-type) brachiopods: *Chonetinella krotovi*, *Dyoros (Dyoros)* sp., *Lamnimargus peregrinus*, *Costatumulus* cf. *tazawai*, *Anidanthus ussuricus*, * Terrakea* sp., *Yakovlevia mammatiformis*, *Stenosisma margaritovi*, *Rhynchopora* sp., *Gypospirifer volatilis*, *Spiriferella saranae*, *Alispiriferella lita* and *Elivina tibetana*. This fauna contains also minor but several Tethyan-type species: *Haydenella* sp., *Transennatia gratiosa*, *Oldhamina* cf. *lianyangensis*, *Derbyia schellwieni* and *Cathaysia spirina* sp. In addition to the above species, some cosmopolitan species are present in this fauna: *Hustedia grandicosta*, *Martinia semiplana* and *Martinia lata*.

To sum up the Takakurayama fauna is a Boreal elements predominant Boreal-Tethyan mixed fauna in the Middle to Late Permian. In generic and specific composition, the Takakurayama fauna is close to the Middle to Late Permian brachiopod faunas of North China (Inner Mongolia), Northeast China (Heilongjiang and Jilin), eastern Russia (South Primorye), northeast Japan (southern Kitakami Mountains in the South Kitakami Belt), central Japan (Moribu in the Hida Gaien Belt) and southwest Japan (Mizukoshi in the Hida Gaien Belt) (see Table 1).

This conclusion supports the Permian reconstruction by Tazawa (2000, 2007), in which the South Kitakami region was located at the eastern margin of North China (Sino-Korea) in the middle latitude area of the Northern Hemisphere. Furthermore, the Permian reconstruction is very evidence for the strike-slip model proposed by Tazawa (1993, 2004), which describes that the South Kitakami region including the Takakurayama area was located at the eastern margin of North China in the Ordovician to Late Jurassic, and it moved to the north about
1,500-2,000 km by sinistral strike-slip faulting along the Tanakura-Median Tectonic Line in the Early Cretaceous to Palaeogene time.

**Systematic descriptions**

Order Productida Sarytcheva and Sokolskaya, 1959  
Suborder Chonetidina Muir-Wood, 1955  
Superfamily Chonetoidea Bronn, 1862  
Family Rugosochonetidae Muir-Wood, 1962  
Subfamily Rugosochonetinae Muir-Wood, 1962  
Genus *Chonetinella* Ramsbottom, 1952

*Chonetinella krotovi* (Fredericks, 1925)  
Figs. 3.1a-3.7

*Chonetes* (*Chonetina*) *krotovi* Fredericks, 1925, p. 6, pl. 1, figs. 54-57.  
*Chonetina substrophomenoides* forma A Shimizu, 1961, p. 317, pl. 16, figs. 11-14.  
*Chonetes uralicus* Moeller: Yanagisawa, 1967, p. 86, pl. 1, fig. 11.  
*Waagenites* aff. *striata* Liao: Yanagida, 1996, figs. 2.10a, 2.10b.

**Material.**—Twenty-two specimens, from locality T;: (1) internal and external moulds of two ventral valves, NU-B1122 (holotype), 1123; (2) external casts of two ventral valves, NU-B1124, 1125; (3) internal moulds of six ventral valves, IGPS8645, NU-B1126-1130; (4) external and internal moulds of a dorsal valve, NU-B1131; (5) external moulds of seven dorsal valves, NU-B1132-1138; (5) internal moulds of four dorsal valves, NU-B1139-1142.

**Description.**—Shell small for genus, length and width about equal, subquadrate in outline, with greatest width at hinge; length 6 mm, width 8 mm in the holotype (NU-B1122); length 7 mm, width about 8 mm in the largest ventral valve specimen (NU-B1126). Ventral valve strongly convex in both lateral and anterior profiles; umbo small, incurved; ears large, trigonal shape, well defined and slightly convex; sulcus deep, narrow, bordered by a pair of high and slightly diverging lateral ridges which broaden anteriorly. External surface of ventral valve ornamented by numerous capillae on whole of valve but obscure on posterior half of ears; capillae numbering 8-9 in 2 mm at anterior margin. Dorsal valve with distinct fold corresponding to ventral sulcus; surface ornament consisting of numerous capillae, numbering 8-9 in 2 mm at anterior margin.

Internally, ventral valve having laterally elongated teeth; short and low median septum. Dorsal valve having small bilobed cardinal process with relatively large alveolus. Endospines in radial rows on both valves.

**Remarks.**—These specimens are referred to *Chonetinella krotovi* (Fredericks, 1925, p. 6,
pl. 1, figs. 54-57) from the Middle Permian Chandalaz Formation of the Vladivostok area, South Primorye, eastern Russia, in size and shape of the shell and in having highly developed ridges bordering the ventral sulcus.

*Chonetinella granti* Waterhouse 1981 (= *Chonetinella* sp. Grant, 1976, p. 79, pl. 17, figs. 23-28), from the Rat Buri Limestone of Khao Chang, southern Thailand, is close to *Chonetinella krotovi*, but it differs from the latter by its less acute cardinal extremities and much lower ridges bordering the ventral sulcus.

One of the Takakurayama specimens (IGPS86645) was described by Yanagisawa (1967) as *Chonetes uralicus* Moeller [= *Chonetinella uralica* (Moeller)], but the Russian species is larger and much transverse species (see Tschernyschew, 1902, pl. 63, figs. 4, 6).

Shells of *Chonetes substrophomenoides* forma A, described by Shimizu (1961) from the Upper Permian Maizuru Group of the Maizuru Belt, southwest Japan, and *Waagenites aff. striata* Liao, figured by Yanagida (1996) from the Upper Permian Tsunemori Formation of the Akiyoshi Belt, southwest Japan, are referred to *Chonetinella krotovi* by their size, outline and surface ornament of both valves.

**Distribution.**—Middle Permian (Wordian-Capitanian) of eastern Russia (South Primorye); Upper Permian (Lopingian) of northeast Japan (Takakurayama in the South Kitakami Belt) and southwest Japan (Kawahigashi in the Maizuru Belt and Tsunemori in the Akiyoshi Belt).

*Chonetinella iwakiensis* sp. nov.

Figs. 3.8a-3.14

**Etymology.**—Fossil locality Iwaki City, Fukushima Prefecture.


**Material.**—Eleven specimens, from locality T7: (1) external and internal moulds of a ventral valve, NU-B1143 (holotype); (2) external moulds of two ventral valves, NU-B1144, 1145; (3) internal moulds of eight ventral valves, IGPS86644A, 86644C, NU-B1146-1151.

**Diagnosis.**—Large, transverse *Chonetinella*, with moderately convex ventral valve having shallow and narrow sulcus, and ornamented by numerous capillae, numbering 7-8 in 2 mm near anterior margin.

**Description.**—Shell large for genus, transversely subrectangular in outline, with greatest width near hinge; length about 10 mm, width about 17 mm in the holotype (NU-B1143). Ventral valve moderately convex in lateral profile; umbo small, blunt, overhanging hingeline a little; ears large, slightly convex; sulcus shallow and narrow in most of specimens, but obscure in some specimens. External surface of ventral valve ornamented by numerous capillae, numbering 7-8 in 2 mm near anterior margin; hinge spines distinct, curved. Interior
of ventral valve with short median septum posteriorly. Other internal structures not preserved.

Remarks.—The specimens from Takakurayama somewhat resemble Chonetinella uralica (Moeller) from the Lower Permian of the Urals in outline of the ventral valves, but the Russian species is larger in size and having more distinct ventral sulcus (see Tschernyschew, 1902, pl. 63, figs. 4, 6).

Chonetinella andamanensis Waterhouse (1981, p. 65, pl. 2, figs. 18, 19; pl. 3, figs. 1-18), from the Lower Permian (upper Sakmarian) of Ko Yao Noi, southern Thailand, is also a large transverse species, but it differs from Chonetinella iwakiensis sp. nov. in having deeper and broader ventral sulcus.

Some of the Takakurayama specimens (IGPS86644A, 86644C) were described by Yanagisawa (1967) as Chonetes blanfordi lata Hayasaka. However, Chonetes blanfordi var. lata Hayasaka (1925, p. 92, pl. 5, figs. 3, 4) from the Middle Permian Kanokura Formation of the Imo area, South Kitakami Belt is clearly distinguished from the present new species by its much larger size.

Distribution.—Upper Permian (Lopingian) of northeast Japan (Takakurayama in the South Kitakami Belt).

Chonetinella transversa sp. nov.
Figs. 3.15-3.17

Etymology.—Latin, transverse, transversely.


Material.—Seven specimens, from localities T1, T1, internal moulds of seven ventral valves, NU-B1152 (holotype, from locality T1) -1158.

Diagnosis.—Medium, transverse Chonetinella, with deep, broad ventral sulcus, ornament of numerous capillae and weak growth lines.

Description.—Shell medium size for genus, transversely subrectangular in outline, widest at hinge; length about 5 mm, width about 10 mm in the holotype (NU-B1152). Ventral valve highly elevated in visceral area; ears large, trigonal, nearly flat; sulcus deep, broaden anteriorly. External ornament consisting of numerous capillae and weak growth lines, although they are not clearly preserved. Interior of ventral valve with thick and short median septum; endospines numerous, arranging in radial rows.

Remarks.—These specimens are safely assigned to the genus Chonetinella by their small, highly convex ventral valve with deep sulcus and strong median septum. The Takakurayama species is named here as Chonetinella transversa sp. nov. The new species is readily distinguished from the above-described species, Chonetinella iwakiensis sp. nov., by its deeper and broader ventral sulcus and more acute cardinal extremities.
The shells, described by Shimizu (1961) as *Chonetina substrophomenoides* forma B Shimizu, 1961 from the Upper Permian (Changhsingian) Maizuru Group of the Maizuru Belt, southwest Japan are referred to *Chonetinella transversa* sp. nov. in the similarity of size and shape of the ventral valve.

*Chonetinella substrophomenoides* (Huang, 1932, p. 3, pl. 1, figs. 3-7) from the Upper Permian (Changhsingian) of Guizhou, south China differs from the present new species by its less transverse shell.

**Distribution.**—Upper Permian (Lopingian) of northeast Japan (Takakurayama in the South Kitakami Belt) and southwest Japan (Kawahigashi in the Maizuru Belt).

Subfamily Svalbardiinae Archbold, 1982
Genus *Dyoros* Stehli, 1954
Subgenus *Dyoros* (*Dyoros*) Stehli, 1954

**Dyoros** (*Dyoros*) sp.
Figs. 3.18, 3.19

**Material.**—Three specimens, from localities T1 and T7, internal moulds of three ventral valves, NU-B1119-1121.

**Remarks.**—The ventral valve specimens from Takakurayama are safely assigned to the subgenus *Dyoros* (*Dyoros*) by their transverse shells (length about 7 mm, width about 14 mm in the larger specimen, NU-B1120), wide hinge, large, angular ears, deep sulcus and visceral region fringed by strong spines on anterolateral side. These specimens are closely similar to *Dyoros aff. transversus* Cooper and Grant, described by Kalashnikov (1993, p. 28, pl. 10, figs. 8, 9) from the Lower Permian (Artinskian) of Pai-Khoi, northern Russia in size and outline of the ventral valve. The present specimens are, however, too imperfect for comparison.

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**Fig. 3.** 1a-7: *Chonetinella krotovi* (Fredericks), 1a, 1b, 1c, 1d: external mould, external latex cast, internal mould and internal latex cast of ventral valve, NU-B1122, 2: internal mould of dorsal valve, NU-B1141, 3: external mould of dorsal valve, NU-B1132, 4: external mould of dorsal valve, NU-B1136, 5: internal mould of ventral valve, IGPS86645, 6a, 6b: internal mould and internal latex cast of dorsal valve, NU-B1140, 7: external cast of ventral valve, NU-B1124. 8a-14: *Chonetinella iwakiensis* sp. nov., 8a, 8b, 8c: external mould, internal mould and external latex cast of ventral valve, NU-B1143 (holotype), 9a, 9b: external mould and external latex cast of ventral valve, NU-B1145, 10: internal mould of ventral valve, NU-B1147, 11: internal mould of ventral valve, IGPS86644C, 12a, 12b: external mould and external latex cast of ventral valve, NU-B1144, 13: internal mould of ventral valve, NU-B1148, 14: internal mould of ventral valve, IGPS86644A. 15-17: *Chonetinella transversa* sp. nov., 15: internal mould of ventral valve, NU-B1156, 16a, 16b: internal mould and internal latex cast of ventral valve, NU-B1158, 17: internal mould of ventral valve, NU-B1152 (holotype). 18, 19: *Dyoros* (*Dyoros*) sp., 18: internal mould of ventral valve, NU-B1119, 19: internal mould of ventral valve, NU-B1120. 20a, 20b: *Haydenella* sp., ventral and lateral views of internal mould of ventral valve, NU-B1077. 21a-23b: *Hustedia grandicosta* (Davidson), 21a, 21b: ventral and dorsal views of internal mould of conjoined valve, NU-B1092, 22a, 22b, 22c, 22d: ventral and dorsal views of internal mould of conjoined valve, external latex cast of ventral valve and external latex cast of dorsal valve, NU-B1087. (All × 2).
Dyoros (Dyoros) transversus Cooper and Grant (1975, p. 1239, pl. 486, figs. 28-67; pl. 487, figs. 1-17; pl. 501, figs. 1-4) from the Upper Leonardian of West Texas is also similar in outline, but the American species is much larger in size.

Suborder Productidina Waagen, 1883
Superfamily Productoidea Gray, 1840
Family Productellidae Schuchert, 1929
Subfamily Productininae Muir-Wood and Cooper, 1960
Tribe Chonetellini Licharew in Sarytcheva, Licharew and Sokolskaya, 1960
Genus Haydenella Reed, 1944

Haydenella sp.
Figs. 3.20a, 3.20b

Material.—One specimen, from locality T1, internal mould of a ventral valve, NU-B1077.

Description.—Shell small for genus, transverse subelliptical in outline, widest at hinge; length about 10 mm, width about 15 mm. Ventral valve strongly and unevenly convex in lateral profile, most convex at umbonal region, slightly convex on anterior half of valve, not geniculated; strongly and evenly convex in anterior profile, with nearly flattened venter and steeply inclined lateral slopes; umbo small, tapering and scarcely projecting over hinge; ears small. External surface of ventral valve nearly smooth, faintly costellate; a row of spine bases at base of ears; numerous fine pits scattered over anterior two-thirds of valve. Internal structures of ventral valve are obscure in the present material.

Remarks.—The single ventral valve specimen from Takakurayama may be a new species of Haydenella. This specimen most resembles the shell, described as Linoproductus kiangsiensis (Kayser) by Shimizu (1961, p. 326, pl. 15, figs. 16, 17) from the Upper Permian Maizuru Group in the Maizuru Belt, southwest Japan in size and outline of the ventral valve. But the poor preservation of the present material makes accurate comparison difficult.

The type species, Haydenella kiangsiensis (Kayser, 1883, p. 185, pl. 26, figs. 6-11) from the Upper Permian of Loping, Jiangxi, South China differs from the Takakurayama species in its larger dimensions.

Haydenella minuta Sarytcheva (in Ruzhentsev and Sarytcheva, 1965, p. 228, pl. 38, figs. 10a-11b) from the Dzulfian and Induan Stages of Transcaucasia differs from the present species by its much smaller and longer shell.

Subfamily Marginiferinae Stehli, 1954
Tribe Paucispiniferini Muir-Wood and Cooper, 1960
Genus Lamnimargus Waterhouse, 1975
Lamnimargus peregrinus (Fredericks, 1924)
Figs. 4.2a-4.4

Paramarginifera peregrina Fredericks, 1924, p. 24, pl. 1, figs. 7, 8; Fredericks, 1925, p. 12, pl. 1, figs. 41-44.

Dictyoproductus zesiensis Lee and Gu, 1976, p. 256, pl. 167, figs. 5, 6; pl. 170, figs. 1a, 1b.

Probolonia caucasica peregrina (Fredericks): Licharew and Kotlyar, 1978, pl. 12, figs. 13, 14.

Paramarginifera? peregrina Fredericks: Duan and Li, 1985, p. 112, pl. 42, figs. 1-7; Lee et al., 1980, p. 356, pl. 166, figs. 18, 28.

Lamnimargus himalayensis (Diener): Kotlyar in Kotlyar and Zakharov, 1989, pl. 23, figs. 9a, 9b.

Lamnimargus peregrina (Fredericks): Wang and Zhang, 2003, p. 73, pl. 14, figs. 3, 8, 9; pl. 15, fig. 11; pl. 21, figs. 14-16, 22-24.

Material:—Three specimens, from localities T1, T7: (1) external and internal moulds of a ventral valve, NU-B1191; (2) internal mould of a ventral valve, NU-B1192; (3) external mould of a dorsal valve, IGPS86643.

Description:—Shell medium size for genus, transversely trapezoidal in outline, with greatest width at hinge; length about 16 mm, width about 27 mm in the best preserved specimen (NU-B1191). Ventral valve gently convex on visceral disc, strongly geniculated and followed by two long trails; umbo small, pointed and slightly incurved; ears large, prominent and slightly convex; sulcus deep, broad, originating a little below umbo and extending to anterior margin. External surface of ventral valve ornamented with numerous costellae and strong concentric rugae on both visceral disc and ears, but costellae only on trail; costellae numbering 7 in 5 mm at midvalve. Large spine bases poorly preserved; one row near base of ears, one pair on anterior portion of visceral disc. Interior of ventral valve, with a faint marginal ridge on anterolateral margins of visceral disc. Other internal structures not observed.

Remarks:—These specimens are poorly preserved, but they can be referred to Lamnimargus peregrinus (Fredericks, 1924), originally described from the Middle Permian Chandalaz Formation of the Vladivostok area, South Primorye, eastern Russia, by their size, shape and external ornament of the ventral valve, in particular, the relatively strong reticulate ornament on the visceral disc.

The type species, Lamnimargus himalayensis (Diener, 1899, p. 39, pl. 2, figs. 1-7; pl. 6, figs. 1, 2) from the Upper Permian Kuling Shales of the Punjab Himalayas is distinguished from Lamnimargus peregrinus by its much larger, prominent ears and coarser costellae on the ventral valve.

Lamnimargus japonicus (Tazawa, 1975, p. 636, pl. 2, figs. 3-6; pl. 3, figs. 1-4) from the Upper Permian (Changhsingian) of the Nabekoshiyama area, South Kitakami Belt, northeast Japan differs from the present species by its smaller size and finer reticulate ornament on the ventral valve.
**Distribution.**—Middle Permian (Wordian-Capitanian) of North China (Inner Mongolia), Northeast China (Heilongjiang), eastern Russia (South Primorye); Upper Permian (Lopingian) of eastern Russia (South Primorye) and northeast Japan (Ofunato and Takakurayama in the South Kitakami Belt).

**Genus Transennatia Waterhouse, 1975**

*Transennatia gratiosa* (Waagen, 1884)

Figs. 4.1

*Productus gratiosus* Waagen, 1884, p. 691, pl. 72, figs. 3-7; Rothpletz, 1892, p. 76, pl. 10, figs. 15, 15a-15c; Diener, 1897, p. 23, pl. 3, figs. 3-7; Mansuy, 1913, p. 115, pl. 13, figs. 1a, 1b; Broili, 1916, p. 12, pl. 116, figs. 4, 5, 7-13; Colani, 1919, p. 10, pl. 1, figs. 2a-2c; Chao, 1927, p. 44, pl. 4, figs. 6-10; Chi-Thuan, 1962, p. 491, pl. 2, figs. 5-7.

*Productus (Dictyoclostus) gratiosus* Waagen: Huang, 1933, p. 88, pl. 11, figs. 14a, 14b; Hayasaka, 1960, p. 49, pl. 1, fig. 8.

*Marginifera gratiosa* (Waagen): Reed, 1944, p. 98, pl. 19, figs. 6-7a.


*Gratiosina gratiosa* (Waagen): Grant, 1976, pl. 33, figs. 19-26; Licharew and Kotlyar, 1978, pl. 12, figs. 5, 6; pl. 20, figs. 1a, 1b; Minato et al., 1979, pl. 61, figs. 11-13.

*Asioproductus gratiosus* (Waagen): Yang et al., 1977, p. 350, pl. 140, figs. 5a-5c; Feng and Jiang, 1978, p. 254, pl. 90, figs. 1a-2; Tong, 1978, p. 228, pl. 80, figs. 7a, 7b; Lee et al., 1980, p. 373, pl. 164, figs. 14a-14c; pl. 166, figs. 5-6b.

*Asioproductus bellus* Chan (Zhan), 1979, p. 85, pl. 6, figs. 7-13; pl. 9, figs. 8-10; text-fig. 18.

*Gratiosina* sp. Minato et al., 1979, pl. 61, fig. 14; Tazawa, 1991, p. 215.

*Transennatia gratiosa* (Waagen): Liu et al., 1982, p. 185, pl. 132, figs. 9a-9d; Wang et al., 1982, p. 214, pl. 92, figs. 6-8; pl. 102, figs. 4-9; Ding and Qi, 1983, p. 280, pl. 95, figs. 14a, 14b.

*Transennatia gratiosa* (Waagen): Yang, 1984, p. 219, pl. 33, figs. 7a-7c; Jin, 1985, pl. 4, figs. 33, 34, 45, 46; Tazawa and Matsumoto, 1998, p. 6, pl. 1, figs. 4-8; Tazawa et al., 2000, p. 7, pl. 1, figs. 3-5; Tazawa and Ibaraki, 2001, p. 7, pl. 1, figs. 1-3; Tazawa, 2001, p. 289, figs. 6.1-6.7; Shen et al., 2002, p. 676, figs. 4.27-4.31; Tazawa, 2002, fig. 10.2; Tazawa, 2008c, p. 43, figs. 6.6a-6.7b.

**Material.**—One specimen, from locality T7, external cast of a ventral valve, NU-B1076.

**Remarks.**—The single specimen from Takakurayama can be referred to *Transennatia gratiosa* (Waagen, 1884) by its transversely subquadrate, strongly convex, small-sized ventral valve (length 11 mm, width 18 mm), with distinct and pointed ears, and fine, reticulate ornament on venter. This specimen is smaller than the type specimens from the Wargal and Chhidru...
Formations of the Salt Range (Waagen, 1884, pl. 72, figs. 3-7), but it is similar in size to the relatively smaller specimens of *T. gratiosa*, from the Middle Permian of the South Kitakami Belt, northeast Japan (Hayasaka, 1960; Tazawa et al., 2000; Tazawa and Ibaraki, 2001), the Hida Gaien Belt, central Japan (Tazawa and Matsumoto, 1998; Tazawa, 2001), South Primorye, eastern Russia (Licharew and Kotlyar, 1978) and Northeast China (Lee et al., 1980).

**Distribution.**—Middle Permian (Wordian-Capitanian) of North China (Shaanxi), Northeast China (Heilongjiang and Jilin), eastern Russia (South Primorye), central Japan (Moribu and Oguradani in the Hida Gaien Belt), South China (Guangxi) and Cambodia (Sisophon); Middle Permian (Wordian) to Upper Permian (Changhsingian) of northeast Japan (Setamai, Kamiyasse-Imo and Ogatsu in the South Kitakami Belt), South China (Hubei) and Pakistan (Salt Range); Upper Permian (Lopingian) of northeast Japan (Takakurayama in the South Kitakami Belt), East China (Anhui and Zhejiang), South China (Jiangxi, Hunan, Guangdong, Guizhou, Sichuan and Yunnan), Southwest China (Tibet), Nepal (Kumaon Himalayas) and Vietnam (Quang Tri).

**Superfamily Linoproductoidea Stehli, 1954**

**Family Linoproductidae Stehli, 1954**

**Subfamily Linoproductinae Stehli, 1954**

**Genus Costatumulus** Waterhouse, 1983

**Costatumulus cf. tazawai** Shen, Archbold, Shi and Chen, 2000

*Fig. 4.5*

**Compare.**—


**Material.**—One specimen, from locality T7, external mould of a dorsal valve, NU-B1187.

**Remarks.**—The single dorsal valve specimen is small in size (length 19 mm, width about 16 mm), slightly concave and strongly geniculated; external ornament consisting of numerous fine costellae (13-14 in 5 mm at midvalve), strong and slightly undulated concentric rugae and numerous quincuncially arranged elongate dimples. The Takakurayama specimen somewhat resembles the shells of *Costatumulus tazawai* Shen, Archbold, Shi and Chen, 2000, described from the Upper Permian (Wuchiapingian) Selong Group of southern Xizang (Tibet), in size, shape and surface ornament of the dorsal valve. But the accurate comparison is difficult for lacking information of the ventral valve.

The type species *Costatumulus tumida* (Waterhouse, 1983) from the Lower Permian (Artinskian) Tiverton Formation of the Bowen Basin, eastern Australia differs from *C. tazawai* by its much larger size and the lower and weak concentric rugae on the dorsal valve.
Subfamily Anidanthinae Waterhouse, 1968b
Genus Anidanthus Hill, 1950

Anidanthus ussuricus (Fredericks, 1924)
Figs. 4.6-4.11

Productus ussuricus Fredericks, 1924, p. 8, pl. 1, figs. 1-5; Fredericks, 1925, p. 18.
Linoproductus cf. lineatus (Waagen): Yanagida, 1963, p. 74, pl. 10, figs. 8-14.
Productus cora d’ Orbigny: Yanagisawa, 1967, p. 87, pl. 1, fig. 4.
Anidanthus abukumaensis: Yanagisawa, 1967, p. 89, pl. 2, fig. 16.
Anidanthus ussuricus (Fredericks): Nakamura, 1972, p. 434, pl. 1, figs. 1a-1c; Grigorjeva and Kotlyar, 1977, p. 56, pl. 5, figs. 1-3; text-fig. 34; Licharew and Kotlyar, 1978, pl. 13, figs. 5a-5g; Lee et al., 1980, p. 379, pl. 170, figs. 5, 9; Duan and Li, 1985, p. 113, pl. 38, figs. 6-9; Gu, 1992, p. 236, pl. 69, figs. 18, 25; pl. 78, figs. 11, 12; pl. 74, figs. 7-8. Tazawa and Hasegawa, 2007, p. 6, figs. 4.1-4.7; Tazawa, 2008c, p. 46, figs. 7.1a-7.5.
Megousia koizumii Nakamura, 1972, p. 438, pl. 2, figs. 1, 4, 5; Tazawa and Gunji, 1982, p. 69, pl. 4, figs. 2a, 2b.
Pseudomarginifera ussuricus (Fredericks): Wang and Zhang, 2003, p. 106, pl. 17, figs. 16-27.

Material.—Eight specimens, from locality T7, external moulds of eight dorsal valves, IGPS86640, 86641, NU-B1080-1085.

Description.—Shell large for genus, transversely subquadrate in outline; hinge straight, equal to greatest width; length about 15 mm, width about 34 mm in the largest dorsal valve specimen (NU-B1082). Dorsal valve slightly concave on venter, strongly geniculated and followed by long trail; ears large, prominent and almost flattened; fold absent. External surface of dorsal valve ornamented by strong concentric lamellae and numerous costellae over visceral disc, some costellae on ears; costellae numbering 8 in 5 mm at midvalve, 11-12 in 5 mm on trail.

Remarks.—These specimens are referred to Anidanthus ussuricus (Fredericks, 1924) from the Middle Permian Chandalaz Formation of the Vladivostok area, South Primorye, on account of size, shape and external ornament of the dorsal valves, in particular, their strong geniculation and having long trail covered by numerous fine costellae.

Yanagisawa (1967) described two productoid shells from the same locality of Takakurayama as Productus cora d’ Orbigny [=Linoproductus cora (d’ Orbigny, 1842)] and Anidanthus abukumaensis Yanagisawa, 1967, but all the specimens can be referred to A. ussuricus.

Distribution.—Middle Permian (Wordian-Capitanian) of North China (Zhesi and Xiujimqinqi, Inner Mongolia), Northeast China (Jilin) and eastern Russia (Vladivostok and Nakhodka, South Primorye); Upper Permian (Lopingian) of northeast Japan (Soma and...
Subfamily Paucispinauriinae Waterhouse, 1986
Genus Terrakea Booker, 1930

Terrakea sp.
Figs. 4.12a, 4.12b

Terrakea sp. A Tazawa, 2008a, p. 63, figs. 2A-2L.

Material.—Two specimens, from locality T_; (1) external and internal moulds of a ventral valve, NU-B1188; (2) internal mould of a conjoined valve, NU-B1189.

Remarks.—These specimens are not well preserved, but can be safely assigned to the genus Terrakea on the basis of its size, shape and external ornament of the ventral valve. The Takakurayama species is close to and identical with Terrakea sp. A, described by Tazawa (2008a, p. 63, figs. 2A-2L) from the lower Kanokura Formation of the South Kitakami Belt, northeast Japan in the small (length about 18 mm, width more than 20 mm in the larger specimen, NU-B1188), strongly convex ventral valve, and the external ornament consisting of numerous costellae (7-8 in 5 mm at the midvalve) and elongate spine bases.

Distribution.—Middle Permian (Wordian) of northeast Japan (Kamiyasse-Imo in the South Kitakami Belt); Upper Permian (Lopingian) of northeast Japan (Takakurayama in the South Kitakami Belt).

Family Yakovleviidae Waterhouse, 1975
Genus Yakovlevia Fredericks, 1925

Yakovlevia mammatiformis (Fredericks, 1926)
Fig. 4.13

Productus mammatiformis Fredericks, 1926, p. 87, pl. 3, figs. 4-6.
Muirwoodia mammatiformis (Fredericks): Solomina, 1960, pl. 12, figs. 7, 8; Kulikov, 1974, p. 89, pl. 3, figs. 6a-6v.
Yakovlevia mammatiformis (Fredericks): Kotlyar, 1961, text-figs. 7, 8; Ustritsky, 1963, p. 12, pl. 2, figs. 6-8; pl. 3, figs. 1-3; Mironova, 1964, p. 97, pl., figs. 14a-14v; Zavodowsky and Stepanov in Zavodowsky et al., 1970, p. 114, pl. 35, figs. 8-10; Ifanova, 1972, p. 119, pl. 6, figs. 15a-16; pl. 7, figs. 1a-2; Kalashnikov, 1983, p. 210, pl. 49, figs. 5, 6, 9; Kalashnikov, 1986, pl. 116, fig. 1; Manankov in Tatarinov et al., 1991, p. 107, pl. 26, figs. 1-3; Kalashnikov, 1993, p. 61, pl. 16, figs. 1-4; Tazawa, 1999, p. 92, fig. 3.6.
Linoproductus cf. mammatus (Keyserling): Yanagisawa, 1967, p. 88, pl. 2, fig. 7.
Material.—One specimen, locality T1, external mould of a dorsal valve, IGPS86649.

Remarks.—This specimen was first described by Yanagisawa (1967, p. 88, pl. 2, fig. 7) as *Linoproductus cf. mammatus* (Keyserling, 1846), and subsequently redescribed by Tazawa (1999, p. 92, fig. 3.6) as *Yakovlevia mammatiformis* (Fredericks, 1926).

Distribution.—Lower Permian (Sakmarian) to Middle Permian (Wordian) of northern Russia (Novaya Zemlya, Pechora Basin, Pah Khoi, northern Urals and Omolon Massif), southern Mongolia, Northwest China (Gansu) and eastern Russia (South Primorye); Upper Permian (Lopingian) of northeast Japan (Takakurayama in the South Kitakami Belt).

Suborder Lyttoniidina Williams, Harper and Grant, 2000
Superfamily Lyttonioidea Waagen, 1883
Family Lyttoniidae Waagen, 1883
Subfamily Lyttoniinae Waagen, 1883
Genus *Oldhamina* Waagen, 1883

*Oldhamina cf. lianyangensis* Chan (Zhan), 1979
Figs. 4.14a-4.15b


Compare.—

*Oldhamina lianyangensis* Chan (Zhan), 1979, p. 92, pl. 12, figs. 11, 12; Xu, 1987, p. 228, pl. 13, fig. 20; pl. 14, fig. 1.

Material.—Two specimens, from localities T7, T8, internal moulds of two ventral valves, IGPS86648, NU-B1079.

Description.—Shell small size for genus; length about 27 mm, width about 29 mm in the larger specimen (IGPS86648); length about 20 mm, width about 16 mm in the smaller specimen.

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Fig. 4. 1: *Transennatia gratiosa* (Waagen), external cast of ventral valve, NU-B1076. 2a-4: *Lamminaragus perigrinus* (Fredericks), 2a, 2b, 2c, 2d, 2e, 2f: ventral and anterior views of external latex cast of ventral valve, and ventral, anterior, posterior and lateral views of internal mould of ventral valve, NU-B1191. 3a, 3b: ventral and anterior views of internal mould of ventral valve, NU-B1192, 4: external mould of dorsal valve, IGPS86643. 5: *Costatumulus cf. tazawai* Shen, Archbold, Shi and Chen, external mould of dorsal valve, NU-B1187. 6-11: *Anidanthus ussuricus* (Fredericks), 6: external mould of dorsal valve, IGPS86640, 7: external mould of dorsal valve, IGPS86641, 8: external mould of dorsal valve, NU-B1085, 9a, 9b, 9c: dorsal, anterior and lateral views of external mould of dorsal valve, NU-B1081, 10a, 10b: dorsal and anterior views of external mould of dorsal valve, NU-B1080, 11: external mould of dorsal valve, NU-B1082. 12a, 12b: *Terrakea* sp., external latex cast and internal mould of ventral valve, NU-B1188. 13: *Yakovlevia mammatiformis* (Fredericks), external mould of dorsal valve, IGPS86649. 14a-15b: *Oldhamina cf. lianyangensis* Chan, 14a, 14b: internal mould and internal latex cast of ventral valve, IGPS86648, 15a, 15b: internal mould and internal latex cast of ventral valve, NU-B1079. (All × 1).
Ventral valve slightly convex in lateral and anterior profiles. Internally ventral valve having a thick median septum and 4-7 symmetrically arranged lateral septa on each side of median septum; lateral septa sharp, inclined anteriorly, and slightly arcuate toward anterior.

Remarks.—These specimens are safely assigned to the genus *Oldhamina* by their sharp and forward-dipping lateral septa. The Takakurayama specimens well resemble *Oldhamina liangyangensis* Chan (Zhan), 1979, originally described from the Upper Permian (Changhsingian) of Guangdong, South China, in their slightly convex ventral valves with nearly straight, symmetrically arranged lateral septa.

Order Orthotetida Waagen, 1884
Suborder Orthotetidina Waagen, 1884
Superfamily Orthotetoidea Waagen, 1884
Family Derbyiidae Stehli, 1954
Genus *Derbyia* Waagen, 1884

*Derbyia schellwieni* Frech, 1911
Figs. 5.16a-5.16d

*Derbyia schellwieni* Frech, 1911, p. 125, pl. 18, figs. 3a-3d; Yang et al., 1977, p. 325, pl. 134, figs. 5a, 5b; Liu et al., 1982, p. 176, pl. 128, figs. 7a, 7b.


Material.—One specimen, from locality T7, external and internal moulds of a ventral valve, IGPS86650.

Description.—Shell medium size for genus, transversely subrectangular in outline; length 29 mm, width more than 33 mm in the sole specimen (IGPS86650). Ventral valve nearly flat, slightly concave and having a low fold posteriorly; external surface with parvicostellate ornament on whole of valve; costellae numbering 11-15 in 10 mm near anterolateral margins; concentric rugae few and irregular. Interior of ventral valve with a strong, short median septum, extending to one fourth of valve length. Other internal structures not observed.

Remarks.—This specimen can be referred to *Derbyia schellwieni* Frech, 1911, from the Upper Permian (Lopingian) of Loping, Jiangxi Province, South China, in its medium-sized transverse shell and fine parvicostellate ornament of the ventral valve.

The present specimen from Takakurayama was first described by Yanagisawa (1967, p. 85) as *Derbyia cf. crassa* (Meek and Hayden), although *Derbyia crassa* (Meek and Hayden) from the Pennsylvanian of Kansas differs from the Takakurayama species by its much smaller size (see Dunbar and Condra, 1932, pl. 3, figs. 1-12; Sutherland and Harlow, 1973, pl. 2, figs. 8-12).

Distribution.—Upper Permian (Wuchiapingian) of South China (Hunan); Upper Permian (Lopingian) of northeast Japan (Takakurayama in the South Kitakami Belt) and South China (Jiangxi).
**Derbyia? sp.**
Figs. 5.15a, 5.15b


**Material.**—One specimen, from locality T7, internal mould of a dorsal valve, IGPS86651.

**Remarks.**—The single dorsal valve specimen from Takakurayama was described by Yanagisawa (1967, p. 87) as *Productus cf. sinensis* (sic) Tschernyschew [=*Productus cf. simensis* Tschernyschew, 1902]. However, the dorsal valve has a large cardinal process fused with strong socket ridges, which is a characteristic internal structure of the superfamily Orthotetoidea Waagen, 1884. The Takakurayama specimen may be a species assigned to the genus *Derbyia* Waagen, 1884, although the specific identification is difficult because of ill-preservation of the present material.

Order Rhynchonellida Kuhn, 1949
Superfamily Stenoscismatoidea Oehlert, 1887
Family Stenoscismatidae Oehlert, 1887
Subfamily Stenoscismatinae Oehlert, 1887
Genus *Stenoscisma* Conrad, 1839

*Stenoscisma margaritovi* (Tschernyschew, 1888)
Fig. 5.1

*Camarophoria margaritovi* Tschernyschew, 1888, p. 355, figs. 1-3; Fredericks, 1924, p. 48, pl. 1, figs. 32-42; text-fig. 4.
*Camarophoria humbletonensis* Howse: Hayasaka, 1922, p. 62, pl. 8, figs. 10-12; pl. 10, fig. 9; Hayasaka, 1966, p. 1226, text-figs. 6-8.
*Stenoscisma humbletonensis* (Howse): Tazawa, 1976, pl. 2, figs. 9, 10; Minato et al., 1979, pl. 66, figs. 6-8.
*Stenoscisma gigantea* (Diener): Lee and Gu, 1976, p. 272, pl. 176, fig. 3; pl. 177, fig. 18; Lee et al., 1980, p. 395, pl. 173, figs. 6, 8.
*Stenoscisma margaritovi* (Tschernyschew): Licharew and Kotlyar, 1978, pl. 17, figs. 7a, 7b; Koczyrkevicz, 1979, p. 50, pl. 11, figs. 5, 6; Duan and Li, 1985, p. 120, pl. 43, figs. 5-8; Tazawa and Matsumoto, 1998, p. 9, pl. 2, figs. 1-5; Tazawa et al., 2000, p. 10, pl. 1, figs. 7-11; Tazawa, 2001, p. 298, figs. 8.1a-8.4; Tazawa, 2002, fig. 10.5; Wang and Zhang, 2003, p. 130, pl. 33, figs. 6-7, 12-16; pl. 50, fig. 19; Tazawa and Chen, 2006, p. 333, figs. 5.7, 5.8.
*Stenoscisma gigantea elongatum* Lee, Gu and Su, 1980, p. 395, pl. 173, figs. 1, 2.
*Stenoscisma purdoni* (Davidson): Lee et al., 1980, p. 395, pl. 173, figs. 4, 5, 7.
**Material.**—One specimen, from locality T7, internal mould of a dorsal valve, NU-B1078.

**Remarks.**—The single specimen from Takakurayama is poorly preserved, but it is safely assigned to the genus *Stenoscisma* by its rhynchonelliform dorsal valve with a spoon-shaped camarophorium supported by short and high median septum. It can be referred to *Stenoscisma margaritovi* (Tschernyschew, 1888), from the Middle Permian of Vladivostok, eastern Russia, on the basis of its medium-sized, transverse dorsal valve (length about 15 mm, width about 23 mm), with strong costae, numbering 6 on fold and 5 on each flank.

**Distribution.**—Middle Permian (Wordian-Capitanian) of North China (Inner Mongolia), Northeast China (Heilongjiang and Jilin), eastern Russia (South Primorye) and Japan (South Kitakami and Hida Gaien Belts); Upper Permian (Lopingian) of northeast Japan (Ogatsu and Takakurayama in the South Kitakami Belt).

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Superfamily Rhynchoporoidea Muir-Wood, 1955  
Family Rhynchoporidae Muir-Wood, 1955  
Subfamily Rhynchoporinae Muir-Wood, 1955  
Genus *Rhynchopora* King, 1865

*Rhynchopora* sp.  
Figs. 5.2a, 5.2b

**Material.**—One specimen, from locality T7, internal mould of a conjoined valve, NU-B1086.

**Remarks.**—This specimen is safely assigned to the genus *Rhynchopora* by its small, transversely subpentagonal shell (length about 10 mm, width about 14 mm), distinct ventral sulcus and dorsal fold, and numerous simple costae on both valves, numbering 4 on fold and 5 on each flank of the dorsal valve. The Takakurayama specimen somewhat resembles *Rhynchopora tchernyshae* Koczyrkevicz (1979, p. 47, pl. 11, figs. 1-4), from the Middle Permian Barabash Formation of the Barabash area, South Primorye, in size and outline of the shell, but it differs from the Russian species by fewer costae on the dorsal valve.

Order Athyridida Boucot, Johnson and Staton, 1964  
Suborder Retziidina Boucot, Johnson and Staton, 1964  
Superfamily Retzioidae Waagen, 1883  
Family Neoretziidae Dagys, 1972  
Subfamily Hustediinae Grunt, 1986  
Genus *Hustedia* Hall and Clarke, 1893

*Hustedia grandicosta* (Davidson, 1862)  
Figs. 3.21a-3.23b
*Retzia radialis* var. *grandicosta* Davidson, 1862, p. 28, pl. 1, figs. 5a, 5b; Broili, 1916, p. 51, pl. 124, figs. 14-22 only.

*Eumetria grandicosta* (Davidson): Waagen, 1883, p. 491, pl. 34, figs. 6-12.

*Hustedia grandicosta* (Davidson): Grabau, 1931, p. 121, pl. 5, figs. 6a-6d; Grabau, 1934, p. 105, pl. 7, figs. 5a-5c; Shimizu, 1961, p. 328, pl. 16, figs. 39-42; Lee and Gu, 1976, p. 275, pl. 160, fig. 17; Koizumi, 1979, pl. 1, fig. 7; Lee et al., 1980, p. 398, pl. 173, figs. 16, 17; Liu et al., 1982, p. 199, pl. 144, figs. 6a-6d; Wang, 1995, pl. 3, figs. 3a-3c; Wang and Yang, 1998, p. 108, pl. 17, figs. 15a, 15b; Wang and Zhang, 2003, p. 141, pl. 34, figs. 2-8.

*Hustedia radialis* var. *grandicosta* (Davidson): Chi-Thuan, 1961, p. 300, pl. 4, figs. 1a-2.

**Material.**—Thirty-one specimens, from locality T1: (1) external and internal moulds of a conjoined valve, NU-B1087; (2) internal mould of a conjoined valve with external mould of the dorsal valve, NU-B1088; (3) internal moulds of sixteen conjoined valves, NU-B1089-1104; (4) external moulds of two ventral valves, NU-B1105, 1106; (5) internal moulds of three ventral valves, NU-B1107-1109; (6) external and internal moulds of two dorsal valves, NU-B1110, 1111; (7) internal moulds of seven dorsal valves, NU-B1112-1118.

**Description.**—Shell medium size for genus, suboval in outline, with greatest width slightly anterior to midvalve; length 10 mm, width 9 mm in the largest and best preserved specimen (NU-B1087). Ventral valve moderately convex in both lateral and anterior profiles, without sulcus. External surface of ventral valve ornamented with strong, simple and rounded costae, numbering 11-14; intercostal spaces narrow. Dorsal valve moderately convex in both profiles, without fold, and ornamented with 11-13 strong, rounded costae. Interior of dorsal valve with short, high median septum. Other internal structures of both valves obscure in the present specimens.

**Remarks.**—The Takakurayama specimens can be referred to *Hustedia grandicosta* (Davidson, 1862), originally described by Davidson (1862) and redescribed by Waagen (1883) from the Middle and Upper Permian (Amb, Wargal and Chhidru Formations) of the Salt Range, by their size, shape and external ornament of both valves.

*Hustedia orbicostata* Xu and Grant (1994, p. 60, figs. 49, 50) from the Changhsingian of Sichuan and Zhejiang, South China somewhat resembles *H. grandicosta*, but the former differs from the latter in its smaller size and fewer costae on both valves.

*Hustedia remota* (Eichwald, 1860) is clearly distinguished from *H. grandicosta* in having wider and flat-bottomed intercostal spaces on both valves (see Tschernyschew, 1902, pl. 47, figs. 8-11; Huang, 1933, p. 81).

**Distribution.**—Lower Permian (Asselian-Kungurian) of Northwest China (Xinjiang), North China (Inner Mongolia), Salt Range and Timor; Middle Permian (Roadian-Capitanian) of North China (Inner Mongolia), Northeast China (Heilongjiang), Salt Range and Cambodia; Upper Permian (Lopingian) of northeast Japan (Takakurayama in the South Kitakami Belt), southwest Japan (Kawahigashi in the Maizuru Belt), South China (Hunan and Guizhou) and Salt Range.
Order Spiriferida Waagen, 1883
Suborder Spiriferidina Waagen, 1883
Superfamily Martinoidea Waagen, 1883
Family Martiniidae Waagen, 1883
Subfamily Martiniinae Waagen, 1883
Genus *Martinia* M'Coy, 1844

*Martinia semiplana* Waagen, 1883

Figs. 5.3a-5.4b

*Martinia semiplana* Waagen, 1883, p. 536, pl. 43, figs. 4a-4e; Tschernyschew, 1902, p. 182, 565, pl. 60, figs. 15-17; Tschernyschew, 1914, p. 23, 57, pl. 10, figs. 5, 6; Grabau, 1936, p. 237, pl. 24, figs. 1-4; Hayasaka and Minato, 1956, p. 146, pl. 23, fig. 2; Zhang and Ching, 1961, p. 406, pl. 2, figs. 16-19; Zeng, 1990, p. 228, pl. 7, figs. 6, 7; pl. 8, figs. 11a-11d; Fan and He, 1999, p. 149, pl. 36, figs. 3a-3d.

**Material.**—Three specimens, from locality T: (1) external and internal moulds of a conjoined valve, NU-B1169; (2) internal moulds of two conjoined valves, NU-B1170, 1171.

**Description.**—Shell medium size for genus, subcircular in outline, gently biconvex, lacking ventral sulcus and dorsal fold, surface of both valves smooth; length 20 mm, width 18 mm in the best preserved specimen (NU-B1169); length about 20 mm, width about 23 mm in the largest specimen (NU-B1171). Internally, both valves having distinct vascular impressions.

**Remarks.**—These specimens are referred to *Martinia semiplana* Waagen, 1883, from the Middle to Upper Permian (Capitanian-Wuchiapingian) Wargal Formation of the Salt Range, by their size, shape and outline of the shells and having no sulcus and fold.

*Martinia orbiculata* Gemmellaro is similar in size and outline of the shell, but it differs from *M. semiplana* in its strongly convex ventral valve (see Tschernyschew, 1902, pl. 17, figs. 1c, 3c).
Distribution.—Upper Carboniferous of North China (Inner Mongolia) and South China (Guizhou); Lower Permian of northern Urals, northern Pamir, North China (Shanxi) and Northeast China (Liaoning); Middle Permian (Wordian) of northeast Japan (Kamiyasse-Imo in the South Kitakami Belt); Middle to Upper Permian (Capitanian-Wuchiapingian) of Salt Range; Upper Permian (Lopingian) of northeast Japan (Takakurayama in the South Kitakami Belt) and East China (Anhui).

Martinia lata Grabau, 1936
Figs. 5.7a-5.14b

Martinia semiplana var. lata Grabau, 1936, p. 239, pl. 21, figs. 1-3; Hayasaka and Minato, 1956, p. 146, pl. 23, fig. 3.

Material.—Ten specimens, from localities T7, T8: (1) internal moulds of three conjoined valves, NU-B1159-1161; (2) external and internal moulds of a ventral valve, NU-B1162; (3) external mould of a ventral valve, NU-B1163; (4) internal moulds of five ventral valves, NU-B1164-1168.

Remarks.—These specimens are referred to Martinia lata Grabau, 1936, originally described as Martinia semiplana var. lata Grabau from the Lower Permian Maping Formation of Guangxi, South China, by their medium-sized, transversely subelliptical shell (length 18 mm, width 26 mm in the best preserved specimen, NU-B1160) with no sulcus and fold. This species was also described by Hayasaka and Minato (1956) from the Middle Permian (Wordian) lower Kanokura Formation of the South Kitakami Belt, northeast Japan.

Martinia semiplana Waagen, 1883, the preceding species, is clearly distinguished from M. lata by its less transverse shell.

Distribution.—Lower Permian (Asselian-Artinskian) of South China (Guangxi); Middle Permian (Wordian) of northeast Japan (Kamiyasse-Imo in the South Kitakami Belt); Upper Permian (Lopingian) of northeast Japan (Takakurayama in the South Kitakami Belt).

Martinia sp.
Figs. 5.5-5.6b

Martinia rhomboidaris Grabau: Koizumi, 1979, pl. 1, fig. 9.

Material.—Three specimens, from locality T; (1) external mould of a ventral valve, with internal mould of a conjoined valve, NU-B1172; (2) internal moulds of two ventral valves, NU-B1173 (holotype), 1174.

Remarks.—These specimens are safely assigned to the genus Martinia by their longer ellipsoidal outline (length about 30 mm, width about 25 mm in the largest specimen, NU-
B1173) and some radial vascular scars on the ventral valves. The Takakurayama specimens may be a new species of *Martinia*, although the preservation of them are not adequate for establishing the new species. The single shell, figured by Koizumi (1979, pl. 1, fig. 9) as *Martinia rhomboïdalis* Grabau, 1931 from the same locality of the Takakurayama area, is deemed conspecific with the present species.

*Martinia uralica* Tschernyschew (1902, p. 183, 566, pl. 18, figs. 1-4) from the Lower Permian of the Urals is somewhat like to the present species in size, shape of the ventral valve. But the accurate comparison is difficult for poorly preserved specimens.

Superfamily Spiriferoidea King, 1846
Family Trigonotretidae Schuchert, 1893
Subfamily Neospiriferinae Waterhouse, 1968a
Genus *Gypospirifer* Cooper and Grant, 1976

*Gypospirifer volatilis* Duan and Li, 1985
Fig. 6.17

*Spirifer cf. moosakhailensis* Davidson: Noda, 1956, p. 17, pl. 6, fig. 10 only.
*Spirifer fasciger* var. *simplex* Grabau: Kobiyama, 1956, fig. 4.
*Neospirifer fasciger* (Keyserling): Yanagida, 1963, p. 71, pl. 8, figs. 1-3; Koizumi, 1979, pl. 1, fig. 16.
*Neospirifer moosakhailensis* (Davidson): Lee and Gu, 1976, p. 286, pl. 175, figs. 1-3 only.
*Gypospirifer volatilis* Duan and Li, 1985, p. 127, 207, pl. 48, figs. 1-2; pl. 49, figs. 1-2c;
Tazawa, 2001, p. 302, figs. 8.23-8.26; Tazawa and Chen, 2006, p. 335, figs. 6.5-6.7;
Tazawa and Hasegawa, 2007, p. 7, figs. 4.8-4.12, 5.1, 5.2; Tazawa, 2008c, p. 54, figs. 9.3-9.7.

**Material.**—One specimen, from locality T7, external cast of a ventral valve, IGPS86653.

**Description.**—Shell medium size for genus, transversely semielliptical in outline, with greatest width at hinge, length about 35 mm, width about 72 mm in the sole ventral valve specimen (IGPS86653). Ventral valve gently convex in lateral and anterior profiles, most convex at umbral region; umbo slightly extended and strongly incurved; sulcus deep and rapidly widening anteriorly, with U-shaped bottom. External surface of ventral valve ornamented by numerous fine costae and concentric ornament of some strong rugae and numerous fine growth lines; costae subridged, often bifurcated, numbering 10-11 in 10 mm at about midvalve.

**Remarks.**—This specimen is referred to *Gypospirifer volatilis* Duan and Li, 1985, from the Middle Permian Zhesi (Jisu) Formation of Zhesi, Inner Mongolia, on account of size, shape
and external ornament of ventral valve.

Yanagisawa (1967) described the Takakurayama specimen as *Neospirifer cf. fasciger* (Keyserling, 1846), but *Neospirifer fasciger*, the type species of the genus *Neospirifer* Fredericks, 1924 is much smaller in size and having conspicuous fasciculate ornament on both valves.

**Distribution.**—Middle Permian (Roadian-Capitanian) of North China (Zhesi and Xiujimqinqi, Inner Mongolia), Northeast China (Heilongjiang) and central Japan (Moribu in the Hida Gaien Belt); Upper Permian (Lopingian) of Northeast China (Jilin), northeast Japan (Takakurayama in the South Kitakami Belt) and southwest Japan (Mizukoshi in the Hida Gaien Belt).

Family Spiriferellidae Waterhouse, 1968a
Genus *Spiriferella* Tschernyschew, 1902

*Spiriferella saranae* (de Verneuil, 1845)
Figs. 6.1-6.4

*Spirifer saranae* de Verneuil, 1845, p. 169, pl. 6, figs. 15a, 15b.
*Spiriferina (Spiriferella) saranae* de Verneuil: Tschernyschew, 1902, p. 121, 522, pl. 12, figs. 4a, 4b; pl. 40, fig. 7; text-figs. 41-46.
*Spiriferella saranae* (de Verneuil): Grabau, 1931, p. 155, pl. 22, figs. 4a, 4b; text-fig. 43;
Yanagisawa, 1967, p. 91, pl. 2, fig. 10 only; Harker, 1960, p. 71, pl. 22, figs. 1-8; pl. 23, figs. 3, 4, 8; Nelson and Johnson, 1968, p. 729, pl. 93, figs. 1-10; pl. 96, fig. 9; text-figs. 4f, 5a, 13f; Ifanova, 1972, p. 135, pl. 11, figs. 3a, 3b; Waterhouse and Waddington, 1982, p. 17, pl. 4, figs. 1-11; text-figs. 14, 16a, 16c; Nakamura et al., 1992, pl. 4, figs. 2, 5; Shi and Waterhouse, 1996, p. 132, pl. 24, figs. 21-32; pl. 25, figs. 1-5.
*Spirifer (Spiriferella) saranae* de Verneuil: Licharew and Einor, 1939, p. 133, 216, pl. 22, fig. 1.

**Material.**—Four specimens, from localities T_1, T_2: (1) external cast of a conjoined valve, NU-B1175; (2) external casts of three ventral valves, IGPS86638, 86654B, NU-B1176.

**Remarks.**—These specimens are poorly preserved, but can be referred to *Spiriferella saranae* (de Verneuil, 1845) from the Lower Permian (Artinskian) of the Urals by their longer ventral valve (length about 28 mm, width about 22 mm in the best preserved specimen, IGPS86638; length more than 42 mm, width more than 39 mm in the largest specimen, IGPS86654B), with deep V-shaped sulcus bearing two or three pairs of faint sulcal costae and strong simple costae on lateral flanks.

*Spiriferella persaranae* Grabau (1931, p. 156, pl. 19, figs. 4a, 4b; text-fig. 61), from the Middle Permian Zhesi (Jisu) Formation of Zhesi, Inner Mongolia, is distinguished from S.
saranae by its smaller dimensions and deeper sulcus with smooth V-shaped bottom on the ventral valve.

Distribution.—Lower Permian (Asselian-Kungurian) of northern Russia (northern Urals, Timan, Pechora Basin and Novaya Zemlya), Arctic Canada (northern Yukon Territory and Devon Island); Middle Permian (Wordian-Capitanian) of Spitsbergen and North China (Inner Mongolia); Upper Permian (Lopingian) of northeast Japan (Takakurayama in the South Kitakami Belt).

Spiriferella? sp.
Fig. 6.5

Neospirifer cf. fasciger (Keyserling): Yanagisawa, 1967, p. 90, pl. 2, fig. 18.

Material.—One specimen, from locality T7, internal mould of a ventral valve, IGPS86637A.

Remarks.—The single ventral valve specimen from Takakurayama was described by Yanagisawa (1967) as Neospirifer cf. fasciger (Keyserling, 1846), but it differs from N. fasciger in having strong simple costae on the flanks. The Takakurayama specimen is seemed to be a species of Spiriferella Tschernyschew, 1902 or Alispiriferella Waterhouse and Waddington 1982, on the basis of its medium size (length about 19 mm, width about 20 mm), strong simple costae numbering four on each lateral flank and deeply impressed heart-shaped muscle field. However, accurate comparison is difficult due to the lack of clear external information in the present specimen.

Genus Alispiriferella Waterhouse and Waddington, 1982

Alispiriferella lita (Fredericks, 1924)
Figs. 6.6, 6.7

Spiriferella saranae mut. lita Fredericks, 1924, p. 36, pl. 1, figs. 16-27; text-figs. 2a, 2b.
Spirifer cf. saranae mut. lita Fredericks: Hayasaka, 1925, p. 98, pl. 5, fig. 14.
Spiriferella keihavii (von Buch): Yanagida, 1963, p. 72, pl. 9, figs. 4-9; pl. 10, figs. 1-7.
Alispirifer aff. laminosus transversa Maxwell: Yanagisawa, 1967, p. 90, pl. 2, fig. 3.
Cancellospirifer? maxwelli Campbell: Yanagisawa, 1967, p. 92, pl. 3, fig. 16.
Timaniella harkeri Waterhouse: Licharew and Kotlyar, 1978, pl. 18, figs. 2, 3.
Spiriferella grandis Kotlyar in Licharew and Kotlyar, 1978, p. 73, pl. 18, figs. 7, 8.
Spiriferella lita (Fredericks): Tazawa, 1979, p. 28, pl. 4, figs. 12a-13b; pl. 5, figs. 1-4, 6;
Spiriferella cf. lita (Fredericks): Tazawa et al., 2000, p. 12, pl. 1, figs. 16, 17.
Alispiriferella neimongolensis Wang and Zhang, 2003, p. 154, pl. 46, figs. 9-18; pl. 50, figs. 5, 9.
Alispiriferella lita (Fredericks): Tazawa and Hasegawa, 2007, p. 9, figs. 5.3-5.11; Tazawa, 2008c, p. 55, figs. 9.8a-9.14.

**Material.**—Two specimens, from locality T7: (1) external and internal moulds of a ventral valve, IGPS86642; (2) internal mould of a ventral valve, IGPS86652.

**Remarks.**—The two ventral valve specimens, collected by Yanagisawa from the locality T7, are available. Yanagisawa (1967) described the larger specimen (IGPS86652) as Alispirifer aff. laminosus transversa Maxwell, 1964, and the smaller specimen (IGPS86642) as Cancellospirifer? maxwelli Campbell, 1953. But these specimens can be referred to Alispiriferella lita (Fredericks, 1924), from the Middle Permian Chandalaz Formation of South Primorye, eastern Russia, by their transversely but not mucronate shell (length about 20 mm, width about 40 mm in the larger specimen), with strong simple costae. The Takakurayama specimens seemed to be young shells. *A. lita* is a Middle Permian (Wordian-Capitanian) species, but in Japan it often occurs from the Upper Permian (Lopingian) beds as reworked fossils (Tazawa et al., 2000; Tazawa and Hasegawa, 2007; Tazawa, 2008c).

The type species, *Alispiriferella ordinaria* (Einor in Licharew and Einor, 1939) is clearly distinguished from *A. lita* by its smaller and less transverse shell with ventral sulcus bearing two prominent sulcal costae and more often fasciculate costae on both ventral and dorsal valves.

**Distribution.**—Middle Permian (Wordian-Capitanian) of North China (Zhesi and Xiujiqinqi, Inner Mongolia), Northeast China (Heilongjiang), eastern Russia (South Primorye), northeast Japan (Kesennuma in the South Kitakami Belt), central Japan (Moribu in the Hida Gaien Belt); Upper Permian (Lopingian) of northeast Japan (Ogatsu and Takakurayama in the South Kitakami Belt) and southwest Japan (Mizukoshi in the Hida Gaien Belt).

**Genus Elivina** Fredericks, 1924

*Elivina tibetana* (Diener, 1897)

Figs. 6.8a-6.16

*Spirifer tibetanus* Diener, 1897, p. 45, pl. 6, figs. 1-7; Hamlet, 1928, p. 37, pl. 7, figs. 1, 2.
*Spiriferina cristata* Schellwien (sic): Yanagisawa, 1967, p. 92, pl. 1, fig. 12; pl. 3, fig. 6.
*Spiriferella tibetana* (Diener): Licharew and Kotlyar, 1978, pl. 18, figs. 4, 5.
*Elivina tibetana* (Diener): Shen et al., 2003, p. 244, pl. 4, figs. 7-10.

*Elivina* sp. Tazawa, 2008c, p. 57, figs. 9.1a-9.2b.

**Material.**—Thirteen specimens, from locality T7: (1) external and internal mouds of a conjoined valve, NU-B1177; (2) external cast of a conjoined valve with external mould of the dorsal valve, NU-B1178; (3) internal mould of a conjoined valve with external mould of the dorsal valve, NU-B1179; (4) external casts of two conjoined valves, NU-B1180, 1181; (5) external and internal moulds of a ventral valve, NU-B1182; (6) external cast of a ventral valve, NU-B1183; (7) external casts of five dorsal valves, IGPS86639A, 86639B, 86655, NU-B1184, 1185; (8) internal mould of a dorsal valve, NU-B1186.

**Description.**—Shell medium size for genus, elongate oval in outline, cardinal extremities rounded, hinge narrow, with greatest width at about midvalve; length 22 mm, width 18 mm in the largest ventral valve specimen (NU-B1182); length 17 mm, width 28 mm in the largest dorsal valve specimen (IGPS86639A).

Ventral valve strongly and unevenly convex in lateral profile, most convex at umbonal region; umbo prominent, pointed, strongly incurved, and overhanging hinge line; interarea highly triangular, concave, bisected by relatively narrow delthyrium; sulcus deep and broad, originating from beak, U-shaped in cross section, having one or two pairs of faint sulcal costae, but no median costa. Dorsal valve transversely subelliptical in outline, moderately convex in lateral profile; interarea low but distinct; fold low, widening anteriorly, with two or three costae. External ornament consisting of strong simple costae, radial capillae and fine growth lamellae; costae rounded, numbering 3-4 on each flank.

Internally, ventral valve having short dental plates; dorsal valve with relatively large longitudinally striated ctenophoridium; median septum thin, short. Other internal features not observed.

**Remarks.**—These specimens are referred to *Elivina tibetana* (Diener, 1897) from the Middle Permian (Capitanian) limestone block of Chichichun, southern Tibet by their size, outline and surface ornament of shells, especially the elongate ventral valve with simple rounded costae on the flanks. Yanagisawa (1967) described or listed a part of the Takakurayama specimens as *Spiriferina cristata* Schellwien (sic) [=*Spiriferellina cristata* (Schlotheim, 1816)] and *Hustedia cf. remota* (Eichwald, 1860), but both *Spiriferellina cristata* and *Hustedia remota* are quite differ from *Elivina* species in its size, outline and external ornament of the shell. *Elivina* sp. (Tazawa, 2008c, p. 57, figs. 9.1a-9.2b) from the Upper Permian Mizukoshi Formation of Mizukoshi, southwest Japan can be referred to *E. tibetana*, although it is small in size.

*Elivina sinensis* Liu and Waterhouse (1985, p. 34, pl. 9, figs. 1-4, 6, 7; pl. 10, figs. 1, 4, 5, 7, 9) from the Zheshi Formation of Xiujimqinqi, Inner Mongolia differs from *E. tibetana* in its triangular outline and stronger simple costae on both valves.

*Elivina hoskingae* Archbold and Thomas (1985, p. 44, figs. 3A-3Y) from the Lower Permian
of the Perth and Carnarvon Basins, western Australia is also a medium-sized, elongate species, but the Australian species is clearly distinguished from *E. tibetana* by its ventral sulcus bearing distinct median costa.

**Distribution.**—Middle Permian (Capitanian) of southern Tibet (Chitichun) and western Timor; Upper Permian (Wuchiapingian) of southern Tibet (Zhongbei in the Indus-Tsangpo Suture Zone) and eastern Russia (West Primorye); Upper Permian (Lopingian) of northeast Japan (Takakurayama in the South Kitakami Belt).

Superfamily Brachythyridoidea Fredericks, 1924
Family Brachythyrididae Fredericks, 1924
Genus *Cathayspirina* Liang, 1990

*Cathayspirina* sp.
Fig. 6.18

**Material.**—One specimen, from locality T7, external cast of a ventral valve, NU-B1190.

**Remarks.**—This specimen is safely assigned to the genus *Cathayspirina* by its small, equidimensional ventral valve (length 14 mm, width 15 mm), deep and broad sulcus without sulcal costae, and simple rounded costae (numbering 3 on each flank) with relatively broad, rounded interspaces.

The Takakurayama specimen most resembles *Cathayspirina aff. fenshuijiangensis* Liang, 1990, figured by Yanagida (1996, figs. 2.1a-2.1c) from the Upper Permian (Lopingian) Tsunemori Formation of Tsunemori in the Akiyoshi Belt, southwest Japan, in its large size.

*Cathayspirina fenshuijiangensis* Liang (1990, p. 340, pl. 54, figs. 1-28) from the Upper Permian (Wuchiapingian) of Zhejiang, east China differs from the present species in its smaller size.

Acknowledgements

I would like to thank Naotomo Kaneko (Geological Survey of Japan, AIST) and Satoshi Hasegawa (Kyushu Regional Office, Yachiyo Engineering Co., Ltd.) for help of field work in the Takakurayama area; Toshiyuki Kurihara (Department of Geology, Niigata University) for help of drawing pictures; Alexander M. Popov (Far East Geological Institute, Russian Academy of Sciences, Vladivostok) for sending some Russian literatures; Atsushi Matsuoka (Department of Geology, Niigata University) for critical reading of the manuscript.

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