

Brachiopod Fossils from the Permian Maizuru Group

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Abstract

The brachiopod faunas of the Permian Maizuru Group in the Maizuru Zone, Southwest Japan are mentioned. Of those, the upper Kawahigashi and the lower Takauchi Faunas are analysed and correlated to other Japanese and the foreign faunas. Two new species are described.

Introduction and Acknowledgements

The Permian Maizuru Group, together with the Triassic strata of different ages and the so-called Yakuno intrusive rocks, forms a complicated structure of the Maizuru Zone in Southwest Japan. Geological studies of the Maizuru Zone has been carried out since 1947 by NAKAZAWA and others in several districts from east—Kyoto Prefecture to west—Okayama Prefecture. The results on the stratigraphy and the geological structure of those districts have already been published. In respect to the Triassic fossils, NAKAZAWA's studies were presented, and as for the fossils of the Permian Maizuru Group, we have NOGAMI's transaction of fusulinid fauna. In addition to these excellent works, the writer wishes to add the description of some brachiopod-fossils from the Maizuru Group.

Before going into description the writer intends to express his thanks to Professor S. MATSUSHITA for his kind guidances and encouragement. He is much indebted to Ass. Prof. K. NAKAZAWA of his Institute for his advices and for offering many good samples for study. Thanks are also due to Prof. M. MINATO and Mr. K. NAKAMURA of Hokkaido University and Prof. Y. ONUKI of Tohoku Univ. for their advices and for offering conveniences with respect to reference literatures.

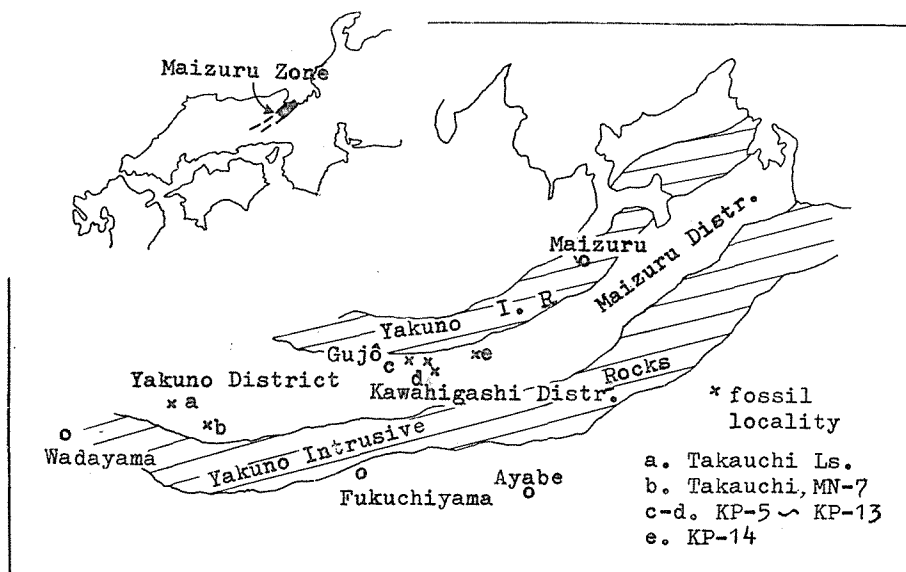
Geological Notes

The Maizuru Group is composed of alternations of shale, siltstone, sandstone, conglomerate, limestone and "Schalstein". At the eastmost Maizuru

District, this group has a following sequence in descending order (NAKAZAWA and others, 1959) :—

1. the upper formation: alternations of shale, sandstone and conglomerate with fusulinids (*Lepidolina* fauna) 800 m.
2. the middle formation: black slate with limestone lenses, with some fossils of coral, bryozoa and others. 550 m.
3. the lower formation: phyllitic Schalstein with black phyllites, no fossils. 700 m.

A similar succession has been ascertained in many districts of the Maizuru Zone. From the upper formation, many brachiopods were found at most places near by the fusulinids which are probably contemporaneous with the former, but they never associate with each other. These fusulinids are of *Lepidolina* fauna and indicate the upper Permian horizon (NOGAMI, 1959). Brachiopods



Text Fig. 1.

are contained in calcareous shale, siltstone, sandstone and conglomerate in association with many fragments of crinoid stems, pelecypods and rarely trilobites. Fossil-bearing beds are found as small lenticular, or thin layers and the fossils are accumulated in an arbitrary direction. It can be estimated that these fossils were transported from their original habitats and deposited by flow or current of shallow sea water. The writer intends to name the fauna the Kawahigashi Fauna for the reason that it flourished most greatly in the Kawahigashi District, Ōe-cho of Kyoto Prefecture.

From the middle formation, especially from the limestone of it, brachiopods, corals and peculiar fusulinids were obtained, but fossils are not so common as those of the upper formation. Among these limestones, the Takauchi limestone of Yakuno is most famous for the discovery of "*Lyttonia*" and other brachiopods (MASHIKO, 1934 and KOBAYASHI, 1939).

Moreover, several brachiopod fossils were noticed by NAKAZAWA (1951) from Gujō in Ōe-cho. They are found from a deltaic facies of the Gujō formation in association with many pelecypods. NAKAZAWA named it the Gujō Fauna and estimated its age to be Triassic from the mesozoic appearance of pelecypods of this fauna, although the brachiopods are of paleozoic type. Lately, the Gujō Formation has been corrected to the Permian in age from the detailed geological observation as well as the paleontological study of NAKAZAWA and others (1958).

These three faunas are geologically and paleontologically independent elements of the Maizuru Group. In the present paper, brachiopods of the Kawahigashi Fauna and of the Takauchi Limestone are described.

Part 1. The Kawahigashi Fauna

The present fauna is characterized by many species of Chonetidae associated with Productidae and Orthotetinae as listed in the table. The writer was deeply impressed by the striking resemblance between the present fauna and

Table 1. Fossil localities of the Kawahigashi Fauna and fossil-bearing rock facies.

District	Loc. No.	Locality Name	Rock Facies
Yakuno	MN-7	Miyaodani, Takauchi, Yakuno-chō, Amada-gun, Kyōto Prefecture.	calcareous med. sandstone
Kawahigashi	KP-5	Katsuradani, Hirobatake, Ōe-chō, Kasa-gun, Kyōto Pref.	calc. fine ss.
	KP-7	Nomaru, Okuyama, Ōe-chō.	calc. very coarse-granulic sandst.
	KP-11	Miyanoooku, Takeuchi, Nishisaka, Monobe-cho, Ayabe City.	calc. fine sandst.
	KP-12	East of Mt. Miyagadake, Matsubara, Toyosato-cho, Ayabe City.	calc. fine sandst.
	KP-13	Bessho, Matsubara, Toyosato-cho, Ayabe City.	calc. fine sandst.
	KP-14	A pass between Okushinjō and Jōdoji, Monobe-cho, Ayabe City (Kuваноé-toge)	calc. silty shale-fine sandstone

All localities except KP-14 had been reported in the former reports.
 (Yakuno-NAKAZAWA, SHIKI and SHIMIZU, 1957)
 (Kawahigashi-NAKAZAWA and SHIKI, 1958)

Table 3. Size ratio of the species of the Kawahigashi Fauna to the original and the conferred species.

<i>Derbyia altestriata</i>	3/4	<i>Productus (Dictyoclostus) gratiosus</i>	3/5
<i>Derbyia</i> cf. <i>grandis</i>	2/3	<i>Prod. (Dictyocl.)</i> cf. <i>margaritatus</i>	1
<i>Derbyia hemisphaerica</i> var. <i>radiata</i>	2/3	<i>Linoproductus kiangsiensis</i>	4/5
<i>Chonetina substrophomenoides</i>	4/5-2/3	<i>Linoproductus interruptus</i>	2/3
<i>Chonetina</i> cf. <i>strophomenoides</i>	1/2-1/3	<i>Aulosteges dalhousi</i>	1/2
<i>Lissochonetes bipartita</i>	3/5-1/2	<i>Hustedia grondicosta</i>	3/5-1/2
<i>Lissochonetes morahensis</i>	9/10-1/2	<i>Hustedia indica</i>	2/3-3/5
<i>Lissochonetes</i> cf. <i>avicula</i>	4/5-2/3		

the late Permian brachiopod fauna of the Loping Series in Southwest China. Both faunas are very similar to that of the *Productus* Limestone of India, of which the upper and the middle divisions have many identical elements. In Japan, the related fauna is found in the Karita Formation in Hiroshima Prefecture (IMAMURA, 1953). The Karita fauna is characterized not only by brachiopod, but also by fusulinids of the *Lepidolina* fauna as in the Maizuru Zone. The Karita formation placed in the west extension of the Maizuru Zone, can be safely correlated to the upper formation of the Maizuru Group. Some part of that, especially its "*Lyttonia*" bearing limestone may be correlated to the middle formation of the Maizuru Group.

Formerly, the brachiopods of the Maizuru have been compared with the "*Lyttonia*" fauna of the Kanokura Series in the southern Kitakami Mountains of Northeast Japan (NAKAZAWA & SHIKI, 1958). The Kanokura Series which is famous for the most abundant products of brachiopods in Japan, is correlated to the "*Neoschwagerina* Zone" of the middle Permian age. It cannot be neglected that the common species among the Kawahigashi Fauna and the Kanokura Fauna are rather poorer than expected, and to correlate the two is not preferable.

The age of the Kawahigashi Fauna must be concluded as the Late Permian Period from above mentined facts, and this fauna may be one of the latest brachipod fauna of the Japanese Permian, probably except the Gujō Fauna. Another support is given to this judgement from stratigraphical evidences, that is the intimate relation between the Kawahigashi Fauna and the *Lepidolina* Fauna is enough to regard them as the stratigraphically equivalent elements in the Maizuru Group. This peculiar relation between the two fauna, intimate relation and non association, is left now as an unfinished problem, but it might have been caused by their isolated habitats and different courses of deposition in some unusual environment of the Maizuru Sea. It is also interesting that the species of the Kawahigashi Fauna are smaller in size than foreign specimens of the identical species. This facts stimulates our consideration on the environments of the Kawahigashi Fauna, that is the closed environment of the Maizuru Group at the late Permian Period, which is also assumed to be an inland-sea

environment from the studies of the sedimentary facies and geographical distribution.

Description of Species
***Derbyia altestriata* WAAGEN**

Pl. 15, figs. 1, 2.

1882. *Derbyia altestriata* WAAGEN, Productus Limestone Fossils: iv, Brachiopoda. Pal. Indica, ser. XIII, Salt Range Fossils, p. 600, Pl. LII, fig. 2.

Outline of the shell is semi-circular or rather quadrate elliptical. Internal surface is covered by coarse striations and three distinct concentric wrinkles in regular distances, which give to this specimen a characteristic appearance. The anterior margin of the shell has a very large apical angle and seems to be almost straight. Beneath the apex, shell is depressed probably caused by later deformation. The valve is rather flattened in the middle part and rapidly vaulted in both lateral margins. The area forms a regular low triangle, and takes almost right angle to the surface of the valve. The strong median septum reaches one third of length of the shell. Pseudodeltidium is rather broad.

The measurements of the shell are as follows.

Length of the shell—30 mm. Breadth of the shell—66 mm. or more.

Thickness of the shell—8 mm.

Remarks: Unfortunately, only one internal mould of ventral valve is at hand, and it is incomplete specimen. But main portion of the valve and its ornamentations are well preserved. The characters are sufficient to identify this specimen to WAAGEN's *Derbyia altestriata*. The apical angle is larger and pseudodeltidium is rather broader than those of the original specimen.

Locality and Occurrence: This specimen was collected from a lense of calcareous silty shale in black shales of the Maizuru Group at Okushinjo, Monobe, Ayabe City, Kyoto Pref. (Loc. No. KP-14). This associates with *Derbyia grandis*, *Chonetina substrophomenoides*, *Chonetina* cf. *strophomenoides*, *Lino-productus interruptus*, *Hustedia grandicosta*, and Crinoid stems.

Reg. No. JP 30004.

***Derbyia* cf. *altestriata* WAAGEN**

Pl. 15, figs. 3, 4, 5.

This specimen is a half dorsal valve with semi-circular outline. The valve is much more strongly inflated and vaulted. The apex is slightly prominent and strongly bent over. The area of the valve is narrow and very indistinct. On the lateral side of the apex, along the hinge-line, the valve is considerably flattened and spread out, forming indistinct wings. The valve bears a concentric sculpture, but not distinct as that of the ventral valve of *Derbyia*

altestriata. The radial striations are very remarkable on the external mould, and somewhat weak on the internal surface. These striations on the external surface are uniform in size upon the whole surface of the shell and increase in number at various distances from the beak by insertion and counted 18 to 20 in a distance of 1 cm. on the frontal margin. The strong dental plates reach to one third of the shell length.

Measurements of this specimen are as follows:

Length of the shell—40 mm. Breadth of the shell—twice of 33 mm.

Thickness of the shell—14 mm.

Remarks: This specimen is only a dorsal valve, and internal structure of ventral valve is not known. But the general shape and surface ornamentations are similar to those of *Derbyia altestriata* WAAGEN. The present specimen is larger than the preceding and WAAGEN's original species.

Locality and Occurrence: Same as the preceding species.

Reg. No. JP 30013 A, B.

***Derbyia* cf. *grandis* WAAGEN**

Pl. 15, figs. 6, 7.

cf. 1883. *Derbyia grandis* WAAGEN, Productus Limestone Fossils: iv, Brachiopoda, Pal. Indica, ser. XIII, Salt Range Fossils, p. 597, Pl. LII, fig. 3 a, b.

Outline of the shell is semi-circular. Internal and external surfaces of the shell are covered by coarse radial striations and irregular concentric wrinkles. The valve is deformed by compression, but rather flat in the middle part and vaulted in the marginal part. Apex is extremely pointed and erected, and apical angle is large. The area is a low triangle and has a rather broad pseudodeltidium. Median septum reaches near one third of the length of the shell. The hinge line is as long as the greatest length of the valve.

Measurements are following:

Length of the shell—15 mm. Breadth of the shell—22 mm.

Thickness of the ventral valve—3 mm.

Remarks: Specimens in hand are two small moulds of ventral valve. The larger specimen is more complete, and the smaller one is only a fragment. The former is very similar to WAAGEN's *Derbyia grandis* (1883, p. 597, Pl. LII, fig. 3) in general outline. The very distinct concentric wrinkles of the valve resemble to those of *Derbyia altestriata*, but very irregular. The smaller specimen is too fragmental for describe the specific characters.

Locality and Occurrence: Same as *Derbia altestriata*.

Reg. No.: JP 30005 A, B, JP 30014 A, B.

Derbyia hemisphaerica var. **radiata** REED.

Pl. 15, figs. 9, 10.

1944. *Derbyia hemisphaerica* var. *radiata* REED, Brachiopoda and Mollusca from the Productus Limestones of the Salt Range, Pal. Indica, N. S. Vol. XXIII, Mem. No. 2, p. 24, pl. III, fig. 2.

Specimen is unfortunately broken at apical part of the internal mould, but its external mould of apical part is preserved. The dorsal valve is not collected. The whole shape of the shell is not known. Ventral valve is quite flat, and very slightly concave. Towards both ends of the hinge-line the margins of the valve are slightly bent up. The area is large and high. Entire length of the shell is larger than the length of the hinge-line. Surface of the valve is covered by rather fine striations and concentric growth lines or wrinkles. The median septum is very strongly developed and reaches almost one third of the entire length of the shell, which is measured 3 mm. or more. Apical angle is 130°.

Remarks: Although the material is incomplete, the outline of the specimen, its flatness, apical angle and surface ornamentations are able to refer the species to *Derbyia hemisphaerica* WAAGEN var. *radiata* REED from the Middle Productus Limestone of the Salt Range.

Locality and Occurrence: This specimen is collected from calcareous sandstone at Miyaodani, Yakuno, Kyoto Prefecture (Loc. No. MN-7), in association with *Lissochonetes bipartita*, *Lissochonetes morahensis*, *Lissochonetes* cf. *avicula*, *Lissochonetes* sp., *Hustedia indica* and *Eolyttonia nakazawai* n. sp.

Reg. No. JP 30007 A, B.

Derbyia sp.

Pl. 15, fig. 8.

Shell is transversely semi-elliptical in outline and hingeline is nearly equal to width of the shell. The valve is gently convex, forming a very low cone and its lateral parts are almost flattened. Beak is erected but not pointed and somewhat overhangs on the hinge-line. Umbo is somewhat distorted and irregularly truncated by elliptical depressed area of attachment, about 6 mm. in diameter, occupying an oblique portion. Hinge area is not preserved and entire length of the hinge line is not decidedly measured. The inner surface of the valve is covered by fine radiating striations which increase in number by intercalation and becoming of uniform size towards the frontal margin. A median septum reaches almost one third or more length of the shell. The external mould is not collected.

Measurements of the shell are as follows:

Shell length—7.6 mm, shell width—13.5 mm.

Remarks: The shell form and characteristic umbo of this species quite resemble to those of *Streptorhynchus* (*Schuchertella*) *purdoni* REED from the Middle Productus limestone of the Salt Range (1944, p. 22, Pl. II, figs. 14-15), but the present species has distinct median septum in ventral valve and must be a species of *Derbyia*. REED's description on *Streptorhynchus purdoni* not refers to its internal structures and it is not able to compare the two species on internal structures. When the internal structures of the Indian species is clearly described, the comparison between the two species may becomes more distinct.

Locality and Occurrence: This species is collected from calcareous fine sandstone of the Maizuru Group at Katsuradani, Hirobatake, Ôe-cho, Kasa-gun, Kyôto Pref. (Loc. No. KP-5) in association with *Chonetina matsushitai* n. sp., *Lissochonetes bipartita*, *Lissoch. morahensis*, *Lissoch. cf. avicula*, *Lissoch. sp.* and *Aulosteges dalhousi*.

Reg. No. JP 30016.

***Chonetina substrophomenoides* (HUANG)**

Pl. 16, figs. 11-23.

1932. *Chonetes substrophomenoides* HUANG. Late Permian Brachiopoda of Southwest China, Part. I, Pal. Sinica, Ser. B, Vol. IX, fasc. 1, p. 3, Pl. I, figs. 3-7.

Outline of the shell is elliptical trapezoidal. The greatest width of the shell extends as long as the straight hinge-line. Sinus is shallow and rather broad. Surface, both internal and external, are characterized by many fine radiating striae. Valve is slightly inflated, but almost flattened at the middle part between the apex and the frontal margin. Transversely, the shell is also slightly curved, impressed in the middle part and slopes gradually towards both sides. The beak is narrow, pointed and not bent over. The ears are concave near the apex and gradually slightly convex at the margins. The shallow and broad sinus is gradually diminishing to the umbonal region. The fine radiating striae of the surface are round topped and closely placed. They are gradually increase in number to the front by insertion at various distances from the apex, and counted 17 in 5 mm. on the shell margin. Striations of internal surface are more weak than external ones. On the internal surface, distinct punctations are distributed along fine striations.

Among many specimens of this species, several different forms are distinguished. They are grouped as forms A, B and C for convenience of description.

Form A (figs. 11-14) is characterized by trapezoidal outline, deep narrow sinus and remarkable folds. The area is prominent and pointed. Hinge line have the greatest width of the shell. Surface striations are (corresponding to trapezoidal outline) very sharp and closely spaced. Inner surface is also covered by rather remarkable striations.

Form B (figs. 15-19) has rather quadrate elliptical outline. Sinus is rather deep and broad, and folds are rounded. Striations of inner surface are weak.

Form C (figs. 20-23) is characterized by very transversely elliptical outline. Shell is convex and ears are narrow. Sinus is very shallow and obsolete and folds are also less rounded. Hinge line is straight, but not possesses the greatest width of the shell. External surface is covered by fine round topped radial striations, which are less closely spaced and separated by shallow rounded valleys. Inner striations are very fine and weak.

Measurements of the specimens are as follows (in mm.):

		ventral valves							dorsal valves		
	Length	6.3	4.7	7.2	7.9	7.5	7.2	7.6	6.4	6.4	
Form A	Width	8.6	6.5	9.5	9.0	8.0	9.0	8.4	8.5	7.5	
	Ratio	1.37	1.38	1.32	1.14	1.07	1.25	1.11	1.33	1.13	1.07-1.38 (1.23)
	Length	5.7	5.2						4.6	5.7	6.8
Form B	Width	9.6	8.0						6.8	9.5	10.8
	Ratio	1.68	1.54						1.48	1.67	1.59 1.48-1.68 (1.59)
	Length	5.9	5.3	4.9	5.6	5.0			5.0	4.2	
Form C	Width	12.0	10.5	9.6	10.2	9.8			9.7	8.4	
	Ratio	2.03	1.98	1.96	1.82	1.96			1.94	1.95	1.82-2.03 (1.95)

Remarks: As mentioned above, specimens of this species are grouped three types and they apparently different as another species, which they are found together and their differences seem to be caused by deformation. That is, specimens of transverse type are arranged parallel each other and their direction has almost right angle to those of the trapezoidal type, and the intermediate type is arranged in intermediate direction between those two types. The intermediate—probably most normal form—has no important differences to *Chonetina substrophomenoides* (HUANG), but that has somewhat deep and narrow sinus than the Chinese original specimens.

The definition of *Chonetina* given by DUNBAR and CONDRA (1932, p. 134) is here followed.

Localities and Occurrences: Bessho, Matsubara, Toyosato-cho, Ayabe City, from calcareous fine sandstone in association with *Chonetina* cf. *strophomenoides*. (KP-13)

A pass between Okushinjo and Jôdoji of Monobe-cho, Ayabe City (KP-14), in association with same species as *Derbyia altestriata*.

Reg. Nos. JP 30017-33.

***Chonetina* cf. *strophomenoides* (WAAGEN)**

Pl. 16, figs. 7-10.

cf. 1883. *Chonetes strophomenoides* WAAGEN, Productus Limestone Fossils: iv, Brachiopoda, Pal. Indica, ser. XIII, Salt Range Fossils, pp. 628-630, Pl. LVIII, fig. 10.

The specimens have somewhat transversely rectangular outline and the greatest breadth of the shell at the straight hinge line. The shell is inflated.

Longitudinally it bends more strongly down and shows a rather bold curve. At the transverse direction, the shell is less inflated especially in the middle part and vaulted in both sides. The apex is not at all prominent, not pointed and not bent over. The area is not preserved. A broad but not very deep sinus commences only at short distance from the apex, and extends down to the front. The whole surface of the shell is covered by many fine radial plications, which are arranged in regular spaces and increase in number by bifurcation. On the frontal margin of the valve these striations are counted 8 to 10 in the distance of 5 mm, and 60 to 80 on the whole surface. Of the internal characters but little are observable. The median sinus is more deep and narrow than that of the external surface, and by high and very round folds on both sides. The median septum in apical part is not observed.

Measurements are as follows:

Length of the shell—5.7 mm, 6.1 mm.

Breadth of the shell—9.0 mm, 7.9 mm.

Remarks: This specimen is related to WAAGEN's *Chonetes strophomenoides*, but not be identified with it. The more inflated valve distinguishes the present species from the WAAGEN's species.

Localities and Occurrences: Okushinjo, Monobe, Ayabe City (KP-14), in association with same species as those of *Derbyia altestriata*. Bessho, Matsubara, Ayabe City (KP-13), in association with *Chonetina substrophomenoides*. Miyano-oku, Takeuchi, Nishisaka, Monobe, Ayabe City, Kyoto Pref. (KP-11) in association with *Chonetina matsushitai* n. sp., *Lissochonetes* cf. *avicula*, *Lissochonetes* sp., *Hustedia indica*.

Reg. Nos. JP 30034-41.

***Chonetina matsushitai* n. sp.**

Pl. 16, figs. 1-6.

Shell is semi-circular or somewhat trapezoidal in out-line, with the greatest width along the hinge-line, which terminates in flatt ends and more or less pointed cardinal extremities. Ventral valve is very moderately and evenly convex. Umbonal slopes are low and very gradual, marking off the flattish ears by a distinct concavity. Beak is pointed and slightly extends beyond the hinge-line. Surface is marked by numerous radiating striae counted about 15 in a distance of 5 mm. They are uniform in size upon the whole surface of the shell, increase in number at various distances from the beak by bifurcation and intercalation and are separated by interspaces of about equal width. The surface is also marked by fine concentric growth-lines. A median sinus commences from the apex, widening towards the front where it is very broad and shallow. Internally, the sinus is deep, not broad, and somewhat angular folds terminates it on both sides. A short median septum is observed at apical part.

Internal surface is marked by numerous fine granules. Brachial valve is semi-circular or rather quadrate in outline, are regularly concave in its visceral portion, and flattish upon the ears. A low and broad fold commences from a little below the beak and becomes broader towards the front. Surface is marked by the same kind of sculptures as that of the opposite valve. In the interior of the brachial valve, a dental socket and a distinct crura exist on either sides of the cardinal process, which is not preserved. From a small distance to cardinal process, a thin and low median septum extends to the middle part of the valve, where it terminates in a high and blade-like protubelance. The muscular impressions are not clear while the position of the brachial ridges is generally shown by an abruptly elevated area.

Measurements of the shells are as follows: (in mm.)

	ventral valves				dorsal valve
Shell length	6.6	8.2	8.1	8.3	6.8
Shell breadth	11.2	13.0	17.8	15.0	12.2

Remarks: This species is referable to *Chonetes* (*Plicochonetes*) *simulata* REED from the lower or middle Productus Limestone of Salt Range, (REED, 1944, p. 117, Pl. XX, figs. 12, 13.), but distinguished from the latter by its more semi-circular outline with long hinge-line and more shallow sinus of ventral valve. This is also related to *Chonetes tenuilata* CHAO by its shape, while its short median septum of ventral valve, more inflated ventral valve and rather coarse surface striations distinguish it from the latter. In these respects, this species obviously new to science. The specific name is dedicated to Professor S. MATSUSHITA of the writer's Institute.

Localities and Occurrences: Nomaru, Okuyama, Ôe-cho, Kasa-gun, Kyôto Prefecture (Loc. No. KP-7). This species associates with *Linoproductus kiangsiensis*, *Productus* (*Dictyoclostus*) cf. *margaritatus*, and *Hustedia grandicosta*.

Miyanooku, Nishisaka, Monobe-cho, Ayabe City, (Loc. No. KP-11), in association with *Chonetina* cf. *strophomenoides*, *Lissochonetes* cf. *avicula*, and *Lissochonetes* sp.

Reg. Nos.: JP 30042-30054.

***Lissochonetes bipartita* (WAAGEN)**

Pl. 16, figs. 27-29.

1884. *Chonetes bipartita* WAAGEN, Productus Limestone Fossils: iv, Brachiopoda. Pal. Indica, ser. XIII, Salt Range Fossils, p. 624, Pl. LIX, figs. 1, 2.

Outline of the shell is transversely oval. The ventral valve is slightly inflated, and regularly curved in the longitudinal direction, but less so transversely. On the marginal part, especially on the lateral side the shell is considerably flattened. Apex is prominent, pointed and bent over. Hinge line is straight and its length is shorter than the entire breadth of the shell. On

the surface of the shell, two very broad rounded folds diverge from apex to frontal margin. These folds are separated from each other by a very narrow sinus. The sinus commences only at a certain distance from the apex. The surface of the valve is perfectly smooth and the interior surface is also quite smooth. The dorsal valve is not obtained.

Measurements of the shells are as follows: (in mm.)

Length of the shell	5.7	6.2	6.3	5.6	6.6
Breadth of the shell	7.9	9.1	9.2	9.0	9.3
Length of the hinge-line	5.7	6.2	6.6	6.7	7.2

Remarks: This species is characterized by smooth exterior, round diverging folds and a narrow sinus, succeedingly this is a species of genus *Lissochonetes* DUNBAR & CONDRA (1932, p. 132). The present species quite resembles *Chonetes bipartitia* WAAGEN from the Upper Productus Limestone of the Salt Range. *Chonetes morahensis* and *Chonetes trapezoidalis* are comparable to the present species, but the former two species are easily distinguishable by their broader median sinus and general outline. The present specimens have smaller shell than those of Indian original species (Japanese species are 1/2 or 2/3 of the original species in size).

Localities and Occurrences: This species is obtained from bluish fine calcareous sandstone of the Permian Nukada Formation of the Maizuru Group at Takauchi of Yakuno (Loc. No. MN-7), in association with same species as those of *Derbyia hemisphaerica* var. *radiata* REED. This species is also collected at Katsuradani, Hirobatake, Ôe-cho, Kyôto Pref. (Loc. No. KP-5).

Reg. Nos.: JP 30055-61.

***Lissochonetes morahensis* (WAAGEN)**

Pl. 16, figs. 24-26.

1884. *Chonetes morahensis* WAAGEN, Productus Limestone Fossils, iv, Brachiopoda, Pal. Indica, ser. XIII, p. 620, Pl. LIX, figs. 6, 7, 8.

This species is given by ill-preserved internal moulds of ventral valve. The outline of the shell is semi-circular and hinge line is as long as or somewhat shorter than the greatest breadth of the shell. The valve is rather flat and not much inflated, especially in the transverse direction, but the posterior part of the shell is rather steeply curved. The apex is less prominent and not pointed. From the apex towards the frontal margin, there extends two diverging broad folds, which are separated each other by a deep but not broad sinus between them. The external surface of the shell is almost smooth, and very fine concentric growth lines are visible in well-preserved specimen, but at almost specimens such fine ornamentations are not observable.

Measurements of the shells are as follows: (in mm.)

Length of the shell	6.5	6.3	5.6	5.5
Breadth of the shell	9.6	10.0	9.3	8.4
Length of the hinge line	9.1	8.7	6.8	6.0

Remarks: The specimens are ill-preserved and minute features of shell are less clear. Though the outline of some specimen is somewhat quadrate, almost specimens resemble to *Lissochonetes morahensis* (WAAGEN) in round semi-circular outline. Comparing to *Lissoch. trapezoidalis* (WAAGEN), the present specimens have more round outline and broad and shallow sinus.

Locality and Occurrence: Same as *Lissochonetes bipartita*.

Reg. Nos. JP 30064-68.

***Lissochonetes* cf. *avicula* (WAAGEN)**

Pl. 16, figs. 30-33.

cf. 1884. *Chonetes avicula* WAAGEN, Productus Limestone Fossils: iv, Brachiopoda, Pal. Indica, Ser. XIII, Salt Range Fossils, p. 622, Pl. LIX, fig. 5.

Specimens of this species are ill-preserved internal moulds of ventral valve. The shell is nearly rectangular or squarish in outline, and slightly inflated. Hinge line is straight and possesses almost entire length of the shell. The valve has two radiating folds, rather prominent and rounded, which intercalate a shallow but distinct sinus between them. The folds are rather less prominent on marginal part. Sinus originates at a certain distance from apex and is most remarkable in the middle between apex and margin. On the frontal margin the sinus becomes more broad and less distinct, corresponding to flat folds. The area is not sufficiently preserved. In some well preserved specimens, the area is comparatively large and characterized by 3 or 4 tubes which begin from hinge line, converge toward apex, but not reach apex. They probably prolongate to external spines, as in cases of other Chonetid species. The valve have a very short, rather obsolete median septum at apex. The external surface of the shell is ill-preserved, and seems to be almost smooth. The internal surface is also smooth.

Measurements of the shells are as follows: (in mm.)

Length of the shell	6.4	5.5	5.6	6.8
Width of the shell	9.8	8.3	7.9	8.4

Remarks: The outline and whole shape of the present species resemble two species of WAAGEN's *Chonetes* (*Chonetes avicula* and *Ch. morahensis*). WAAGEN had distinguished *Ch. avicula* from *Ch. morahensis* only by its nearly squarish out-line and undulating shell margin. The difference between two species in his figures is not so remarkable as description. The writer hardly defines the present species to *Ch. avicula* by its outline.

Locality and Occurrence: Same as *Lissochonetes bipartita*.

Reg. Nos. JP 30069-75.

Lissochonetes sp.

Pl. 16, figs. 34-38.

Specimens of this species are internal moulds of ventral valves. The outline of the shell is somewhat inflated, almost flat in middle part and gradually curved to marginal part. Two folds are represented by very obscure, parallel and round ridges in the middle of the shell. They are separated by very narrow and shallow sinus or rather valley between them. At apical and marginal parts, they are obsolete. In some specimens the folds and sinus apparently entirely absent. Apex is not prominent and somewhat pointed. Hinge line is straight and its length is as wide as entire breadth of the shell. Surface is quite smooth. At the apex, a short but very distinct septum is observed, and which decreases its height posteriorly and changes to low but distinct ridges with about two third length of the shell. Surface of the internal mould is quite smooth, and in some well-preserved case small punctations are visible on whole surface.

Measurements: (in mm.)

Length of the shell	5.5	6.2	5.6	6.7	6.0	6.3
Width of the shell	10.0	8.6	9.5	10.6	10.8	8.5?

Remarks: The present species is characterized by semi-circular outline, very shallow sinus and low but long median septum. The folds and sinus are somewhat alike but more obscure than those of WAAGEN's *Chonetes bipartita*. In some specimen, these surface ornaments apparently absent. On the outline, the present species resembles *Chonetes morahensis* WAAGEN, however the folds and sinus of the latter is more remarkable. The low but long median septum is most characteristic in this species and not comparable to those of other Chonetids. Although, the external shape of this valve is not presented, the present species is probably new to science.

Locality and Occurrences: Same as those of *Lissochonetes bipartita*.

Reg. Nos.: JP 30076-88.

Products (Dictyoclostus) graciosus WAAGEN

Pl. 15, figs. 19-21.

1884. *Productus graciosus* WAAGEN, Productus Limestone Fossils, iv Brachiopoda, Pal. Indica, ser. XIII, Salt Range Fossils, pp. 691-693, Pl. LXXII, figs. 3-7.
1897. *Productus graciosus*. DIENER, The Permocarboniferous Fauna of Chitichun, No. 1. Pal. Indica, ser. XV, Himalayan Fossils, Vol. I, p. 23, Pl. III, figs. 3-7.
1916. *Productus graciosus*. BROILI, Die Permischen Brachiopoden von Timor. Pal. von Timor, p. 12, Pl. CXVI (2), figs. 4, 5, 7-13.
1927. *Productus graciosus*. CHAO, Productidae of China, pt. 1, Pal. Sinica, ser. B, Vol. 5, fasc. 2, pp. 44-47, Pl. IV, figs. 6-10.

1933. *Productus (Dictyoclostus) graciosus*, HUANG, Late Permian Brachiopoda of Southwest China, Pt. I, Pal. Sinica, ser. B, Vol. IX, fasc. 2, p. 88, Pl. XI, fig. 14.
1960. *Productus (Dictyoclostus) graciosus*, HAYASAKA. On the Occurrence of *Neospirifer fasciger* (Keyserling) in Japan, and a Note on Some Associate Permian Brachiopods from around Kesen-numa City, Northeast Japan, Coll. Essays Comm. 10th Anniv. Shimane Univ. (Nat. Sci.), pp. 49-50, Pl. I, fig. 8.

Incomplete moulds of one ventral valve is in hand, of which the external one is fragmental. The shell is strongly inflated, but its curve is not equal in the longitudinal direction. It is slightly inflated in the apical part, then strongly geniculated. After there the shell curves regularly down to the frontal margin. Transversely the curve is regular and strongly impressed in the middle. The hinge line is not so long, but occupying the greatest breadth of the shell. The wings are small, but distinct and pointed. From the apex, a deep and narrow sinus commences, and extends to the frontal margin, becoming more broad and shallow. In the apical part, the shell is covered by very distinct and fine reticulation, which extends from apex for about 16 mm. along the curve. After the geniculation, only the radial ribs remain. The radial ribs are fine and not distinct for ill-preservation. The frontal margin of the shell is not preserved. The dorsal valve is not obtained.

Measurements:	Length of the shell in a straight line	15? mm.
	Length of the shell along the curve	30? mm.
	Length of the hinge-line	26.0 mm.
	Thickness of the valve	16.0 mm.

Remarks: The present specimen agrees with *Productus graciosus* WAAGEN in the shell shape, in the surface ornamentation and in the character of the sinus. It is strongly geniculated than that of Indian original specimens.

Locality and Occurrence: This species is collected from calcareous very coarse—granulic sandstone of the Maizuru Group at Nomaru of Okuyama, Ōe-cho, Kasagun, Kyoto Prefecture (Loc. No. KP-7), in association with *Chonetina matsushitai* n. sp., *Productus (Dictyocl.) cf. margaritatus*, *Prod. (Dictyocl.)* sp., *Linoproductus kiangsiensis* and *Hustedia grandicosta*.

Reg. No. JP 30089 A, B.

***Productus (Dictyoclostus) cf. margaritatus* MANSUY**

Pl. 15, fig. 28.

- cf. 1913. *Productus margaritatus* MANSUY. Faunes des Calcaires a Productus de l'Indochine, Premier Serie, Mém. Service géol. de l'Indochine, Vol. II, fasc. IV, p. 38, pl. II, fig. 6.
- cf. 1931. *Productus (Dictyoclostus) margaritatus*, HUANG, Late Permian Brachiopoda of Southwest China, Part. I, Pal. Sinica, Ser. B, vol. 9, pp. 30-32, 32, Pl. I, figs. 22-24.

This species is represented by incomplete external moulds of brachial valve. The valve has semi-circular outline, and is somewhat concave. It is rather flattened at the umbonal region but becomes strongly concave to posterior

margin. Transversely, the shell is moderately depressed and gradually turns upward at margins. The beak is not pointed. The hinge line is straight and extends as greatest width of the shell. The ears are small and flattish, not distinctly marked off and form almost right angle at the extremities. The umbonal region is somewhat deepened and gradually tends shallow and turns to a shallow fold at the posterior margin. The surface sculpture is consisted of radial plicae and concentric ribs, which give rise to a fine reticulation on the all surface of the shell. The plicae and ribs are of nearly equal strength and are spaced at equal intervals, about 14 of them being counted in a distance of 5 mm. on the umbonal region and 10 on the posterior margin.

Measurements: Length of the shell in a straight line 16.5 mm.

Greatest width along hinge line 27.8 mm. +

Remarks: Some broken brachial valves are at hand. The pedicle valve is not obtained. Although the writer is not able to refer Mansuy's original description and HUANG's description not gives characters of brachial valve, the figure of HUANG's brachial valve intimately resembles the present specimen. So the writer can confirm the present specimen to be *Productus (Dictyoclostus) margaritatus*.

Locality and Occurrence: Same as *Productus (Dictyoclostus) gratiosus*.

Reg. Nos. JP 30090-92.

***Productus (Dictyoclostus)* sp.**

Pl. 15, figs. 13-15.

cf. 1897. *Productus boliviensis* d'ORBIGNY var. *chitichunensis* DIENER. The Permocarboniferous Fauna of Chitichun, No. 1, Pal. Indica, Ser. XV, Himalyan Fossils, Vol. I, Pt. 3, pp. 20-23, Pl. II, Figs. 2, 4.

One external mould of dorsal valve is obtained. The shell is strongly concave, having transverse outline. The curvature of the shell is very regular, somewhat flat at apical part and rather strongly geniculate in the middle and becomes less inflate at frontal margin. Beak is not prominent nor bent over. Hinge line is straight and possesses the greatest width of the shell. The most characteristic feature of this specimen is two distinct and long ears. Consequently, the outline of this specimen seems a trapezoidal profile. Very low and shallow fold commences from near the apex and becomes more broad and shallow posteriorly. The surface sculpture is consisted of radial and concentric ribs, which are fine and equal in size and form distinct reticulation at umbonal part. On the posterior half of the shell, only radial ribs remain. The internal structure is not preserved.

Measurements: Length of the shell on a straight line 17.0 mm.

Length of the shell on curvature 23.5 mm.

Length of the hinge line 17? mm.

Thickness of the shell 9.0 mm.

Remarks: The present species is referable to *Productus* (*Dictyoclostus*) *semireticularis* and its allied species on its shape, surface ornamentation etc., but it is most probable that the present specimen belongs to *Productus boliviensis* var. *chituchinensis* DIENER on its strong curvature and long and distinct ears. Unfortunately, the writer cannot obtain the ventral valves and refer d'ORBIGNY's description. For these reason, the decided specific determination of this specimen is impossible.

Locality and Occurrence: Same as *Productus* (*Dictyoclostus*) *gratiosus*.

Reg. Nos. JP 30093-95.

***Linoproductus kiangsiensis* (KAYSER)**

Pl. 15, figs. 16, 17.

1882. *Productus kiangsiensis* KAYSER, Richthofen's China, Vol. IV, p. 185, Pl. XXVI, figs. 6-11.

1884. *Productus tumidus* WAAGEN. *Productus* Limestone Fossils: iv, Pal. Indica, Ser. XIII, Salt Range Fossils, p. 708, Pl. LXXX, figs. 1-3.

1927. *Avonia? kiangsiensis* (KAYSER), Chao, *Productidae of China*, Pt. 1, *Producti*, Pal. Sinica, Ser. B, Vol. 5, p. 125, Pl. XIV, figs. 14-16.

1928. *Thomasia kiangsiensis* (KAYSER), Chao, *Productidae of China*, pt. II, Pal. Sinica, Ser. B, Vol. 5, p. 59, Pl. VI, fig. 18.

1932. *Linoproductus kiangsiensis* (KAYSER), Huang, *Late Permian Brachiopoda of Southwest China*, Pal. Sinica, Ser. B, Vol. 9, p. 46, pl. III, figs. 3-15, 19.

This species is represented by incomplete internal and external moulds of a ventral valve, and of which the latter is less complete. Shell is transverse and subrectangular in outline. The valve is strongly and regularly inflated. Beak is pointed, only slightly incurved and barely overhanging on hinge line. Transversely, the shell is strongly curved, being flattened in middle part but sloping very steeply towards both sides. Ears are incompletely preserved, small and flattish. No sinus nor folds are presented. Surface is marked only by low striae and small number of spine-base-like spots. These striae are fairly regular in earlier stage and increase in number by bifurcation on posterior part. Though concentric ribs are entirely absent on main part of the shell, some prominent wrinkles are observable on each ears.

Measurements are as follows:

Length of the shell on a stright line	14.4 mm.
Entire breadth of the shell	?9.0 mm.
Thickness of the shell	5.5 mm.
Length of the hinge line	?8.0 mm.

Remarks: This specimen is incomplete, but outline of the shell and surface ornamentations are enough to determine it as *Linoproductus kiangsiensis* (WAAGEN's *Productus tumidus*). The present specimen has little spine bases on the external surface than those of original species.

Locality and Occurrence: Same as *Productus (Dictyoclostus) graciosus* WAAGEN.
Reg. No. 30096 A, B.

***Linoproductus interruptus* HUANG**

Pl. 15, figs. 11, 12.

1931. *Linoproductus interruptus* HUANG, Late Permian Brachiopoda of Southwest China, Pal. Sinica, Ser. B, Vol. 9, fasc. 1, pp. 44-45, Pl. III, figs. 8, 9.

This species is represented by moulds of a dorsal valve. Out line of the shell is exceedingly transverse and subquadrate. It is deeply excavated in umbonal region becoming less so anteriorly. Towards front it abruptly bends upwards resulting in a strongly reflected cincture while at the frontal margin the shell resumes its downwards growth. The cincture occupies almost half length in straight line of the shell length. The hinge line is straight and possesses almost width of the shell. Area is not shown. The beak is pointed and slightly elevated from the hinge line. In the umbonal region, the hinge line is somewhat elevated. Though the area absent, the cardinal extremities are very characteristic. The shell margin, forming a circular, curves gradually inwards the hinge-line. As it approaches the latter, however, it bends abruptly outwards forming an acute angle with the hinge line.

The surface is covered by characteristic radial striae and concentric ribs. The striae are very fine and rounded in cross section. They extend from the beak to the anterior margin and increase in number by intercalation and bifurcation. They may be counted 11 on the front, while 16 in the umbonal region in space of 3 mm, but they are not homogeneous according to deformed shape. The concentric ribs are very coarse and irregular and are separated by deep valleys. On the anterior part, they appear very strong and wide on flanks, but become rather vaguely developed in the median area. On the cincture, the ribs are very weak and vanished. Spines are not preserved.

Measurements:	Length of the hinge-line	14 mm.+
	Length of the valve	8.5 mm.+

Remarks: This specimen strikingly resembles HUANG's species, but the present specimen is small and ill-preserved than original one. The ribs are very weak in the umbonal region than that of Chinese specimen.

Locality and Occurrence: Same as *Derbyia altistriata*.
Reg. No. 30097 A, B.

***Aulosteges dalhousi* DAVIDSON**

Pl. 17, figs. 1-3.

1862. *Aulosteges dalhousi* DAVIDSON. On Some Carboniferous Brachiopoda collected in India. Quart. Jour. Geol. Soc. London, Vol. XVIII, p. 33, Pl. II, fig. 7.

1884. *Aulosteges dalhousi*, WAAGEN. Productus Limestone Fossils: iv, Brachiopoda, Pal. Indica, Ser. XIII, Salt. Range Fossils, p. 662, Pl. LXIII, fig. 1.

This species is represented by one cast of ventral valve. The general outline of the shell is broadly triangular and wider than long. The valve is not very strongly vaulted, and its curve is somewhat irregular. Longitudinally, the valve is tolerably flat in most part of the shell and it slightly bends up to the front line. Transversely, the curve is more regular, and indented in the middle by a broad and very shallow median sinus, which decreases its depth anteriorly and becomes almost obscure at the middle of the shell. The hinge line is short and ill-preserved. The apex is prominent, pointed and a little bent to the hinge line. The area is not clearly observed. The whole surface of the valve is covered with closely set hollow spines, of which the majority is directed forward, and some of them are erected. Very fine concentric growth lines are preserved. The dorsal valve is not collected.

Measurements: Length of the shell	29 mm.
Width of the shell	20.5 mm.
Length of the hinge-line	10 mm.
Thickness of the valve	8.5 mm.
Apical angle	70°

Remarks: Among the specimens of Productidae of the Kawahigashi Fauna, the present species is most characteristic in its shape and many spines. This specimen resemble to *Aulosteges dalhousi* DAVIDSON from the Carboniferous? Limestone of Moosakheil of India. The present specimen has more elongated and slender beak than that of the original specimen, and it is more intimate to same species of WAAGEN from the upper beds of the Middle Productus Limestone of the Salt Range. TSCHERNYSCHEW reported this species from the Schwagerinen Kalk of Ural, but his specimen has more round and inflated shell and cannot be compared to original and the present specimens.

Locality and Occurrence: This species is collected from calcareous sandstone at Katsuradani, Kawahigashi, Ôe-cho, Kyoto Pref. (KP-5). This species associates with *Chonetina matsushitai* n. sp., *Lissochonestes bipartita*, *Lissoch. morahensis* etc.

Reg. No. JP 30098 A, B.

Hustedia grandicosta (DAVIDSON)

Pl. 16, figs. 39-42.

1862. *Retzia radialis* PHILL., var. *grandicosta* DAVIDSON, Quart. Jour. Geol. Soc. London, Vol. XVIII, p. 28, Pl. I, fig. 5.
1882. *Eumetria grandicosta*, WAAGEN, Productus Limestone Fossils, iv, Brachiopoda, Pal. Indica, Ser. XIII, Salt Range Fossils, p. 491, Pl. XXXV, figs. 6-12.
1899. *Eumetria grandicosta*, DIENER, Anthracolithic Fossils of Kashmir and Spiti, Pal. Indica, Ser. XV, Himalayan Fossils, Vol. I-2, p. 54, Pl. 61, fig. 10.
1911. *Retzia (Hustedia) grandicosta*, FRECH, Richthofen's China, 5 Bd., S. 117, T. 16, figs. 7, 8.
1916. *Retzia (Hustedia) grandicosta*, BROILI, Die Permischen Brachiopoden von Timor, XII, p. 54, Pl. CXXV, figs. 1-3, Pl. CXXIV, figs. 14-22.

Some internal and external moulds of both valves are in hand. General outline of the shell is more or less elongately oval with slender prominent beak. Neither sinus nor median fold is developed. Area is not preserved. Ventral valve is moderately convex. The beak is long, quickly tapering and well bent over. Foramen is not found. Externally bears 11 or 12 coarse radiating costae, which are rounded on their tops and separated from each other by angular interplical valleys. The median valley is not broader and deeper than others. On the dorsal valve, bears 12 or over costae and the median one of them nearly always commences at certain distance from apex and is less stronger than others in the middle part. But the difference in size decreases towards posterior portion. Surface of the both valves are quite smooth and the growth line is not observed. A median septum of dorsal valve is short, besides, on the ventral valve, no internal structures are presented.

Measurements of the shells are as follows: (in mm.)

	ventral valves				dorsal valve
Length of the shell	8.5	9.4	7.6	8.4	6.4
Breadth of the shell	6.5	7.0	5.8	6.0	5.7
Thickness of the valve	2.0	2.3	—	1.9	2.0
Number of constation	12	12	11	11-12	10

Remarks: Several isolated valves from different localities are presented, and none of them are clearly observable on the hinge characters. The general outline and surface sculptures are strikingly similar to those of *Hustedia grandicosta* (DAVIDSON). The present species is distinguished from *Hustedia remota* (EICHWALD) by its narrow and angular interplical valleys.

Localities and Occurrences: This species is collected from calcareous very coarse to granulic sandstones at Nomaru of Okuyama, Ôe-cho, Kasa-gun, Kyôto Pref. (Loc. No. KP-7), and associates with *Chonetina matsushitai* n. sp. and other species. This is also collected from calcareous fine sandstone east of Mt. Miyagadake, Matsubara, Toyosato-cho, Ayabe City (Loc. No. KP-12) in association with *Lissochonetes* cf. *avicula* and *Hustedia indica*. Many specimens are collected in association with *Derbyia altestriata*.

Reg. Nos. JP 30099 A, B, JP 30102-30105.

***Hustedia indica* (WAAGEN)**

Pl. 16, figs. 43-45.

1882. *Eumetria indica* WAAGEN, Productus Limestone Fossils, iv, Brachiopoda, Pal. Indica, Ser. XIII, Salt Range Fossils, p. 493, Pl. XXXV, figs. 1, 2.
 1902. *Hustedia indica*, TSCHERNISCHEW, Die obercarbonischen Brachiopoden des Ural und des Timan, Mém. Com. Géol. Russie, Vol. XVI, No. 2, p. 512, Pl. 47, fig. 12.
 1916. *Retzia (Hustedia) indica*, BROILI, Die Permischen Brachiopoden von Timor, Palaeontologie von Timor, VII, p. 54, Pl. 47, figs. 4-6.
 1932. *Hustedia indica*, HUANG, Late Permian Brachiopoda of Southwest China, Pal. Sinica, Ser. B, Vol. IX, p. 78.

This species is represented by several internal moulds of both valves, which are not isolated. The general outline of the shell is elliptical oval and as long its breadth is almost as its length. The ventral valve is generally inflated and shows a regular curve. Beak is thick, prominent and very little curved, but not so long. The ventral venes are ornamented by 9 to 10 coarse radiating folds, which are rounded on top and separated each other by equally broad but somewhat sharp furrows, of which the median one is very slightly broader and deeper. The dorsal valve is less inflated than the ventral valve. It is covered by 7 to 9 coarse radiating folds, of which the median one is slightly large. The surface of both valves are smooth and fine ornamentations like as the growth lines are not preserved.

Measurements:	Length of ventral valve	7.0 mm
	Length of dorsal valve	5.5 mm
	Width of shell	5.5 mm
	Thickness of shell	3.0 mm

Remarks: This species are mostly related to *Hustedia grandicosta*, but can be distinguished from that species by its round and broad furrows and more globular shape with rather short beak. The present species is not so globular in outline like as *Hustedia remota* (EICHWALD). Although the preset specimens are less inflated, they can be defined as *Hustedia indica* by their shapes and external ornamentations.

Locality and Occurrence: The present species is collected from Miyaodani, Takauchi of Yakuno (Loc. No. MN-7) in association with *Chonetina matsushitai* n. sp. &c, and from Miyano'oku, Monobe of Ayabe City (Loc. No. KP-11) in association with *Chonetina* cf. *strophomenoides* &c, and from east of Mt. Miyagadake, Matsubara of Ayabe City (Loc. No. KP-12) in association with *Lissochonetes* cf. *avicula* and *Hustedia grandicosta*.

Reg. Nos. JP 30106-7.

***Eolyttonia nakazawai* n. sp.**

Pl. 15, figs. 22.

This species is represented by only one internal mould of ventral valve. Outline of the shell is elliptical and possesses very distinct continuous margin. Breadth of the shell is wider than the length. Shell is flat and somewhat concave. Lateral septa are represented by three furrows which are rather narrow, almost straight and parallel. Secondary callosity of the lateral septa in external lobes is entirely absent and it is represented by narrow, distinct and high ridges in lateral furrows. Median septum is short and not distinct, but composed of complex septa. Of these lateral ridges, the second and the third ones of the right half were destroyed in the course of cleaning. Spaces between the lateral septa are rather wide and flattened. On the surface of

mould, many lateral striations are visible. They are probably impressions of ornamentation of other brachiopod shell, on which the present specimen had attached and they have been impressed after the shell had been dissolved.

Measurements: Length of the shell 11 mm.
 Width of the shell 16.5 mm.

Remarks: After the establishment of the genus *Leptodus* by KAYSER in 1883, this most characteristic brachiopoda of the Permian System has been studied by many paleontologists and some allied genera have been found. In 1916, FREDERICKS proposed a hypothesis on the development of shell structure of the Lyttoninae group. He said, "The highest stage of development of the septal apparatus we find in *Oldhamina-Lyttonia*, which has between the external lobes of the primary septum a secondary callosity (it has a complex median and lateral septa), this is called the Lyttonia-type septal apparatus. The preceding stage differs from the one described by full absence of secondary callosity in the external lobes of septum; the number of septal lobes of this stage is intermediate between *Oldhamina* and *Keyserlingina* type, this is called para-keyserlingina type of septal apparatus and the corresponding genus is called *Parakeyserlingina*". In 1923 he established a new genus *Eolyttonia* as an intermediate type between *Oldhamina-Lyttonia* and *Parakeyserlingina*. This new genus is small in size and fixed by all the surface of ventral valve throughout life.

The present species rather resembles *Parakeyserlingina* in entire absence of secondary callosity of lateral septa, but the former is distinguished from the latter by its narrow spaces between the lateral lobes, composed median septum and type of attachment. Accordingly, the present species must be a species of *Eolyttonia* FREDERICKS judging by these features. This species is comparable to FREDERICKS' *Eolyttonia iwanovi* and *E. mira* judging by the small sizes and small number of lateral septa. But the flatness and weak median septum and smaller size distinguish the former from the latter two FREDERICKS' species. WAAGEN's species *Lyttonia tenuis* differs from the present species in the more developed secondary callosity and type of attachment. Moreover the present species has no long median septum as that of *Lyttonia tenuis*. In short, the present species of *Eolyttonia* is new to science and a most primitive form of that genus and a intermediate type between *Parakeyserlingina* and *Eolyttonia*. The specific name is dedicated to Dr. Keiji NAKAZAWA who collected the present specimen.

Locality and Occurrence: This specimen was collected from a calcareous sandstone at Miyaodani of Takauchi, Yakuno-cho, Kyôto Prefecture, (Loc. No. MN-7) in association with *Derbyia hemisphaerica* var. *radiata* &c.

Reg. No. JP 30100.

Part 2. The Takauchi Fauna

The Takauchi Brachiopoda Fauna, here described, has been well known as a "*Lyttonia*" bearing fauna in Takauchi Limestone of Yakuno, Kyoto Prefecture, Southwest Japan. This limestone bearing formation has been very little studied geologically and also paleontologically for a long time, and was merely known as the Jurassic in age from fossil evidence reported by Dr. M. YOKOYAMA, 1891. In 1934, Mr. MASHIKO discovered from this limestone a fossil of "*Lyttonia*" *richthofeni* and proved its age the Permian Period. Accordingly, many geologists visited this district, especially Dr. KOBAYASHI had shown the Triassic formation and the Permian formation in a complicated structure. He reported from this Takauchi limestone some fossils of brachiopod and bryozoa, namely, *Martinia* sp., *Squamularia* sp., *Spirifer* sp., *Schizophoria* sp., *Camarophoria* sp., Productid sp., Stenopora sp., Pinatopora, Fisturipora and crinoid stems.

A most recent work was reported by NAKAZAWA, SHIKI and the writer in 1958. According to this report, the Permian Formation (the Nukada Formation) is composed of sandstone, slate, conglomerate and limestone lenses and contains the *Lepidolina* fauna in calcareous conglomerate, some brachiopods in calcareous sandstone and gastropods in limestone lenses. Brachiopods of the Nukada Formation (in its sandstone) were described as the Kawahigashi Fauna in the preceding part of this paper.

The Takauchi Limestone was included in the Nukada Formation in the former report, but it is an isolated rock mass of limestone and slate and has no direct connection with the Nukada Formation proper, and the fossils of this limestone are not similar to those of the Kawahigashi Fauna. Consequently, the writer intends to name this formation the Takauchi Formation, and the brachiopod fauna the Takauchi Fauna. The Nukada and the Takauchi Formations compose the Permian Maizuru Group of the Yakuno District.

This fauna is composed of the following species.

- Leptodus richthofeni* KAYSER
- Squamularia indica* (WAAGEN)
- Squamularia elegantula* (WAAGEN)
- Squamularia* cf. *calori* (GEMELLARO)
- Streptorhynchus semiplanus* (WAAGEN)
- Streptorhynchus kayseri* SCHELLWIEN
- Martinia elegans* DIENER
- Kiangsiella deltoidens* (WAAGEN)
- Strophalosiina tibetica* (DIENER)
- Neospirifer* sp.

Among them, the most remarkable species is *Leptodus richthofeni*, and by it the fauna had been correlated to the Middle Permian. Concerning this species, we have the excellent work of Dr. HAYASAKA (*Lyttonia richthofeni*

Table 4. Faunal list of the Takauchi Fauna and its relation to other faunas.

	Kitakami Kanokura	SW China			Prod. Ls.		
		Ch	Ma	Lop	Low	Mid	Up
<i>Leptodus richthofeni</i>	+			—		—	
<i>Squamularia indica</i>				—		—	
<i>Squamularia elegantula</i>				—		—	
<i>Squamularia cf. calori</i>			—			—	
<i>Streptorhynchus kayseri</i>				—			—
<i>Streptorhynchus semiplanus</i>							—
<i>Martinia elegans</i>							—
<i>Kiangsiella deltooidens</i>						—	
<i>Strophalosiina tibetica</i>						—	
<i>Neospirifer</i> sp.	?					?	

KAYSER em., 1922), and the writer finds no description to add to former works. Nevertheless, the writer believes that the specific name KAYSER's *Leptodus richthofeni* has a priority to WAAGEN's *Lyttonia nobilis*.

The Takauchi Fauna is compared with the fauna of the Loping Series of Southwest China, especially with its lower formation, and these two fauna have some same elements as those of the middle Productus Limestone of Indian Salt Range. From these facts, the Takauchi Fauna can be correlated to the upper to middle Permian and a lower horizon than the Kawahigashi Fauna. It is probable that the Takauchi Fauna indicates the upper division of the middle Permian System.

Description of Species

Squamularia indica (WAAGEN)

Pl. 17, figs. 4-7, 13.

1882. *Reticularia indica* WAAGEN, Productus Limestone Fossils: iv Brachiopoda, Pal. Indica, Ser. XIII, Salt Range Fossils, pp. 542-545, Pl. XLIII, fig. 2.
1911. *Spirifer (Reticularia) indicus*, FRECH, Richthofen's China, Vol. V, p. 18, 141, 156, Pl. XXVIII, fig. 4.
1916. *Spirifer (Reticularia) lineatus*, BROILI, Palaeontologie von Timor, Vol. VII, p. 40, Pl. CXXII, fig. 5.
1931. *Squamularia indica*, GRABAU, Permian of Mongolia, Nat. Hist. of Central Asia, Vol. IV, p. 200, Pl. XVII, fig. 5, Pl. XVIII, figs. 2-4.
1933. *Squamularia indica* HUANG, Late Permian Brachiopoda of Southwest China, Pt. II, p. 38, Pl. V, figs. 8-10.

This species is represented by several fragmental specimens of isolated both valves. The general outline of the shell is not preserved, but its orbicular shape can be estimated. Shells are slightly inflated with a prominent, not very strongly bent beak. The ventral valve is slightly vaulted and thus alightly deeper than the dorsal one. The curvature of the shell is stronger in the apical part than in the frontal region. The beak is very prominent, pointed and little bent over. The area is not clearly preserved, but its space is occupied by the extremely large triangular fissure, and the width of it on the hinge line occupies two thirds of the entire width of that line. Pseudodeltidium absent. Sinus is shallow and almost obsolete at frontal margin.

The dorsal valve is flatter than the ventral valve and curves more strongly in the transverse than in the longitudinal direction. The apex is less prominent, pointed and slightly bent over. Fold is not developed.

The surface ornamentation is ill-preserved, and the most specimens are stripped off their outmost shell layer. In some specimen, weak concentric growth lines are visible. Good-preserved specimens have many uniramous spine bases along the growth-lines. In the ventral valve, neither dental plate nor median septum is present. The dorsal valve also has no internal structure. Entire length of the shell is not measured. Entire width of it is measured 48 mm in straight line.

Remarks: Though ill-preservation of the specimens, whole shape, curvature and apical character of the shell are quite enough to define the specimens as *Squamularia indica* (WAAGEN). According to MINATO, genus *Squamularia* has neither dental nor median septum in ventral valve, and it is distinguished from *Phyricodothyris* by uniramous spine bases along growth lines on shell surface. The present specimens have such characteristic ornamentations on the shell surface in some good cases.

Locality and Occurrence: This species is collected from Takauchi Limestone of Yakuno, Kyôto Prefecture, in association with *Leptodus richthofeni*, *Squamularia* cf. *calori*, *Squamularia elegantula*, *Streptorhynchus semiplanus*, *Streptorhynchus kayseri*, *Martinia elegans*, *Kiangsiella deltoicens*, *Strophalosiina tibetica* and *Neospirifer* sp.

Reg. Nos.: JP 30110-114.

***Squamularia* cf. *calori* (GEMELLARO)**

Pl. 17, figs. 9, 10.

cf. 1898. *Reticularia calori* GEMELLARO. La Fauna dei Calceri con Fusulina della Valle del Fiume Socio, Molluscoidea IV, Pt. I, Pl. XXXIV, pp. figs. 11-20.

1933. *Squamularia* cf. *calori*, HUANG. Late Permian Brachiopoda of Southwest China, Pt. II, Pal. Sinica, Ser. B, Vol. 9, fasc. 1, pp. 38-40, Pl. V, figs. 11-12.

Only one ventral valve of this species is obtained. It is a broken specimen. Shell is elongately oval in outline. The valve is regularly and strongly inflated.

The longitudinal curve is not uniform and most convex in the anterior and becoming nearly flat in the posterior portion. Transversely the shell is more convex. The beak is very prominent, pointed, overhanging and flanked by concave shoulders. The area and hinge are ill-preserved and minute characters are not clear. The sinus is almost obsolete. The posterior part of the shell is irregularly deformed. Though the ill-preservation of the surface, it is observable that fine concentric growth lines are decorated by minute uniramous spine bases. The growth lines are rather widely spaced.

Entire length of the shell is measured 45 mm., and the width of it is measured 37 mm. at straight line.

Remarks: The writer cannot refer the original description of GEMELLARO. The present specimen is somewhat similar to *Squamularia indica* (WAAGEN) in its whole shape and ornamentation, but very prominent beak differs from that of WAAGEN's species, and on the contrary that characters is referable to that of Chinese species *Squamularia* cf. *calori* (GEMELLARO) of HUANG's paper. The present specimen is distinguished from the Chinese species on some features, that is, beak of the latter is less over-hanging and longitudinal curvature is less convex than that of the latter.

Locality and Occurrence: Same as that of *Squamularia indica*.

Reg. No.: JP 30117.

***Squamularia elegantula* (WAAGEN)**

Pl. 17, figs. 8, 14.

1883. *Reticularia elegantula* WAAGEN, Productus Limestones Fossils, iv Brachiopoda, Pal. Indica, Ser. XIII, Salt Range Fossils, pp. 545-546, Pl. XLIV, fig. 1.

A broken ventral valve is in hand. The shell is rather flat, but very regularly curved to both directions and becomes almost flat in both sides. It is more inflate longitudinally than transversely. This shell is somewhat wider than its length. The beak is very thin, but not long and little prominent. It is rather pointed and its apex is well bent over. Neither area nor triangular fissure is observed for its ill-preservation. Neither sinus nor fold present. The surface sculpture is characteristic, that is, it consists of very regular concentric fine folds, which are rather closely and somewhat irregularly spaced. They are counted 11 in a distance of 10 mm. in the middle part of the shell. These folds are occupied by closely arranged row of fine uniramous spine bases. The internal constitution of this specimen is not observed.

Measurements: Length of the shell 30 mm+
 Width of the shell 44 mm

Remarks: This specimen is unfortunately a broken shell, but the whole shape, its curvature and surface ornamentations are referable to those of WAAGEN's *Reticularia elegantula*. Although the internal structure is not shown and generic

determination is not possible. From the surface sculpture the present specimen can be shown as *Squamularia*. From *Squamularia asiatica* (WAAGEN), the present species can be distinguished by its more prominent beak and by its rather less inflated curvature.

Locality and Occurrence: Same as *Squamularia indica*.

Reg. No. JP 30116.

***Streptorhynchus kayseri* SCHELLWIEN**

Pl. 17, figs. 15-18.

1883. *Streptorhynchus crenistria* var. *aenelis* KAYSER (non PHILLIPS), Richthofen's China, Vol. IV, p. 178, Pl. XXIII, fig. 1. (cetera exclus)
1900. *Streptorhynchus kayseri*, SCHELLWIEN. "Beitrage zur Systematik der Strophomeniden des oberen Palaeozoikum", Neues Jahrb. für Min. etc., Jahrg. 1900, Vol. I, p. 6.
1931. *Streptorhynchus kayseri*, GRABAU, Permian of Mongolia, Nat. Hist. Central Asia, Vol. IV, II, Pl. p. 241, Pl. XXIV, figs. 1 a-b.
- cf. 1933. *Streptorhynchus kayseri*, HUANG, Late Permian Brachiopoda of Southwest China, Pal. Sinica, ser. B, Vol. 9, fasc. 2, pp. 15-16, Pl. II, figs. 11-12, Pl. III, fig. 7.

Specimen in hand is one ventral valve and its both lateral sides are lost. This valve is deep, with a high horizontal and flat area. The shell gently curves from beak to frontal margin and forms almost conical shape. The beak is broken at its apex, but erect and somewhat bent to hinge line. The umbonal sides are deflected inwards with an abrupt rounding, passing without sharp demarcation into the hinge area, so that the shoulders proper are depressed and obscure. For this rounding, it is difficult to determine the exact width of area, and consequently hinge line. The area is ill-preserved, but narrow concavity is observed. Shell gently curves from the obtuse cardinal angles, and forms almost conical form, on which neither median sinus nor flattening present. The longitudinal curvature is steep, but regular and almost straight, except for three growth interruptions which form step-like descents in the shell surface. The first one is shallow and faint, the second broad and stronger, while the third is very broad and irregular. Surface sculpture consists of fine radiating striae which are separated by broader interspaces. Growth lines are not visible.

Measurements:	Length of the valve	24 mm.
	Width of the shell	26 mm. (estim.)
	Length of hinge line	9 mm. (13 mm. is estimated)
	Height of area	15 mm.

Remarks: The present specimen can be defined to *Streptorhynchus kayseri* SCHELLWIEN, by its somewhat conical shape and its high area and surface sculptures. Especially the specimens illustrated by GRABAU from Jisu Honger of Mongolia is very similar to present specimen. Unfortunately this specimen is broken at its both lateral wings and more smaller in size than the former

specimens. This is comparable to *Streptorhynchus minutus* HUANG by the whole shape and other characters, but HUANG's specimen is more smaller in size than the two specimens above mentioned. The triangular shape and distinctly bent apex of *Strep. minutus* distinguish it from the present specimen.

Locality and Occurrence: Same as *Squamularia indica*.

Reg. No. JP 30118.

***Streptorhynchus semiplanus* (WAAGEN)**

Pl. 17, figs. 11, 12.

1884. *Orthotetes semiplanus* WAAGEN. Productus Limestone Fossils: iv, Brachiopoda, Pal. Indica, Ser. XIII, Salt Range Fossils, pp. 608-609, Pl. LV, figs. 1, 2.

The ventral valve is flat conical in shape and rather vaulted in the transverse and but little arched in the longitudinal direction. The area is very large, flat, triangular and strongly reclining. It is interrupted in the middle by a very large and strongly vaulted pseudodeltidium. The apex is prominent, pointed and bent over just as its extremity. Neither median sinus nor fold are there on the surface. All surface is covered by very fine radial striations. Besides very strong concentric growth line gives a characteristic features and some of which becomes imbricating concentric wrinkles. They are round topped and separated by deep and angular valleys, and are rather developed at marginal region. On the area, numerous fine striations (both vertical and horizontal) are visible. The frontal margin of the shell is almost in one plane. The hinge-line is straight and shorter than the entire width of the shell. Of the internal characters, dental plate and septum are absent. The external mould of the ventral valve and the dorsal valve is not obtained.

Measurements: Entire length of the shell	27 mm.
Width of the shell	37 mm. or more
Length of the hinge-line	25 mm.
Apical angle	109° (internal mould)

Remarks: The whole shape of the present specimen much resembles that of *Streptorhynchus semiplanus* (WAAGEN), but it has larger size and very distinct concentric wrinkles than those of the latter.

Locality and Occurrence: Same as *Squamularia indica*.

Reg. No. JP 30119 A, B, C.

***Martinia elegans* DIENER**

Pl. 18, figs. 1-3.

1897. *Martinia elegans* DIENER, The Permocarboniferous Fauna of Chitichun, No. 1, Pal. Indica, Ser. XV, Vol. I-3, pp. 54-55, Pl. IX, figs. 1-2.

The general outline of the ventral valve is slightly elongated circular with broad apex or as long as it is broad. The valve is strongly vaulted laterally and less curved in longitudinal direction, but somewhat distinctly curved at apical part and frontal margin. The apical region is not so much inflated. The beak is rather small and slightly curved. On its dorsal side, it bears a rather small area of a nearly equilateral shape, which is almost entirely occupied by the triangular fissure. This area is separated from the remainder of the shell by rather angular ridges near hinge line, but becomes round and less distinct towards the apex. The hinge line is short, reaching three fifths of the entire breadth of the shell. A broad sinus commences as a flattening from the middle part of the shell and becomes slightly distinct toward frontal margin. The dorsal valve is not collected. The internal structures of this species are not clearly observed, but in one specimen, neither median septum nor dental plate are present. The surface of the shell is covered by very fine radial striations and equally fine concentric growth lines.

Measurements: Length of the shell	30.5 mm.
Breadth of the shell	32.0 mm.
Length of the hinge line	14.0 mm.

Remarks: The present species is identical to *Martinia elegans* DIENER especially to his specimen of Pl. IX, fig. 1, from the Chitichun limestone of Himalaya, which is approximately homotaxial with the upper division of the Productus Limestone of the Salt Range. This species resembles in outline to DIENER's species, but has less distinct sinus, rather flat frontal margin and less bent apex than those of the original specimens. This has also more round outline, rather prominent beak and large triangular fissure of the apical area.

Locality and Occurrence: Same as *Squamularia indica*.

Reg. No.: JP 30120.

Kiangsiella ? deltoidens (WAAGEN)

Pl. 18, figs. 5-8.

1884. *Streptorhynchus deltoidens* WAAGEN, Productus Limestone Fossils, iv, Brachiopoda, Pal. Indica, Ser. XIII, Salt Range Fossils, Vol. I-4, pp. 585-587, textfig. 15.

The general outline is elongately triangular, much longer than it is broad. The ventral valve is quite flat, and in the longitudinal as well as in the transverse direction, it bends very slightly. In the latter direction, however, it is somewhat more considerable than longitudinally, and the lateral parts especially bend rather abruptly down and even inwards to the hinge line and the lateral shell margins. The apex of the valve is strongly prominent and pointed. There is neither sinus nor median folds to be observed, and the frontal line is lacking in the undulations caused by the radial folds, quite straight. The radial folds on

the surface are very irregular and less distinct. Internally, neither median septum nor dental plates are found.

Measurements: Length of the shell	33.5 mm.
Breadth of the shell	30.5 mm.
Apical angle	110° ?

Remarks: This species is represented by two incomplete specimens, of which one is ill-preserved external surface and the other is found as a internal shell surface. But the whole shape, its flatness, outline, and surface sculptures of this species are comparable to WAAGEN's *Streptorhynchus deltoidens* from the lower part of the middle Productus Limestone of the Salt Range. This is also distinguished from *Streptorhynchus pectiniformis* WAAGEN by its elongated form and weak plications. Although the surface plications are irregular and not so distinct, especially in the smaller specimen, these specimens may be included in the Genus *Kiangsiella* GRABAU et CHAO.

Locality and Occurrence: Same as *Squamularia indica*.
Reg. Nos. JP 30121-22.

***Strophalosiina tibetica* (DIENER)**

Pl. 18, figs. 9, 10.

1897. *Aulosteges tibeticus* DIENER, The Permian Fauna of Chitichun No. 1, Pal. Indica, ser. XV, Himalayan Fossils, Vol. I-3, pp. 35-37, Pl. V, figs. 3-6.

One ventral valve is obtained, of which the apical part is not preserved. Outline of the shell is subtriangular, with a semi-circular frontal margin. The valve is moderately inflated, but its convexity is very unequal in different directions. Longitudinal curvature is somewhat flattened near apical part to almost half of the shell, then rather steeply geniculated and bending down to the frontal line. This geniculation is strongly marked and makes a characteristic feature of this species. Transversely the curve is more regular, being interrupted by a median sinus, which is very shallow and almost obscure at apical part and becomes somewhat distinct near the line of geniculation. The beak is elongated and tapering towards apex, but its extremity is broken. The lateral sides of the beak steeply down and possess no wings. Succeedingly, the transverse profile of the beak forms a angular trapezoidal outline. The surface sculpture consists of numerous concentric wrinkles. They are interrupted by many elevated roundish tubercles, which have supported thick spines. These tubercles are rather elongated longitudinally and scattered in regular quincunx. They are most distinct and numerous at the middle of the shell and rather small at apical part. Besides, many spine-bases are preserved on apical part. These spines seem to be directed anteriorly with acute angle to the surface. The hinge-line and area are not preserved.

Measurements: Length of the shell in a straight line	22 mm. or more
Length along the curvature	28.5 mm.
Width of the shell	19.5 mm.
Thickness of the shell	9.5 mm. or more

Remarks: This species is very strange in its out line among the related species. On its triangular shape, strong geniculation and concentrically arranged tubercles, the present specimen much resembles *Aulosteges tibeticus* DIENER from the Chitichun Limestone of Tibet. Besides, absence of radial ribs on shell margin distinguishes the former from the latter species. Although, for those concentrically arranged tubercles on all surface the present specimen is related to *Strophalosia poyangensis* KAYSER from the Loping of Southwest China, our specimen must belong to DIENER's species by its characteristic shape. Designating this species as type, LICHAREW established a new genus *Strophalosiina* in 1935.

Locality and Occurrence: Same as *Squamularia indica*.

Reg. No. JP 30123.

Neospirifer sp.

Pl. 18, figs. 11-13.

Incomplete moulds of a ventral valve are in hand. Whole outline of the shell is not preserved, but it is estimated as a very transverse shape. The shell is a little inflated. In the longitudinal direction, the curvature is rather irregular, that is the shell is convexed regularly at umbonal part and then tends to almost flatt frontal margin after a concentric wrinkle. This concentric notch seems to be somewhat distinct in the middle of the shell and more obscure on lateral wings. Transverse curvature is more regular and less convex. From the umbonal part, a very shallow sinus commences and becomes very broad and almost faint toward marginal front. Surface is covered by many fasciculated radial costae and some concentric wrinkles. The former ornamentation is very remarkable and increases in number by insertion at various distances from the beak. They are round-topped and separated each other by narrow and shallow valleys. The beak, cardinal area or hinge characters are not presented.

Remarks: This species is more or less similar to *Neospirifer fasciger* (KEYSERLING) (= *Spirifer moosakheylensis* DAVIDSON) in its shape and surface ornamentations, but the writer regrets that these features are so poorly preserved for specific determination.

Locality and Occurrence: Same as *Squamularia indica*.

Reg. No. JP 30124.

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Plate 15

Explanation of Plate 15.

- Figs. 1, 2. *Derbyia altestriata* WAAGEN. $\times 1$.
 1. apical and 2. ventral view of an internal mould of the ventral valve.
- Figs. 3-5. *Derbyia cf. altestriata* WAAGEN. $\times 1$.
 3. apical and 4. dorsal view of a dorsal valve, 5. external mould of the same valve.
- Figs. 6, 7. *Derbyia cf. grandis* WAAGEN. $\times 2$.
 6. external and 7. internal moulds of a ventral valve.
- Fig. 8. *Derbyia* sp. $\times 2$.
 an internal mould of the ventral valve, showing a distinct median septum and elliptical depressed area of attachment.
- Figs. 9, 10. *Derbyia hemisphaerica* var. *radiata* REED. $\times 1$.
 9. external and 10. internal moulds of the ventral valve.
- Figs. 11, 12. *Linoproductus interruptus* HUANG. $\times 2$.
 11. external and 12. internal moulds of a dorsal valve.
- Figs. 13-15. *Productus (Dictyoclostus)* sp. 13, 14 $\times 1$; 15 $\times 2$.
 13. frontal and 14. apical view of an external mould of the dorsal valve, showing the distinct long ears. 15 external sculptures of another specimen.
- Figs. 16, 17. *Linoproductus kiangsiensis* KAYSER. $\times 1$.
 16. ventral and 17. frontal view of a ventral valve.
- Fig. 18. *Productus (Dictyoclostus) cf. margatitatus* MANSUY. $\times 1$.
 external mould of a dorsal valve.
- Figs. 19-21. *Productus (Dictyoclostus) gratiosus* WAAGEN. $\times 1$.
 19. lateral, 20. frontal and 21. apical view of an internal mould of the ventral valve.
- Fig. 22. *Eolyttonia nakazawai* n. sp. $\times 4$.
 internal mould of ventral valve.

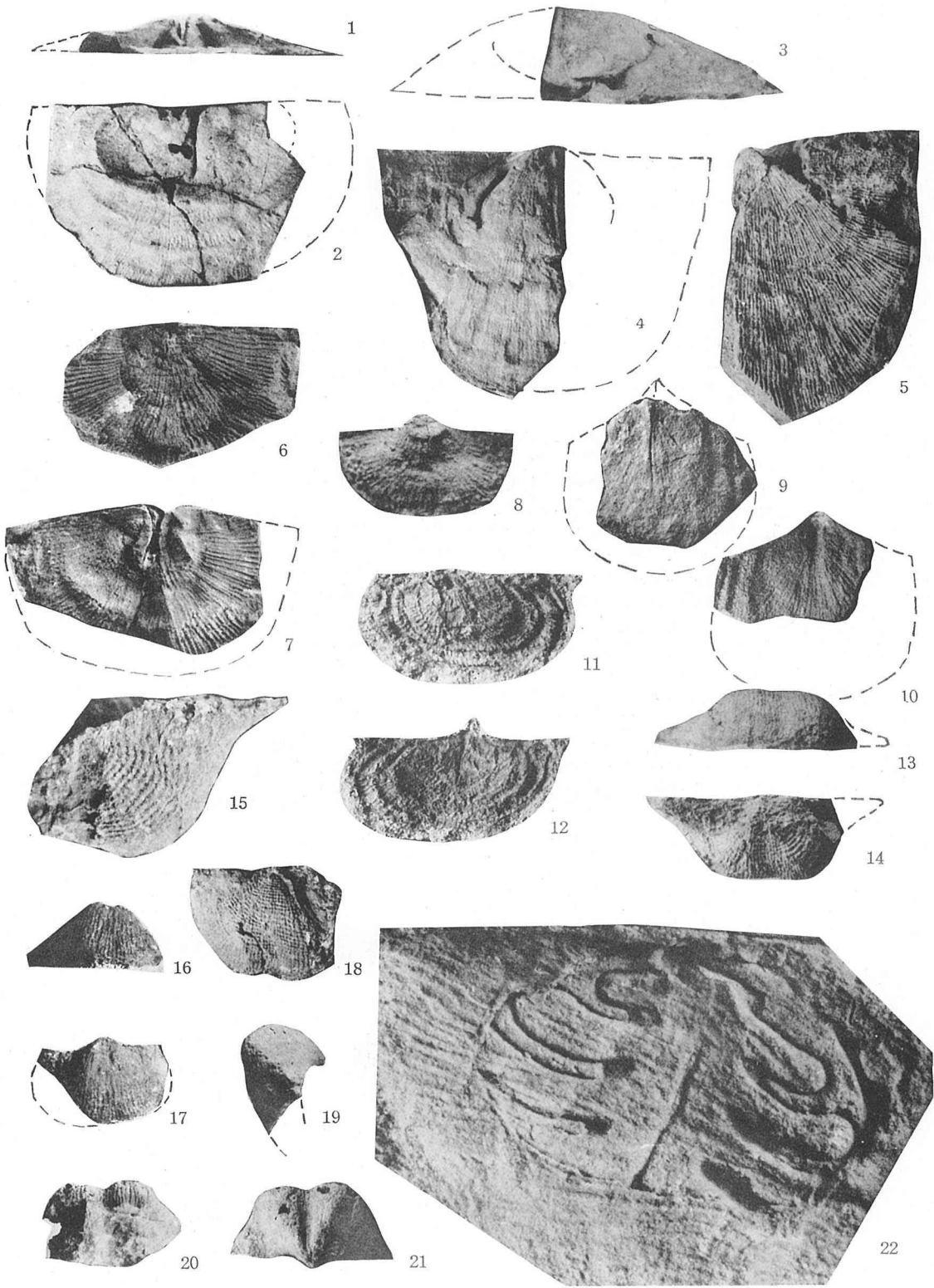


Plate 16

Explanation of Plate 16.

All figures are enlarged $\times 2$.

Figs. 1-6. *Chonetina matsushitai* n. sp

1-3. internal moulds of ventral valves, 4. external mould of the same of fig. 3.
5. external and 6. internal mould of dorsal valve.

Figs. 7-10. *Chonetina* cf. *strophomenoides* (WAAGEN)

7, 10 internal moulds of ventral valves. 8. external and 9. internal moulds of a ventral valve.

Figs. 11-23. *Chonetina substrophomenoides* (HUANG)

11. internal mould of a ventral valve. 12. external mould of a dorsal valve. 13. internal and 14. external moulds of a dorsal valve. 15. internal and 16. external moulds of a ventral valve. 17. external mould of dorsal valve. 18. internal and 19. external moulds of ventral valve. 20 and 21. internal moulds of ventral valves. 22. internal and 23. external moulds of a ventral valve.

Figs. 24-26. *Lissochonetes morahensis* (WAAGEN)

internal moulds of ventral valves.

Figs. 27-29. *Lissochonetes bipartita* (WAAGEN)

internal moulds of ventral valves.

Figs. 30-33. *Lissochonetes* cf. *avicula* (WAAGEN)

internal moulds of ventral valves.

Figs. 34-38. *Lissochonetes* sp.

34. internal mould of a dorsal valve. 35-38. internal moulds of ventral valves.

Figs. 39-42. *Hustedia granadica* (DAVIDSON)

39. external and 40. internal moulds of ventral valves. 41. internal mould of a ventral valve. 42. internal mould of a dorsal valve.

Figs. 43-45. *Hustedia indica* (WAAGEN)

43. ventral and 44 dorsal views. 45. ventral view of another specimen.

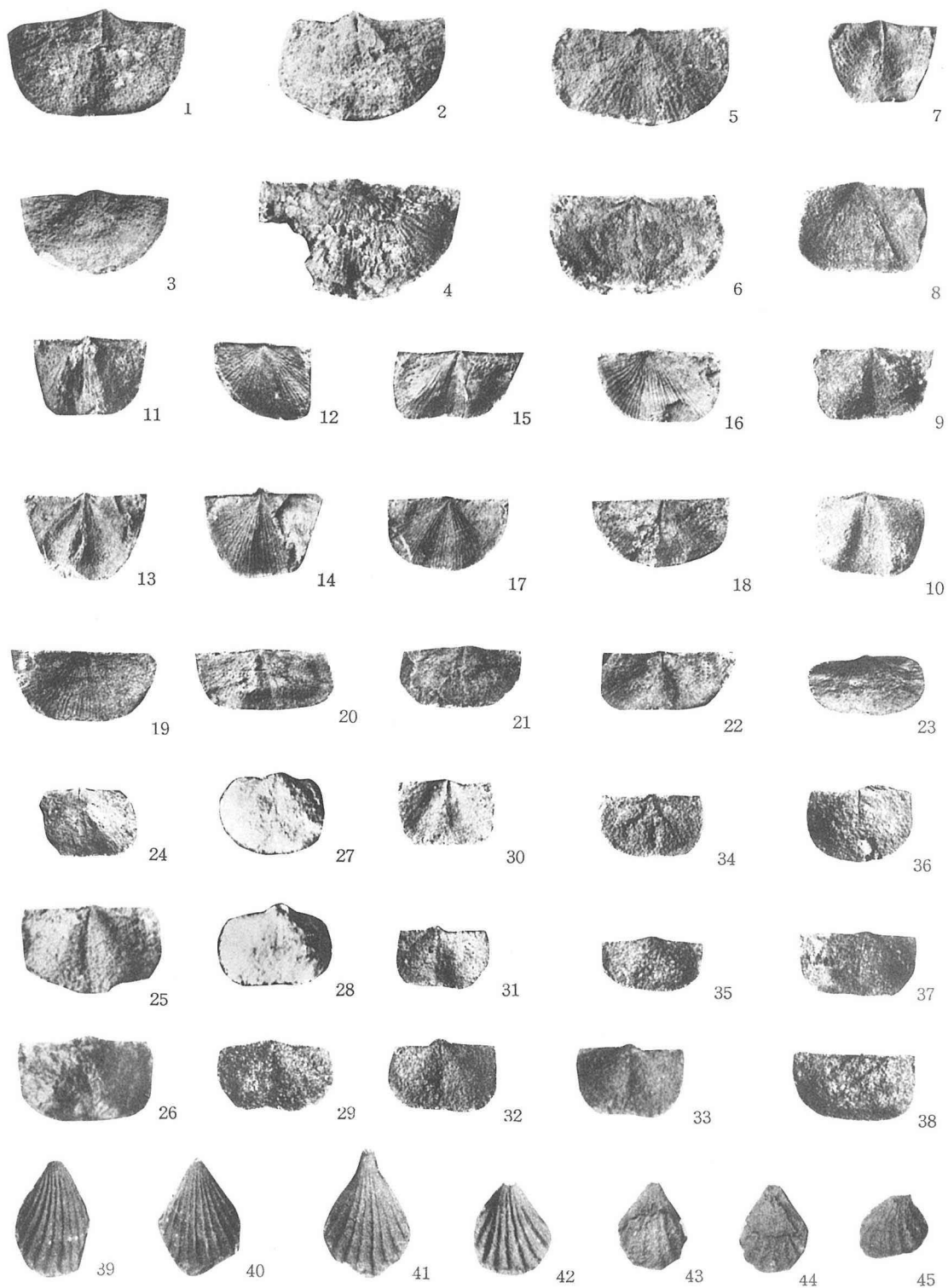


Plate 17

Explanation of Plate 17.

Figs 1-3. *Aulosteges dalhousi* DAVIDSON, 1, 2 $\times 1$; 3, $\times 3$.

2. internal mould and 1, rubber cast of external mould of a ventral valve, 3. enlarged external mould of same valve, showing many spines.

Figs. 4-7, 13. *Squamularia indica* (WAAGEN) $\times 1$.

4. ventral and 5. dorsal view of a ventral valve. 6. dorsal and 7. ventral view of a dorsal valve. 13. a small ventral valve.

Figs. 9, 10. *Squamularia* cf. *calori* (GAMELLARO) $\times 1$.

9. ventral and 10 lateral view of a ventral valve.

Figs 11, 12. *Streptorhynchus semiplanus* (WAAGEN) $\times 1$.

11. cardinal and 12 ventral views of a ventral valve.

Figs. 14, 8. *Squamularia elegantula* (WAAGEN) $\times 1$.

14. a ventral valve, 8. same enlarged, showing many concentric row of uniramous spine bases.

Figs. 15-18. *Streptorhynchus kayseri* SCHELLWIEN $\times 1$.

15. lateral, 16. cardinal, 17 apical and 18. frontal views of a conical ventral valve.

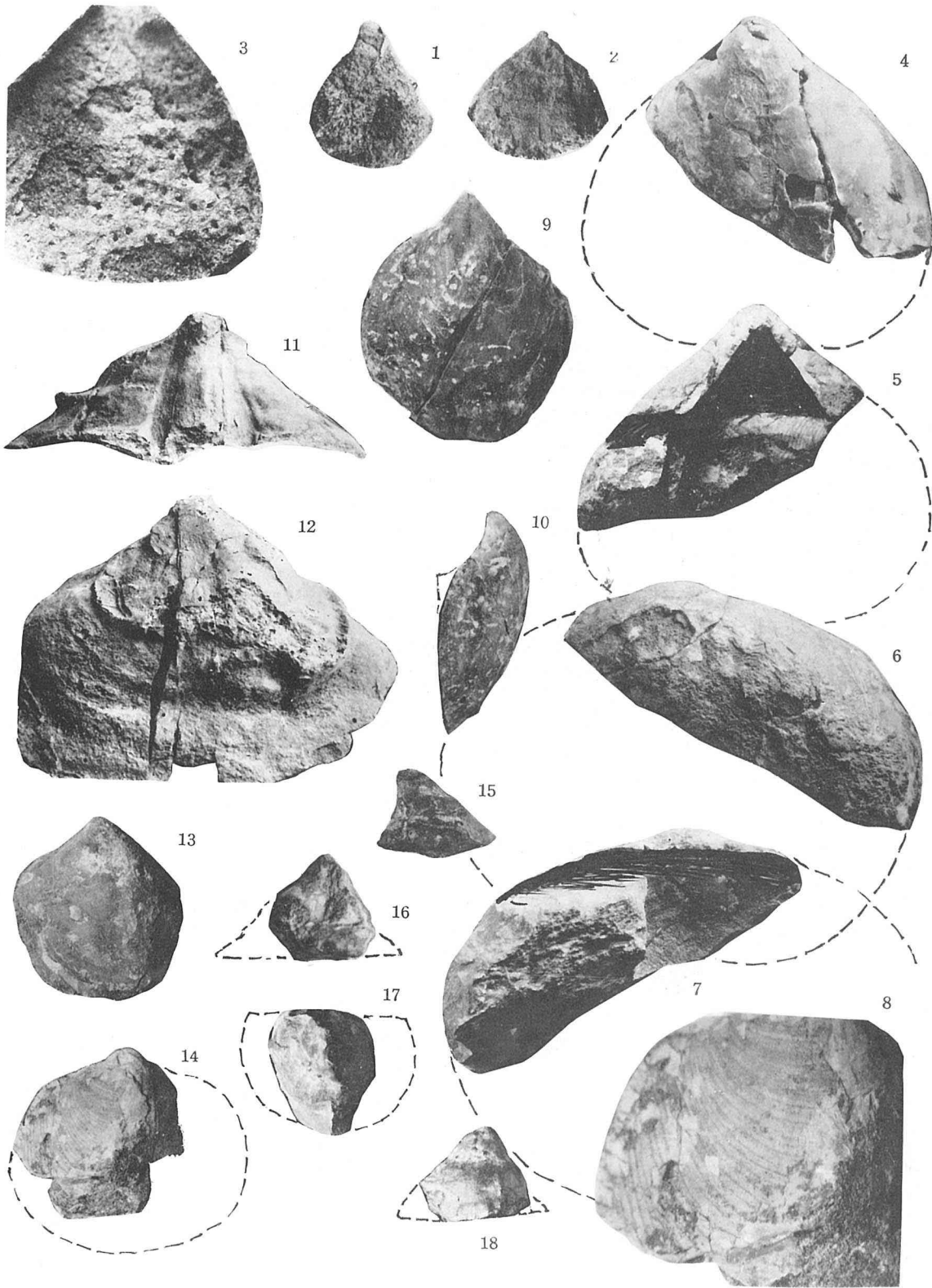


Plate 18

Explanation of Plate 18.

Figs. 1-3. *Martinia elegans* DIENER $\times 1$.

1. apical, 2. dorsal and 3. ventral views of a ventral valve.

Figs. 5-8. *Kiangsiella? deltoidens* (WAAGEN) 5-7. $\times 1$; 8. $\times 2$.

5. internal view of a ventral valve. 6. ventral, and 7. lateral view of a internal rubber cast of the same. 8. external view of another ventral valve.

Figs. 9, 10. *Strophalosiina tibetica* (DIENER)

9. ventral view of a ventral valve, $\times 1$. 10. same enlarged, showing many spine bases, $\times 2$.

Figs. 11-13. *Neospirifer* sp. $\times 1$.

12. external mould and 11, its rubber cast of a ventral valve. 13. internal mould of the same.

Figs. 14, 15. *Leptodus richthofeni* KAYRER. $\times 1$.

14. external and 15. internal moulds of a ventral valve.

