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SOME LOWER PERMIAN SAKAMOTOZAWA BRACHIOPODS

By

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The Lower Permian Sakamotozawa series typically developing in the Kitakami Mountains is characterized by the presence of *Pseudoschwagerina* fauna. The lower part of the series is composed of conglomerate, slate, sandstone, carbonaceous slate, less abundant liparitic tuff and schalstein, while the upper half is mainly consisting of limestone.

The brachiopod remains which will be treated in this paper have been collected from the lower part of the Sakamotozawa series by the staff of our department of Geology and Mineralogy, including the writer himself.

They are:

Phricodothyris sp.
Avonia echidniformis GRABAU em. CHAO
Juresania juresanensis (TSCHERNYSCHEW)
Mesolobus mesolobus (NORWOOD and PRATTEN)
Productus yohi CHAO

All those species above listed may be safely concluded to be the Lower Permian elements having been known from the Permian of China, except for *Mesolobus mesolobus*. This species has long been believed to be a typical Pennsylvanian form.

Before going into description, the writer wishes to express hearty thanks to his respected teacher, Prof. M. MINATO who has earnestly guided him in the course of the present study.

Messrs. H. TAKEDA and M. HARADA offered him for study many brachiopod specimens collected by them.

Also, he is greatly indebted to Mr. S. KUMANO for his kind help in taking photographs illustrated in this paper. He wishes to express here his gratitude to all these persons.

Description of species

Phricodothyris sp.

Pl. 1 Figs. 1a-c.

Material: Available for study is only one specimen, which is composed of external and internal moulds of ventral valve.

Reg. No.: 13083.

Description: Shell small in size. The specimen seems to be somewhat depressed by pressure, so as not to show the original convexity but the ventral valve might have been originally transverse and oval in outline, moderately convex in both longitudinal and transverse directions.

Lateral and frontal margins are regularly rounded, while both sides of umbonal region are nearly straight. Hinge-line is shorter than the greatest width of the shell which is measured in the middle of the whole length. Beak small and more or less strongly incurved. Median depression is hardly observable. Surface sculptures are not well preserved but they can be observed in some part of the shell. Concentric bands, large and small spine-bases are to be found especially in the anterior part of the shell.

The more the concentric bands may approach to the anterior margin of the shell, the less wide the interspace becomes between each pair of concentric bands. There is one row of relatively large spine-bases along each concentric band.

Besides, there are to be perceived a lot of fine small spine-bases between one series of larger spine-bases and concentric bands. Of them, the larger spine-bases seem to be separated into two parts of narrow and short ridges.

This feature is not always clearly observable but it is quite sure that the larger spine-bases may be biramous.

Internally, no apical plates are developed.

Remarks: This specimen is quite characteristic in its smaller size, transversely oval form and in having small but much incurved beak. In these regards, this may be probably referable to so-called *Squamularia asiatica* CHAO. According to CHAO, *Squamularia asiatica* CHAO may be conspecific with those specimens having been called by WAAGEN (1883), SCHELLWIEN (1892) and BROILI (1916) under the name of *Reticularia lineata*. According to GRABAU (1936), *Squamularia asiatica* OZAKI (1931) may be fully conspecific with CHAO's species, too.

Unfortunately, those specimens enumerated above were, however,

not good in preservation, so far as the figured specimens are concerned. Especially, CHAO's specimens do not clearly show the sculpture of the external surface. In his figures one can surely recognize one row of large spine-bases disposed along each concentric band, but none of the more fine spine-bases are observable. However, the writer is now wondering whether that may be resulted in consequence of non-existence or from the bad state of preservation.

Anyhow, in CHAO's specimens, the larger spine-bases seem to be biramous instead of uniramous based upon the highly magnified figure (14g, Pl. 11).

Such being the case, the writer now believes that the Japanese specimen now under consideration should be regarded to be somewhat allied to so-called *Squamularia asiatica* CHAO, one of the most well-known Chinese Permian brachiopods.

Avonia echidniformis GRABAU em. CHAO

Pl. I. Figs. 2-8.

1883. *Products aculeatus* MARTIN var. KAYSER: Obercarbonische Fauna von Lo-ping. Richthofen's China IV. p. 185, pl. XXVI, fig. 5.
1892. *Products aculeatus* var. SCHELLWIEN (non DAVIDSONQ: Die Fauna des karnischen Fusulinenkalks. Palaeontographica, 39, p. 25, pl. III, figs. 10a-b.
1898. *Productus aculeatus* LOCZY (non DAVIDSON): Wissenschaftliche Ergebrisse der Reise des Garfen Bela Szecheryi in Ostasien, III, p. 64, text-fig. 9.
1925. *Productus echidniformis* CHAO: On the age of the Taiyuan series. Bull. Geol. Soc. China, vol. IV, nos. 3-4, p. 239, pl. II, figs. 7-9.
1927. *Avonia echidniformis*, CHAO: Productidae of China, I. Palaeont. Sinica, ser. B, vol. 5, fasc. 2, part I, p. 120 pl. XIV, figs. 17-27.
1931. *Avonia echidniformis*, OZAKI: Upper Carboniferous Brachiopods from North China. Bull. Shanghai Sci. Inst. Vol. 1, No. 6, p. 108, pl. X, figs. 6-9.
1948. *Avonia echidniformis*, SOKOLSKAYA: Evolution of *Productella* Hall and its contiguous form in Palaeozoic of Untermoscovian Basin. (in Russian) p. 119, pl. VIII, figs. 16-18.

Materials: Some external and internal moulds of both valves.
Reg No.: 12485, 12482, 12483, 12474, 12476, 12475, 12570, 12481, 12477, 12478.

Description: Shell always below medium in size, transversely semicircular in outline, concavo-convex in curvature and has exteremely thin visceral cavity. Hinge-line nearly equal to or a little shorter than the greatest width of the shell, and ventral valve uniformly convex, but becomes somewhat gentle at an anterior portion. The frontal and lateral

margins are rounded. Ears small, flat, only slightly twisted and clearly distinguished from the remainder.

Cardinal angle almost 90° but there are only a few such specimens whose angles are a little larger than 90°.

Beak globose, pointed and little incurved over the hinge-line. Median depression nearly lacking.

Surface ornamentation varies at each growth stage. At the early stage it is composed of radially arranged tubercles which are longitudinally long, and further there are to be seen many tiny hollows on them left by spines. Those tubercles gradually change into plicae at the mature stage, on whose surface there are left many large spine-bases as hollows arranged somewhat concentrically. Those plicae increase in number by branching towards the anterior.

Internal structure unknown.

In the dorsal valve no marked median fold is observable. In this valve the surface is also ornamented by short tubercles which gradually become more or less incomplete plicae towards the anterior portion. They are generally counted six to seven in a distance of 10 mm. at the anterior margin. Besides, there are observable traces of minute spines irregularly scattered on the surface, but they never grow as large as those found in the ventral valve.

Remarks: Although the present specimens are very imperfect and not numerous, there is no doubt that they may be assignable to *Avonia echidniformis*.

As CHAO has already noted, the specimens having been described and figured by SCHELLWIEN (1892) from the Carnic Alps, under the name of *Productus aculeatus* var. and so-called *Productus aculeatus* described by LOCZY (1898) from South China, may be fully conspecific with *Avonia echidniformis* CHAO (1927) but they may be neither congeneric nor conspecific with MARTIN's species *Productus aculeatus*.

Among the specimens illustrated by DAVIDSON (1861) under the name of *Productus aculeatus*, there must be regarded to be at least two types, which should be generically distinguished from each other.

Specimens figured in 16 which is MARTIN's original example, fig. 17 and 20 may belong to the genus *Krotovia*, while only fig. 19 must be the genus *Avonia*. DAVIDSON believed that his specimen figured 19 may be a larger and older specimen compared with others figured in fig. 16, 17 and 20 but this belief may be not trustworthy.

Meanwhile, SCHELLWIEN (1892) and ROCZY (1898) compared their specimens to DAVIDSON's specimen figured 19, because their specimens

seemed to be so much like each other. However, the specimen of fig. 19 on DAVIDSON's plate is rather less transverse than those found in Asiatic Permian, besides, it has no spines.

On the contrary, the Asiatic species including Japanese ones are more transverse in outline and possess many spine-bases arranged somewhat concentrically.

Further, as CHAO (1927) pointed out, SCHELLWIEN and ROCZY made mistakes, because their specimens are external moulds of dorsal valves. And they tried to compare them to the figured specimen 19 of DAVIDSON, which is, however, surely an external cast of the ventral valve. Granted that those valves may be much resemblant to each other, but they never guaranteed to be conspecific.

KAYSER (1883) once described and illustrated some specimens under the name of *Productus aculeatus* from Lo-ping. Of them the specimens figured 1-4 may be belonging to genus *Spinomarginifera,* while, specimen of his figure 5 may be conspecific with CHAO's species, although KAYSER's specimen is a little less wide, more highly convex, and possesses more globose and larger beak.

Also FRECH's specimen called *Productus scabriculus* (MARTIN) may be presumedly conspecific with CHAO's species, although it is somewhat different from the latter in having a large beak, more strong concentric lines in the outer surface in having more concave dorsal valve.

Besides, FRECH's specimen may be worthy of note in being always larger than CHAO's specimens. In respect to the Japanese specimens, they agree largely with SCHELLWIEN, ROCZY, and FRECH's specimens especially in sizes, and are rather different from CHAO's materials.

However, the form and ornamentation of the shell of Japanese specimens are very much like the figured specimens of CHAO.

Juresania juresanensis (TSCHERNYSCHEW)

Pl. II. Figs. 1a-c.

1925. *Productus juresanensis* CHAO: On the Age of Taiyuan series. Bull. Geol. Soc. China, vol. IV, nos. 3-4, p. 204, pl. II, fig. 5.

1927. *Buxtonia juresanensis* CHAO: Productidae of China, part I. Palaeont. Sinica, ser. B, vol. V, fasc. II, p. 81, pl. VIII, figs. 4-8.

1931. *Pustula* (*Juresania*) *jureasnensis* OZAKI: Upper Carboniferous Brachiopods from North China. Bull. Shanghai Sci. Inst. vol. I, no. 6, p. 107, pl. X, figs. 5a-c.

1935. *Buxtonia juresanensis* IVANOV: Brachiopoda of the Middle and Upper Carboniferous of the Moscow Basin. Part. I. Trans. Moscow Geol. Trust, Fasc. 8, p.28, pl. IV, figs. 2a-b.

1936. *Juresania juresanensis* GRABAU: Early Permian Fossils of China, part II. Fauna of the Maping Limestone of Kwangsi and Chuanshan, Kueichow. Pal. Sinica, ser. B, vol. 8, fasc. 4, p. 104, pl. XIII, figs. 5 and 6.

Material: External and internal moulds of ventral valve.

Reg. No.: 13064.

Description: Shell medium in size, subquadrate in outline. Width a little shorter than the length. Hinge-line nearly equal to the greatest width of the shell.

Ventral valve moderately convex in the longitudinal direction, while lateral flanks more or less abruptly fall to the lateral margins. Beak somewhat pointed and extending slightly over the hinge-line. Median sinus begins to appear immediately at the beak, from where the concentric markings become distinct. Ears rather small and flat.

Surface covered by concentric bands in which two kinds of spinose tubercles irregularly arranged in adult stage. There are to be perceived only spines in the apical region. Those spines are also to be abundantly found in the ears.

Dorsal valve unobtainable.

Remarks: The specimen now under consideration is doubtlessly assignable into the genus *Juresania*. In respect to the validity of that genus, quite diverse views have been held among palaeontologists. Some have not agreed to distinguish *Juresania* from *Buxtonia* generically. But the ornamentation of the external surface of the shell should be regarded to be quite different in the two genera. For instance, no spinose plicae can be found in the genus *Juresania*, while the reverse is the condition in the genus *Buxtonia*.

In the early stage the shell of *Juresania* is ornamented by scattered short spines, while in the adult stage the spines become pustules, which are to be differentiated into at least two types of pustules, larger and smaller ones. Additionally, the concentric markings are found in mature stage.

Now, of the species belonging to the genus *Juresania*, the Japanese specimens may be surely conspecific with the genotype, from the view point of similarity in respect to size, form and ornamentation.

According to IVANOV, *Juresania juresanensis* was distinct from *Buxtonia scabricula* in the following points. The former is less transverse and possesses a median sinus starting to grow at the umbonal region, while the latter is somewhat broad especially at anterior part and does not possess long median sinus. This is quite true, although the writer

can not agree with him in the view that the genus *Juresania* may be synonymous with the genus *Buxtonia*.

Mesolobus mesolobus (NORWOOD and PRATTEN)

Pl. II. Figs. 2-3.

1932. *Mesolobus mesolobus* DUNBAR and CONDRA: Brachiopoda of the Pennsylvanian System in Nebraska. Nebraska Geol. Surv. Bull. 5, Second series, p. 161, pl. XX, figs. 1-2.

Materials: External and internal moulds of ventral valve.

Reg. Nos.: 13077, 13076, 12629.

Description: Shell extremely small in size and transversely trapezoid in outline. Hinge-line nearly equal to the greatest width of the shell.

Ventral valve more or less arched. Ears narrow, slightly convex. The boundary between the ears and the remainder of the shell is rather ambiguous.

Cardinal extremities blunt and angular forming angles of nearly 90° degrees with lateral margins. Beak small and not pointed. Median sinus long and broad where a fold develops occupying the whole length of the sinus. This fold and sinus anteriorly become a little broader.

The surface is ornamented by radially distributed fine striae which count about twenty in number within 5 mm. at anterior margin. Those striae anteriorly increase by bifurcations and intercalations. Besides, only a few hollows are left presumedly by spines. The spines might be perpendicular to the surface of the shell; the bases of these spines are found on striae in some parts of the shell.

Internal character unknown.

Remarks: Although the internal structure is unknown, this specimen may be safely concluded to belong to the genus *Mesolobus* which is characterized by the presence of a fold in the sinus.

The genotype of this genus is *Chonetes mesolobus* (NORWOOD and PRATTEN), into which the Japanese species now being considered should be specifically assigned.

In those days when DUNBAR and CONDRA (1932) established this genus they were in belief that the genus *Mesolobus* should be stratigraphically confined to early Pennsylvanian, so far as they were concerned but many a species belonging to this genus has been known from the Permian of the Carnic Alps and the Chitral of the Himalayas and Japan, as well as from the Carboniferous.

In the Kitakami Mountains at least two species assignable into this genus are known from the Permian. They are so-called *Chonetes sinuosa* and the other is the species under discussion. The former is found from Lower Kanokura series, while the latter is found from Lower Sakamotozawa series. The difference between the two species is quite marked.

Chonetes mesolobus has a fold occupying the area of the entire sinal depression, while *Chonetes sinuosa* possesses a fold occupying a part of the sinus; the former is rather smaller than the latter in size and also is ornamented by finer radial striae than the latter.

Productus yohi CHAO

Pl. II. Figs. 4-5.

1928. *Productus yohi* CHAO: Productidae of China, Part. II. Palaeont. Sinica. ser. B. vol. V, fasc. III, p. 60, pl. V, figs. 13-17.

Materials: Imperfect external and internal moulds of both ventral and dorsal valves.

Reg. No.: 13061, 13062.

Description: Shell small in size, much elongate with very long trial.

Ventral valve highly convex and has strong geniculation. Beak prominent and incurved. Ears small, ornamented by strong spines. Median sinus begins to appear immediately below the beak and becomes gradually deep toward anterior margin.

Surface covered by radial plicae on which small spines sometimes are arranged. Concentric ribs, though not so strong, sometimes make reticulate appearance in association with radial plicae especially in umbonal region.

Dorsal valve is a little better preserved than the ventral valve. Visceral disk, which is flat, is geniculated suddenly at an angle of 90° degree towards the long trail.

Apical region more or less excavated. The middle portion somewhat concave. Ornamentations similiar to those of the ventral valve are to be found in this valve. The plicae increase by bifurcations and intercalations in the visceral disk, while they are constant in number in the trail. A very broad but low fold begins to appear from the middle portion of the visceral disk which becomes high and somewhat broad beyond the geniculation.

Internally, median septum is very low.

Remarks: From the form and ornamentation, the species now under

consideration may be conspecific with *Productus yohi* CHAO described and illustrated by CHAO from Lower Permian in Kueichow. The Japanese specimens are smaller in size compared with the Chinese ones.

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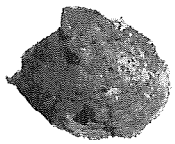
Explanation of Plate 1

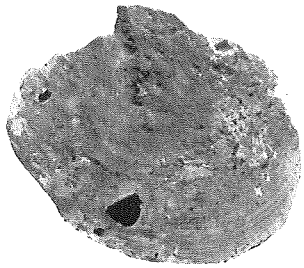
Explanation of Plate I.

Figs. 1a-c. *Phricodothyris* sp.
1a. External mould of ventral valve. (×1)
1b. The same. (×2)
1c. Internal mould of ventral valve. (×1)
Reg. no.: 13083.

Figs. 2-8. *Avonia echidniformis* GRABAU em. CHAO.
2, 3, 5. Internal mould of ventral valve. (×1)
Reg. nos.: 12475, 12485, 12477.
4, 6, 7. External mould of dorsal valve. (×1)
Reg. nos.: 12482, 12570, 12478.
6c. Cardinal view.
6d. Lateral view.
6b. Enlarged figure of 6a. (×2)
8. External mould of ventral valve. (×2)
Reg. no.: 12481.



1a



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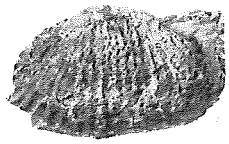

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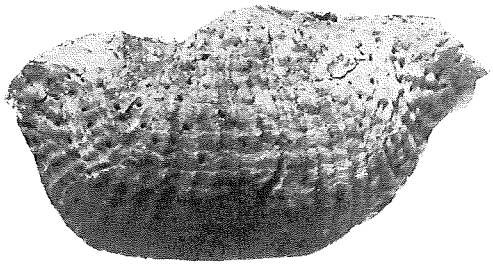


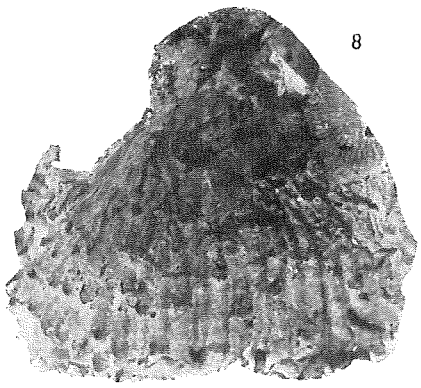
6b

4

5

6a

6c



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6d

7

Photo. K. NAKAMURA

Explantaion of Plate 2

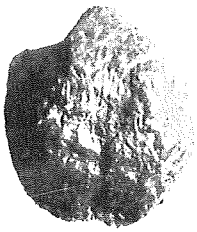
Explanation of Plate II.

Figs. 1a-c. *Juresania juresanensis* (TSCHERNYSCHEW)
- 1a. Restoration of ventral valve. (×1)
- 1b. Lateral view of the same.
- 1c. External mould of ventral valve. (×2)
- Reg. no. : 13064.

Figs. 2-3. *Mesolobus mesolobus* (NORWOOD and PRATTEN).
- 2a. Restoration of ventral valve. (×1)
- 2b. External mould of ventral valve. (×1)
- 2c. Enlarged figure of the same. (×2)
- Reg. no. : 13077.
- 3a. Internal mould of ventral valve. (×1)
- 3b. Enlarged figure of the same. (×2)
- 3c. External mould of ventral valve. (×2)
- Reg. no. : 12629.

Figs. 4-5. *Productus yohi* CHAO.
- 4a. External mould of dorsal valve. (×1)
- 4b. Lateral view of the same.
- Reg. no. : 13062.
- 5a. External mould of dorsal valve. (×1)
- 5b. Enlarged figure of the same. (×2)
- 5c. Lateral view. (×1)
- 5d. Frontal view. (×2)

All specimens now figured were derived from the Lower Sakamotozawa series at Nakadaira, Yahagi-machi, Rikuzen-takada city, Iwate Prefecture.



1a

1b

2a

2b

3b

1c

3a

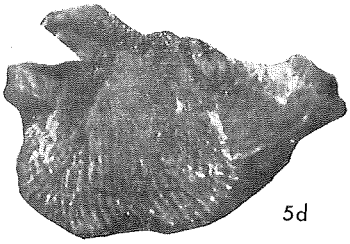
2c

3c

4a

4b

5a



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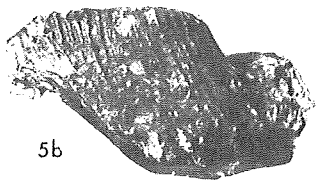
5c



5b

Photo. K. NAKAMURA