



Title	On Permudaria, A New Genus of the Brachiopod Family Linoproductidae
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Citation	Journal of the Faculty of Science, Hokkaido University. Series 4, Geology and mineralogy, 14(3), 293-300
Issue Date	1970-02
Doc URL	http://hdl.handle.net/2115/35995
Type	bulletin (article)
File Information	14(3)_293-300.pdf



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ON *PERMUNDARIA*, A NEW GENUS OF THE BRACHIOPOD FAMILY LINOPRODUCTIDAE

by

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(with 1 plate)

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Introduction

While collecting brachiopod fossils from the Lower Kanokura series of the Kitakami Mountains, the last-named author noticed a Linoproductid shell with strong concentric rugae in addition to numerous fine costellae developing throughout the entire surface of the pedicle valve. This is not the first record of the occurrence of this type of brachiopod from that mountains. HAYASAKA and MINATO (1956) described this peculiar form as *Striatifera?* sp. from the same series at a nearby locality to the present occurrence, and already paid great attention to the characteristic pattern of the surface ornamentation.

Recently NAKAMURA and KATO had an opportunity to study the Permian brachiopods from the Sisophon limestone, Cambodia. Within a large collection of the Sisophon materials two Linoproductid specimens with the same type of unusual sculpture on the surface of the pedicle valve were also turned out.

Although *Fluctuaria*, *Undaria* and *Compressoproductus* are known at present as the Linoproductid genera with considerably pronounced rugae, both Kitakami and Sisophon forms do not seem to be generically attributed to three genera above enumerated. Thus, the authors now propose to establish a new genus for them with the generic name of *Permundaria*.

The species here assigned to the newly proposed genus have been hitherto detected from the Middle to Upper Permian strata of South China, Kashmir, besides Japan and Cambodia belonging to the Tethys sea province. In all, five species including the two treated in this paper may be referred to the genus *Permundaria*.

On Linoproductid genera with pronounced rugae in both valves

Recently MUIR-WOOD and COOPER (1960, 1965) defined the family Linopro-

ductidae as "costellate and rugose Productacea, with rows of fine spines near hinge, trilobate cardinal process with separated lobes, small body cavity, dendritic adductors." Further, they subdivided the family into the following five subfamilies, Linoproductinae STEHLI, 1954, Proboscidellinae MUIR-WOOD and COOPER, 1960, Monticuliferinae MUIR-WOOD and COOPER, 1960, Paucispiniferinae MUIR-WOOD and COOPER, 1960 and Striatiferinae MUIR-WOOD and COOPER, 1960.

Among them, the Proboscidellinae is characterized by having trail of pedicle valve forming tube, while the Monticuliferinae by its unusual ornament of monticules placed on the surface of the shell. The Paucispiniferinae is also distinguished by its four or more halteroid spines projecting from the surface of the pedicle valve. The nature of the other two subfamilies, Linoproductinae and Striatiferinae appears to be most closely connected with each other. According to MUIR-WOOD and COOPER (1960, 1965), the latter subfamily, however, differs from the former in having more elongate shell outline, much narrower hinge-line and disagreements in internal characters, an unilobate instead of variously lobated cardinal process of the Linoproductinae. Among the genera belonging to these two subfamilies, the genus *Compressoproductus* included in the Striatiferinae, and *Undaria* and *Fluctuaria* in the Linoproductinae are characterized by relatively short-hinge and trigonally elongate outline, and the constant presence of rather numerous concentric rugae on the surface of the both valves.

The occurrence of the genus *Compressoproductus* may be restricted to Permian in age and has been hitherto known from Europe, Greenland, Asia, Australia and South America. *Undaria* and *Fluctuaria*, on the other hand, have been only described from the Carboniferous strata; the former from the Viséan to Moscovian of Great Britain, Belgium, U.S.S.R. etc., while the latter from the formations of the same age of France and U.S.S.R. in addition to England and Belgium.

The genus here newly proposed by the present authors seems to be closely related with the three genera referred above in having numerous conspicuous rugae on the surfaces of the both valves. The genus is, however, easily distinguishable from *Fluctuaria* which has more angular and fewer rugae, and more strongly convex pedicle valve than in the former.

On the other hand, in surface features, the new genus is very much like *Undaria* and *Compressoproductus*, but both of which have pedicle valve of trigonal outline tapering to the umbo and considerably shorter hinge-line, in contrast to almost subquadrate or subcircular shell form and much longer hinge-line in the present genus. Moreover, the genus *Compressoproductus* is distinguished from this new genus in having vertically bent down narrow ears.

Although no internal character of the brachial valve is known, the genus now in concern is possibly classified as a member of the Linoproductinae but not as the Striatiferinae, judging from the general outline.

Occurrences of the materials

The species described in the present paper are based on the specimens collected from the Lower Kanokura series of the Kitakami Mountains, Northeast Honshu, Japan, and from the Permian Sisophon limestone of Cambodia.

The lower part of the Kanokura series may be roughly corresponding to the *Parafusulina* and possibly *Neoschwagerina* zones in fusulinid zonation.

According to ISHII (1966), on the other hand, the Permian strata of Sisophon district can be lithologically divided temporarily into A, B, C, and D beds in ascending order. The specimens used in this study were found from the lower part of C bed at Phnon Svai which may be stratigraphically corresponding to the lower half of the *Yabeina* zone by faunal evidences based on fusulinids.

Acknowledgements

The authors wish to express their most sincere thanks to Prof. Masao MINATO of Hokkaido University, for his kind guidance and valuable suggestions given them in the course of the present study and for critically reading this paper in manuscript.

Thanks are also due to Dr. Kenichi ISHII of Osaka City University for stratigraphical comments of the Sisophon limestone and kind offer of the materials studied here.

Description of species

Family Linoproductidae STEHLI, 1954

Subfamily Linoproductinae STEHLI, 1954

Genus *Permundaria* n. gen.

Generic diagnosis: Medium to large in size, and semicircular, rectangular or subquadrate in outline. Hinge-line straight and nearly equal to or only slightly shorter than the greatest width. Pedicle valve with moderately elevated umbonal region and nearly flat or slightly convex venter. Umbo small and never incurved. Ears triangular, flattened and hardly demarcated from visceral disc and flanks. Neither sinus nor fold traceable.

Pedicle valve ornament of fine costellae or capillae with numerous bifurcations and intercalations; rugae pronounced, often irregular, on entire surface of both valves. Interior of brachial valve unknown.

Type species.—*Permundaria asiatica* n. sp. Lower Kanokura series of the Kitakami Mountains, Japan; Upper Permian (*Yabeina* zone) of Cambodia; Upper

Permian Zewan bed of Kashmir.

Occurrence.—Middle to Upper Permian, Japan, Cambodia, China, Kashmir.

Species other than the type species assigned to the genus.—

Permundaria sisophonensis n. sp. Upper Permian (*Yabeina* zone) of Cambodia;

Upper Permian Loping series of South China.

Cancrinella undata var. *tenuistriata* THUAN. Upper Permian (*Yabeina* zone) of Cambodia.

Linoproductus kayseri CHAO. Loping series of South China; Permian of Iran.

Linoproductus interruptus HUANG. *Lyttonia* horizon of Kueichow, South China; Permian Maizuru group of Southwest Japan.

Permundaria asiatica n. sp.

Pl. 2, figs. 1-2

1908. *Productus undatus*, DIENER (non DEFRANCE): The Anthracolithic fossils of Kashmir and Spiti. *Palaeont. Indica*, ser. 15, Himalayan fossils, vol. 1, pt. 2, p. 23, pl. 1, fig. 10 (excl. 9).

1956. *Striatifera?* sp., HAYASAKA and MINATO: Some brachiopods from the Lower Kanokura series of the Kitakami Mountains, Japan. *Jour. Proc. Palaeont. Soc. Japan*, N. S., no. 21, pp. 144-145, pl. 23, figs. 6 and 7.

Material: Two specimens from the Kitakami Mountains and the Sisophon limestone are available for study; The former (Holotype—UHR 19015) is preserved as external and internal moulds of pedicle valve and slightly deformed by rock pressure, while the latter (Paratype—UHR 19016) as the strongly exfoliated pedicle valve. Accordingly the features of the brachial valve are unknown. The Holotype is collected from Budo-sawa, a small tributary of Katti-sawa, Sumita-cho, Iwate Pref., Japan, and the Paratype is from Phnon Svai, Sisophon, Battambang region, Cambodia.

Description: The shell is medium to large in size, elongate subquadrate in outline. The hinge-line is straight and occupies the widest part.

The pedicle valve is nearly flat or very slightly convex except more elevated umbonal region. The ears are triangular, flattened and ambiguously demarcated from the remainder of the shell by broad and shallow depressions. The cardinal extremities are blunt. No trace of a median sinus is recognized, though the valve becomes flattened medially.

The surface of the valve is covered uniformly by numerous fine radial costellae

and coarse concentric wrinkles. The costellae are narrow in comparison to sulci between them, well rounded on the shell surface and strongly interrupted by concentrically developed rugae. They are counted about 6–8 in 3 mm. at distance of 10 mm. from the umbo. Increase in number of costellae occurs mostly by means of intercalations. The rugae are considerably conspicuous, and often become irregular or flexuous especially on the ears as well as in the anterior part of the pedicle valve. The interspaces of the rugae are very narrow in the umbonal region but become gradually wider towards the anterior margin.

The conceivable dimensions of the two specimens are as follows: length of the pedicle valve, 45 mm., greatest width, 48 mm. in the Kitakami specimen; while length of pedicle valve, 60 mm., greatest width, 68 mm. in the Sisophon specimen. Remarks: In 1908, DIENER identified one Linoproductid shell from the Zewan bed of Kashmir with *Productus undatus* DEFRANCE. The species was, however, later designated as the type species of the genus *Undaria* proposed by MUIR-WOOD and COOPER in 1960. As mentioned in the foregoing lines, the genus *Undaria* has been known to occur only from the Lower Carboniferous, and characterized by its trigonal shell outline. On the other hand, it was certain that the Indian species was derived from the Upper Permian Zewan bed and the shell was rectangular in outline. Accordingly, DIENER's identification in that case may be erroneous, and although being somewhat wider than the Kitakami and Sisophon specimens, the shell illustrated in figure 10 by DIENER may be conspecific with the present species.

HAYASAKA and MINATO (1956) doubtfully assigned two brachiopods from the Lower Kanokura series of the Kitakami Mountains to the genus *Striatifera*. From the viewpoint of features of general outline and surface ornamentation observed, however, they may be referred to the new genus now proposed and further conspecific with the present species.

Two Chinese species assigned to this genus, *kayseri* and *interruptus*, can be easily distinguished from the present species by much wider, rectangular shell with sharp geniculation, and the differences of the details in surface ornamentations.

Permundaria sisophonensis n. sp.

Pl. 2, figs. 3a–b

1883. *Productus undatus*, KAYSER (non DEFRANCE): Oberkarbonische Fauna von Loping, in RICHTHOFEN's China, vol. 4, p. 188, pl. 26, fig. 12 (excl. 13).

Material: Only a pedicle valve from the Sisophon limestone is used for observation

of specific characters. UHR 19017, Phnon Svai, Sisophon, Battambang region, Cambodia.

Description: The shell is medium in size and almost semicircular in outline. The hinge-line is straight and slightly shorter than the greatest width.

The pedicle valve is slightly convex on the whole, but the umbonal region is much more elevated than the preceding species. The beak is small and not incurved. The ears are flat and almost undivided from the visceral disc and flanks. The cardinal extremities are not acute but rather blunt. The valve is not sulcate but flattened medially.

The capillae of variable strength of the pedicle valve are generally very fine and rounded, and grow in number by means of intercalations as well as by bifurcations of previously existing capillae. They are mostly as wide as the sulci between them and counted about 15 in 3 mm. at distance of 10 mm. from the umbo. About 22 rugae are developed throughout the entire surface of the pedicle valve in the Sisophon specimen. They are narrow, rather regular, rounded on the top and divided by the broader furrows. The capillae are not flexuous and scarcely interrupted by the rugae.

The dimensions are: width, 34 mm., length, 29 mm. and length of hinge-line, 33 mm.

Remarks: *Permundaria sisophonensis* n. sp. differs from the type species by its more elevated umbonal region, much finer radial costellae or capillae and more regularly developing concentric rugae. Moreover, the shell outline of the present species is nearly semicircular, instead of being subquadrate in the preceding species.

In 1883, KAYSER described two brachiopod shells under the name of *Productus undatus* DEFRANCE from the Loping series in Kuangsi Province of South China. Afterwards, FLIEGEL (1901), as well as FRECH (1911) who re-examined KAYSER's original specimens, were of the opinion that KAYSER's *Prod. undatus* surely akin to *Prod. mongolicus* which was first introduced by DIENER (1897). This argument was later followed by certain specialists, such as CHAO (1927), HUANG (1932) and YANAGIDA (1967).

Judging from the illustrations in KAYSER's monograph, however, two samples referred to *Prod. undatus* by KAYSER may not belong to a single species, but may be separable into two distinct species. One of them (fig. 13 of KAYSER's plate 26) seems to be specifically identifiable with *Compressoproductus mongolicus* DIENER, as FLIEGEL and the others pointed out; while the other (fig. 12 of the same plate) can be distinguished from the former and may be conspecific with the present species here dealt with, from its broader form, longer hinge-line and less convex pedicle valve.

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(Manuscript received on 21 May, 1969)

PLATE 2 AND EXPLANATION

Explanation of Plate 2

Permundaria asiatica n. sp.

Figs. 1, 2.

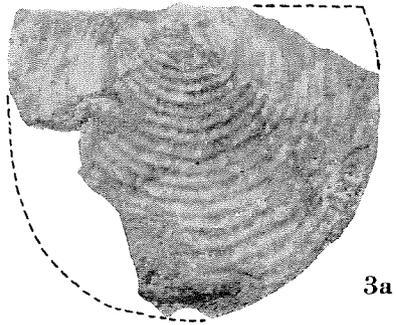
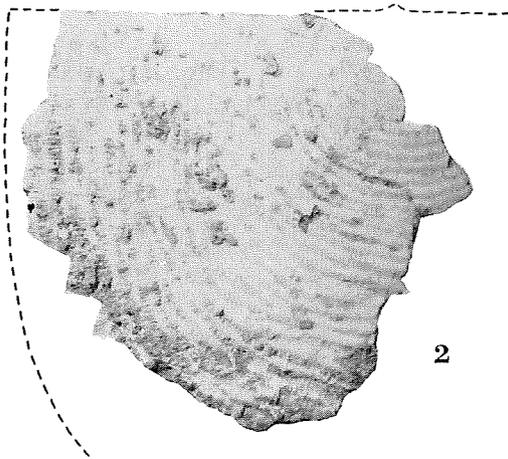
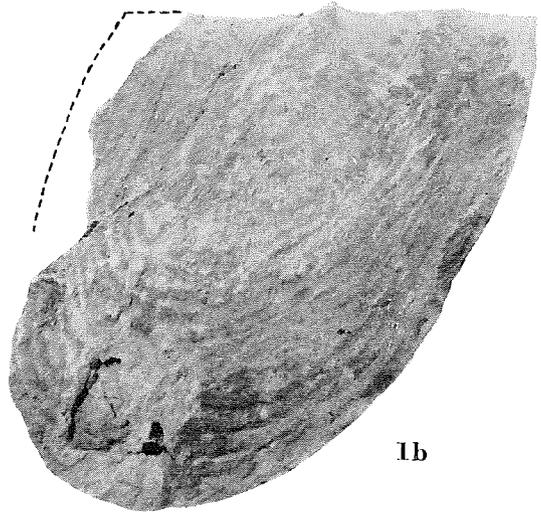
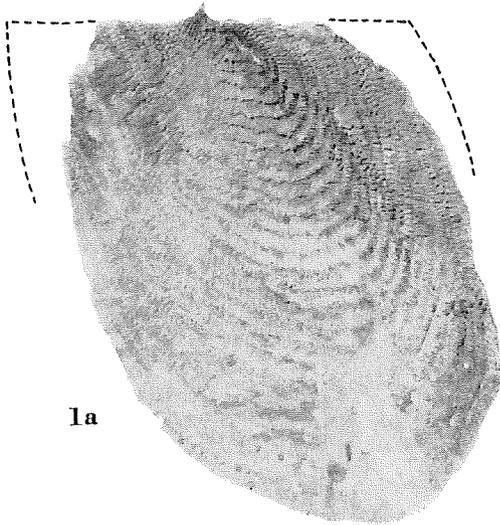
- 1a. External mould of pedicle valve. Holotype from the Kitakami Mountains, $\times 1.4$, UHR 19015.
- 1b. Internal mould of the same valve, $\times 1.4$.
- 1c. Portion of 1a enlarged 10 times natural size, showing details of costellae and some concentric rugae.
- 2. Ventral view of a specimen from Sisophon limestone, $\times 1.4$, UHR 19016.

Permundaria sisophonensis n. sp.

Figs. 3a, 3b.

- 3a. Ventral view of Holotype from Sisophon limestone, $\times 1.4$, UHR 19017.
- 3b. Portion of 3a enlarged 10 times natural size, more clearly showing characters of surface ornamentations.

Plate 2



3b

