Stereoscopic Photographs and Descriptions of New Syringothyroid Brachiopods from the Lowest Carboniferous of the Southwestern Kitakami Region, Northeast Japan.

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INTRODUCTION.

In the previous papers, the writer reported the presence of the specimens belonging to the genus *Syringothyris* in the lowest Carboniferous of the Higashiyama district, Iwate Prefecture, but he didnot yet describe as the specimens were imperfect for description. In this paper three new species of *Syringothyris* are described: *Syringothyris karaumedatensis* n. sp., *Syringothyris japonica* n. sp. and *Syringothyris sakamotoi* n. sp.

All the specimens studied were collected from the Karaumedate formation which disconformably rests upon the Upper Devonian Tobigamori formation. The latter formation contains the abundant specimens of *Cyrtospirifer* and a characteristic Upper Devonian plant, *Leptophloeum australe*. *Syringothyris karaumedatensis* is a widely distributed species in the Karaumedate, being associated with *Rhipidomella*, *Leptaena* and *Prospira nodai* (Tachibana). *Syringothyris japonica* is obtained together with *Globispirifer nagasakaensis* (Tachibana) which is one of the best index fossils of the Karaumedate. *Syringothyris sakamotoi* is represented by only one specimen, but it bears a distinguishing feature.

These species are the eariest of *Syringothyris*. Especially *Syringothyris japonica* is closely related to *Syringothyris* (*Syringopleura*) *randalli* Simpson from the base of the Mississippian in Eastern North America.

The spcimens collected in this field are generally deformed by the Oshima orogenic movements of the early Cretaceous age in the Kitakami Mountainland, Northeast Japan, and they occur in the form of internal and external moulds taken from sandstone.

All of the figures illustrated on the plates in this paper are stereoscopic photographs made by the writer.

The writer wishs to thank Prof. K. Hatai, Geological and Palaeontological Institute of Tohoku University, for reading the manuscript; Dr. D. V. Nalivkin, Academy of Sciences of the USSR and Dr. F. N. Chernyshova, Central Geological Museum, Leningrad, for the gift of South Uralian specimens.

DESCRIPTION OF SPECIES.

Family SYRINGOTHYRIDIDAE Frederiks, 1926.
Subfamily SYRINGOTHYRIDINAE Frederiks, 1926.
Genus SYRINGOTHYRIS Winchell, 1863.

Syringothyris karaumedatensis Tachibana, n. sp.
Pl. I, figs. 1—8; Pl. II, figs. 1—6.
Syringothyris cf. *cuspidatus* Tachibana, 1952; Jour. Geol. Soc. Jap., Vol. 58, p. 358.

Shell of medium size, wider than long, with the hinge-line marking the greatest width. The cardinal extremites are angular. The width of the average specimen is 45 mm. along the hinge-line.

The pedicle valve is subpyramidal in form. The surface slopes with the even, gentle convexity from the umbo to the lateral margins and cardinal extremities. The median sinus originates near the beak, and it becomes broader and deeper towards the front with a subangular bottom, forming a lingual extension. The beak is small and bluntly pointed. The cardinal area is high and flat, occasionally a little arched near the apex, generally marked by horizontal growth lines, bisected by a triangular delthyrium which is very narrow with a delthyrial angle of about 20°, and in a few specimens the vertical striae are observable on each side of the delthyrium. The delthyrial grooves are narrow and shallow. The cardinal area makes an angle of about 90° with the plane of valve-contact. The transverse delthyrial plate is flat and a little sunken below the level of the cardinal area, extending from the apex to about one-third or half the length of the delthyrium. The apical angle is about 90°—100°.

The brachial valve is less convex than the pedicle one. The beak is small and incurved. The cardinal area is linear. The surface slopes with a gently convex curvature from the umbo to the anterior and lateral margins, but in some specimens the anterior portion of the lateral slopes is somewhat abruptly compressed laterally on either side of a median fold. The median fold is laterally bounded by a somewhat strong furrow and originates at the beak, being usually broad and rounded at the top but a little flattened near the anterior portion.

The surface of each lateral slope is marked by simple and subangular plicae separated by slightly deep, narrow furrows, but these plicae become gradually more finer and obscure towards the cardinal extremities. They are about 18 in number on each lateral slope. Besides these radial plicae, the entire surface of the valve is marked by concentric fine growth lines with concentric growth lamellae impressed at irregular intervals. The median sinus and fold are entirely non-plicated, being crossed by only concentric growth lines.

Internally the dental lamellae are usually thick, short, and divergent with a little wider angle than the lateral sides of the median sinus, extending forwards along the valve floor for one-third of the length from the beak. The transverse delthyrial plate between the dental lamellae bears a syrinx, which is generally

split along the inner surface. Though the syrinx is somewhat variable in form, it is generally represented by a slit tube formed by two thin plates which strongly curl ventrally or incurve, the point of the syrinx extending two-thirds the distance from the apex to the hinge-line. The adductor scars are much narrow and elongate along the median line of the valve. Diductor scars are subovate in outline, usually longitudinally striated.

In the brachial valve the cardinal process consists of about 20 thin plates and furrows. On either side of the cardinal process there are narrow dental sockets which become wider and deeper antero-laterally, being bounded by distinct socket plates. Broad crural plates form posteriorly a thickened process on which the cardinal process is present. Muscle scars are not well preserved. A distinct median septum extends anteriorly from near the cardinal process to the half of the valve. The ovarian pits are distributed in the internal face of the cardinal area excepting the muscle field.

Remarks: This species is common but not abundant throughout the Karaumedate formation, and is characterized by its medium shell, its blunt beak, its somewhat incurved or frequently flattish pedicle cardinal area, its subangular sinus, its comparatively smaller apical angle, its gently convex lateral slopes and by its somewhat various form of the syrinx. This spacies resembles *Syringothyris hannibalensis* (Swallow) from the lower Kinderhookian, but it differs from the latter in having a longer hinge-line with angular cardinal extremities, a smaller delthyrial angle and a different shape. The syringothyrids from Japan have so far been described from two localities, one from the Arisu formation of the Kesen district in the Kitakami Mountainland, another from the Oomi limestone of Niigata Prefecture. These syringothyrids are all larger than *Syringothyris karaumedatensis*. Minato described *Syringothyris kitakamiensis* Minato, *Syringothyris transversa* Minato, *Syringothyris jumonjiensis* Minato and *Syringothyris* sp. Of these, *S. kitakamiensis* is larger in size and has a little wider apical angle and delthyrial angle. *Syringothyris jumonjiensis* is figured by an external mould, but according to Minato's description, it attains a large sized shell of 130 mm. in width, having a very high and flat cardinal area. *Syringothyris transversa* Minato also has a long hinge-line of 81 mm. in width, and wider apical and delthyrial angles. *Syringothyris* sp. is also extraordinally large and has a higher cardinal area. The specimen compared with *Syringothyris cuspidatus* Martin by Hayasaka from the Oomi limestone has also a larger and a different shape and the shell of the Oomi specimen is very thick. Thus, it is noted that *S. karaumedatensis* is smaller than the other known species of the syringothyrids so far reported from the Tournaisian of Japan. This species closely resembles *Syringothyris elongata* North from the lower Carboniferous of England, from which it is discriminable in having a slightly incurved cardinal area which is not so high, and its more alate cardinal extremities. From *Syringothyris principalis* North from the Kleistopora zone of the Avonian, it differs in having a slightly

larger size, more angular cardinal extremities, and in having a relatively low and occasionally slightly incurved area. Its nearest relative is *Syringothyris uralensis* Nalivkin from the Etroeungt zone of South Ural, from which it differs in a smaller apical angle and narrower median sinus.

Occurrence: Karamedate formation. Higashiyamamachi, Higashi-iwaigun, Iwate Prefecture.

Syringothyris japonica Tachibana, n. sp.

Pl. III, figs. 1—5; Pl. IV, figs. 1—8; Pl. V, figs. 1—7; Pl. VI, figs. 1—4.

Syringothyris sp. Tachibana, 1952; Jour. Geol. Soc. Jap., Vol. 58, p. 358.
Syringothyris cf. *randalli* Tachibana, 1962; Bull. Fac. Liberal Arts, Nagasaki Univ., Vol.3, p. 53, fig. 1.

Shell of medium to large size, wider than long, with the greatest width at the hinge-line, the cardinal extremities acutely angular. The width of the largest specimen is 60 mm. along the hinge-line.

The pedicle valve is subpyramidal in form. The beak is small, bluntly pointed and slightly incurved. The median sinus begins at the beak as a narrow furrow and becomes slightly wider and deeper anteriorly with a rounded bottom. Sinal bounding plicae are not prominent. The cardinal area is apsacline and posteriorly slopes from the hinge-line at the obtuse angle with the plane of the valves. It is generally somewhat strongly concave in the vicinity of the beak. Though most of specimens bear a high cardinal area, occasionally a somewhat low cardinal area is observed in a few specimens. A triangular delthyrium is narrow and is variously closed by secondary shell material from the bases of dental lamellae for about the upper one-half of the length from the apex, being bounded by deep delthyrial grooves on both sides. The delthyrial angle is about 20°—25°, and the apical angle is about 110°—130°. From the corners of the delthyrium two pointed teeth protrude.

In the brachial valve, the beak is small and slightly protudes beyond the hinge-line. The cardinal area is narrow and linear. The median fold is well defined and narrow near the beak, becoming anteriorly wider and more elevated with a broadly rounded top.

The lateral slopes of both valves are covered with about 20 simple radial plicae, which are somewhat depressed and subrounded at the top and are separated by narrower furrows. They become successively smaller and somewhat obscure towards the cardinal extremities. The cardinal area is marked by faint horizontal growth lines. The median sinus and fold are non-plicate. The surface of both valves is also covered by crowded concentric fine growth lines of variable strength.

In the interior of the pedicle valve, the dental lamellae are well developed

and usually thick, diverging at an angle much wider than the lateral margins of the median sinus.

Except for immature shells, the apical portion of the delthyrial cavity is heavily filled with secondary deposition of calcitic material. Near the juncture of the bases of the dental lamellae, there is a syrinx which is variable in shape. In some spcimens it is a solid rod and frequently pointed at the top, but in another it is rather broad and blunt, extending into the interior of the valve. It is generally marked longitudinally by a narrow groove or slit. In the specimen of Pl. III, fig. 5, two plates bend ventrally to make a syrinx which bears internally a median narrow but deep groove.

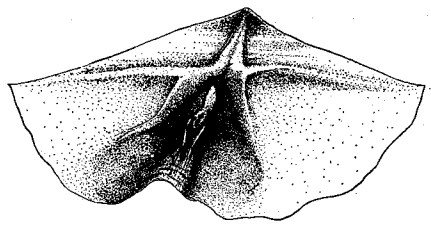

Fig. 1. Sketch showing the pedicle valve interior of *Syringothyris japonica* n. sp.

In most specimens, an elevated bilobed posterior adductor process is well exhibited in the posterior part of the muscle field, being divided into two ridges by a longitudinal median sulcus which appears to extend posteriorly to the slit of the syrinx and anteriorly to the long narrow sulcate adductor scars. In some cases, one of the two plates forming the syrinx extends anteriorly as a thin plate within the median sulcus of the posterior adductor process mentioned above. Long and narrow adductor scars occupy the central portion of the muscle field, being bounded by two low slender longitudinal ridges on their lateral margins. The diductor scars are broadly ovate in outline and strongly impressed posteriorly, being marked by numerous longitudinal striae and furrow.

Numerous ovarian pits are developed on the interior of the cardinal area and on the postero-lateral portion surrounding the muscle field.

In the interior of the brachial valve, the cardinal process is concave and broadly divided by a large longitudinal median depression, being consisted of somewhat irregularly arranged, exceedingly thin plates and furrows. Well-defined dental sockets are widely divergent and become wider and deeper antero-laterally, being supported by distinct socket plates for most of their length. A median ridge is low and thin, frequently indistinct. The muscular scars are not well preserved in the specimens here studied.

Remarks: The specimens of this species are somewhat variable, but they are included in a one locality. The present species is characterized by its transverse outline, the concave cardinal area which is posteriorly inclined from the hinge-line, the presence of the sulcate posterior adductor process, the various

form of the projecting syrinx, deeply impressed diductor scars marked by longitudinal striae, the delthyrial cavity heavily filled with shell material, widely devergent thick dental lamellae, and by the broadly concave cardinal process with a deep angular median depression. Especially this species is very close, if not identical, to *Syringothyris* (*Syringopleura*) *randalli* Simpson from the Corry sandstone of the lowest Carboniferous age in Eastern America and agrees with the latter species in many details. The type specimen of Simpson's species, however, has a few plicae in the median sinus though Sass (1960) illustrates the specimen of the pedicle valve with a non-plicated sinus and in this species the diductor scars of the pedicle valve are marked by distinct radial striae which are obscure or lacking in the Japanese specimens so far collected. *S. japonica* is entirely different from *S. karaumedatensis* and can be easily discriminated in many respects.

Occurrence: Karaumedate formation. Higashiyamamachi, Higashi-iwaigun, Iwate Prefecture.

Syringothyris sakamotoi Tachibana, n. sp.
Pl. 6, figs. 5—7.

The shell is spiriferoid in shape. The cardinal area is low. Though the cardinal extremities are brokened, the greatest width is probably along the hinge-line. The lateral slopes are somewhat strongly but uniformly convex. The median sinus is non-plicate and has a rounded bottom. Simple, somewhat depressed lateral plicae bounded by narrow and shallow furrows are distinct on each side of the median sinus but become obscure towards the cardinal extremities, being aproximately 10 or more in number on each lateral slope though the specimen of an internal mould is not well preserved. The dental lamellae are strong and subparallel, extending anteriorly to the one-half the length of the valve along the lateral margins of the median sinus. The triangular delthyrium is broad and the delthyrial angle is about 35°—40°. The apical angle is about 130°—150°. Near the juncture of the bases of the dental lamellae, there is a very small syrinx from which a slender narrow ridge extends forwards and continues to the median ridge dividing the low narrow adductor scars bounded by two slender long ridges. The diductor scars is enclosed by the dental lamellae, and its sculpture is not well preserved.

Remarks: The present species is placed in the genus *Syringothyris* because of the non-plicated median sinus, simple lateral plicae, well-defined thick dental lamellae and a small syrinx. Besides these features, this shell is characterized by the low cardinal area, subparallel dental lamellae extending anteriorly at a same angle with the sinal one, strongly but uniformly convex shell, and by the less numerous lateral plicae. This species has some resemblance to *Syringothyris*

australis Maxwell from the Tournaisian of Australia, but the Australian species has a large syrinx and more transverse outline.

Occurrence: Karaumedate formation. Higashiyamamachi, Higashi-iwaigun, Iwate Prefecture.

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EXPLANATION OF PLATES

All specimens are from the Karaumedate formation and are preserved in the University of Iwate.

Plate I.

Syringothyris karaumedatensis Tachibana, n. sp.

Figs. 1–4. Respectively brachial, pedicle, anterior and posterior views of the internal mould. ×1. Holotype.
Fig. 5. Internal mould showing the pedicle interior of the preceeding specimen. ×1. Holotype.
Fig. 6. Internal mould showing the posterior part of the pedicle valve. ×2.
Fig. 7. Internal mould showing the pedicle interior. ×2.
Fig. 8. Internal mould of the brachial valve. ×1.

Plate II.

Syringothyris karaumedatensis Tachibana, n. sp.

Fig. 1. External mould of the pedicle valve showing the horizontal and vertical striae. ×2.
Fig. 2. Internal mould showing the pedicle interior. ×1. 5.
Fig. 3. External mould showing the pedicle exterior. ×1. 5.
Fig. 4. Internal mould of the pedicle valve showing a syrinx. ×2. 5.
Fig. 5. Internal mould of the pedicle valve showing a syrinx. ×2. 5.
Fig. 6. Internal mould of the brachial interior. ×2. 5.

Plate III.

Syringothyris japonica Tachibana, n. sp.

Fig. 1. Internal mould showing the pedicle interior. ×1. 5.
Fig. 2. Internal mould showing the pedicle interior. ×1. 2.
Fig. 3. Internal mould showing the pedicle interior. ×1. 2.
Fig. 4. Internal mould showing the pedicle interior. ×1. 3.
Fig. 5. Internal mould showing the pedicle interior. ×1. Holotype.

Plate IV.

Syringothyris japonica, Tachibana, n. sp.

Fig. 1. Internal mould showing the pedicle interior. ×1.
Fig. 2. Internal mould showing the posterior part of the valves. ×1.
Fig. 3. Internal mould showing the pedicle interior. ×1. 5.
Fig. 4. Internal mould showing the pedicle interior. ×1.
Fig. 5. Internal mould showing the pedicle interior. ×1.
Fig. 6. Internal mould of the preceeding specimen. ×1.
Fig. 7. Internal mould of the pedicle valve. ×1.
Fig. 8. Cast showing the pedicle interior. ×2.

Plate V.

Syringothyris japonica Tachibana, n. sp.

Fig. 1. External mould showing the pedicle exterior. ×1. 5.
Fig. 2. Internal mould showing the pedicle interior. ×1. 5.
Fig. 3. Internal mould showing the pedicle interior. ×1. 5.
Fig. 4. Internal mould showing the pedicle interior. ×1.
Fig. 5. Internal mould showing the brachial interior. ×2.
Fig. 6. External mould showing the brachial exterior. ×1.
Fig. 7. External mould showing the posterior part of the valves. ×1.

Plate VI.

Syringothyris japonica Tachibana, n. sp.

Fig. 1. Internal mould of the pedicle valve. ×1.
Fig. 2. Internal mould of the pedicle valve. ×1. 1.
Fig. 3. Internal mould of the pedicle valve. ×1.
Fig. 4. Internal mould of the pedicle valve. ×1. 5.

Syringothyris sakamotoi Tachibana, n. sp.

Fig. 5. Internal mould of the pedicle valve. ×1. Holotype.
Fig. 6. Internal mould showing the pedicle interior. ×1. 5. Holotype.
Fig. 7. Internal mould showing the pedicle interior of the preceeding specimen. ×2. Holotype.

Errata		
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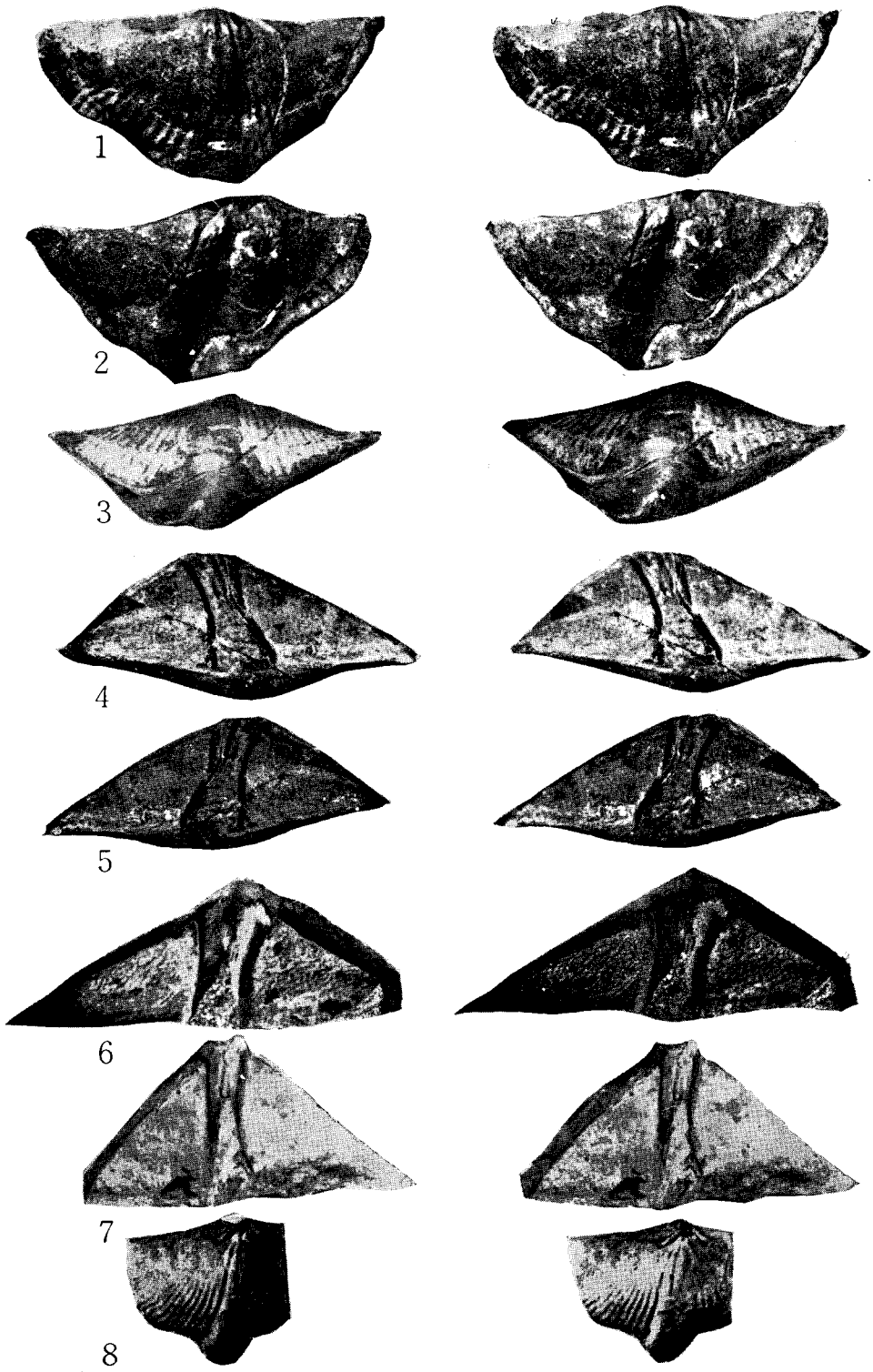

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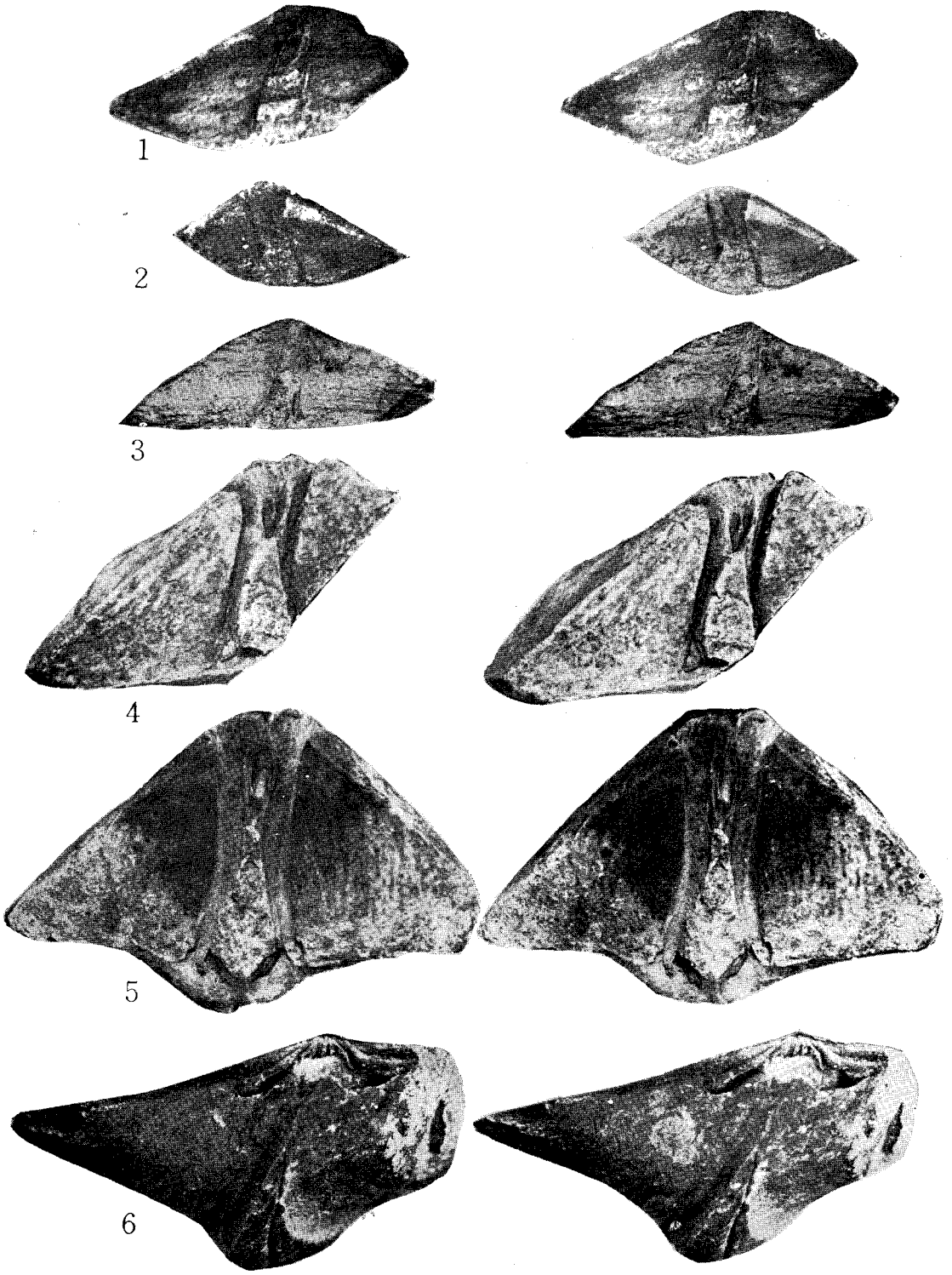

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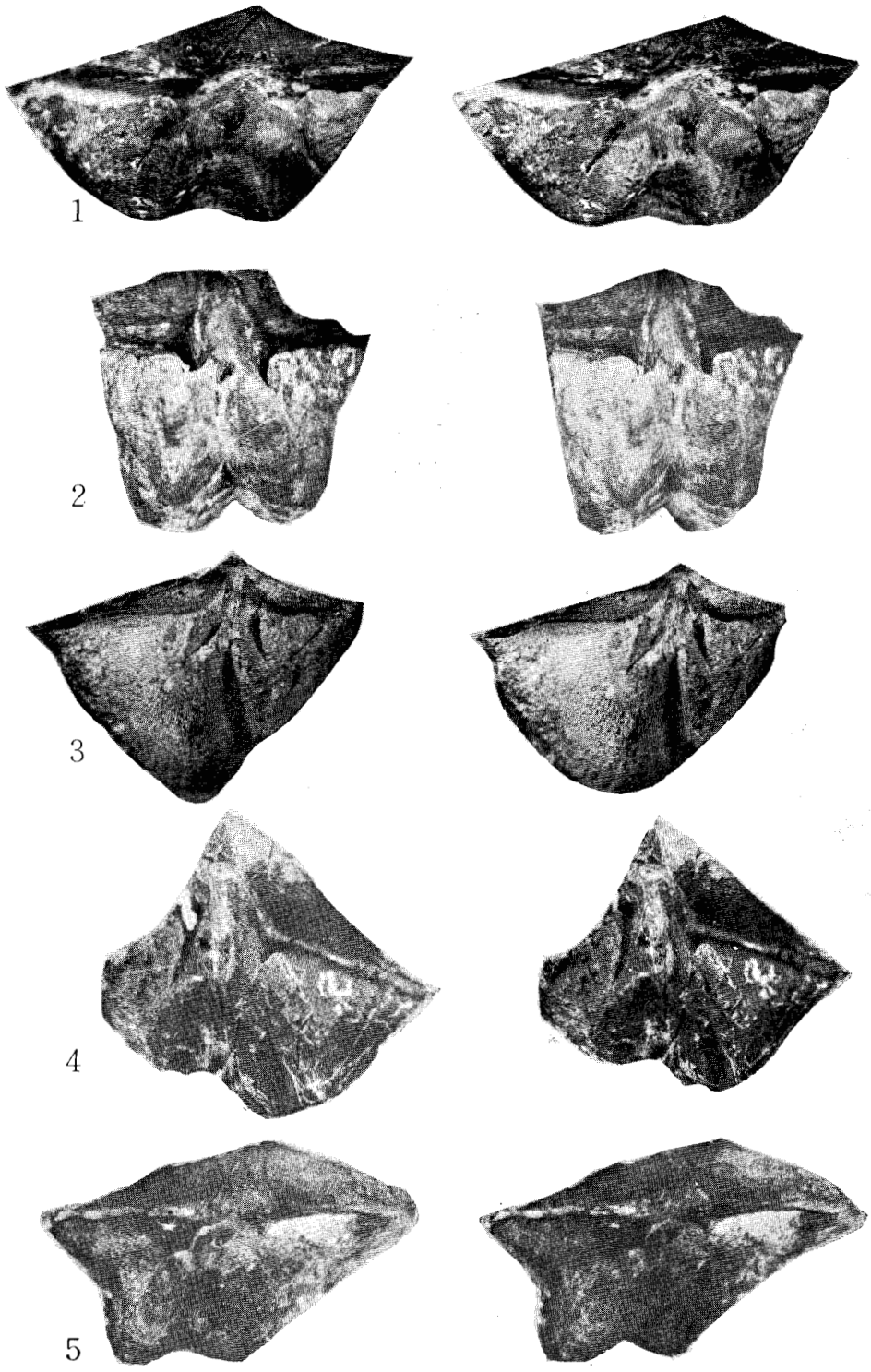

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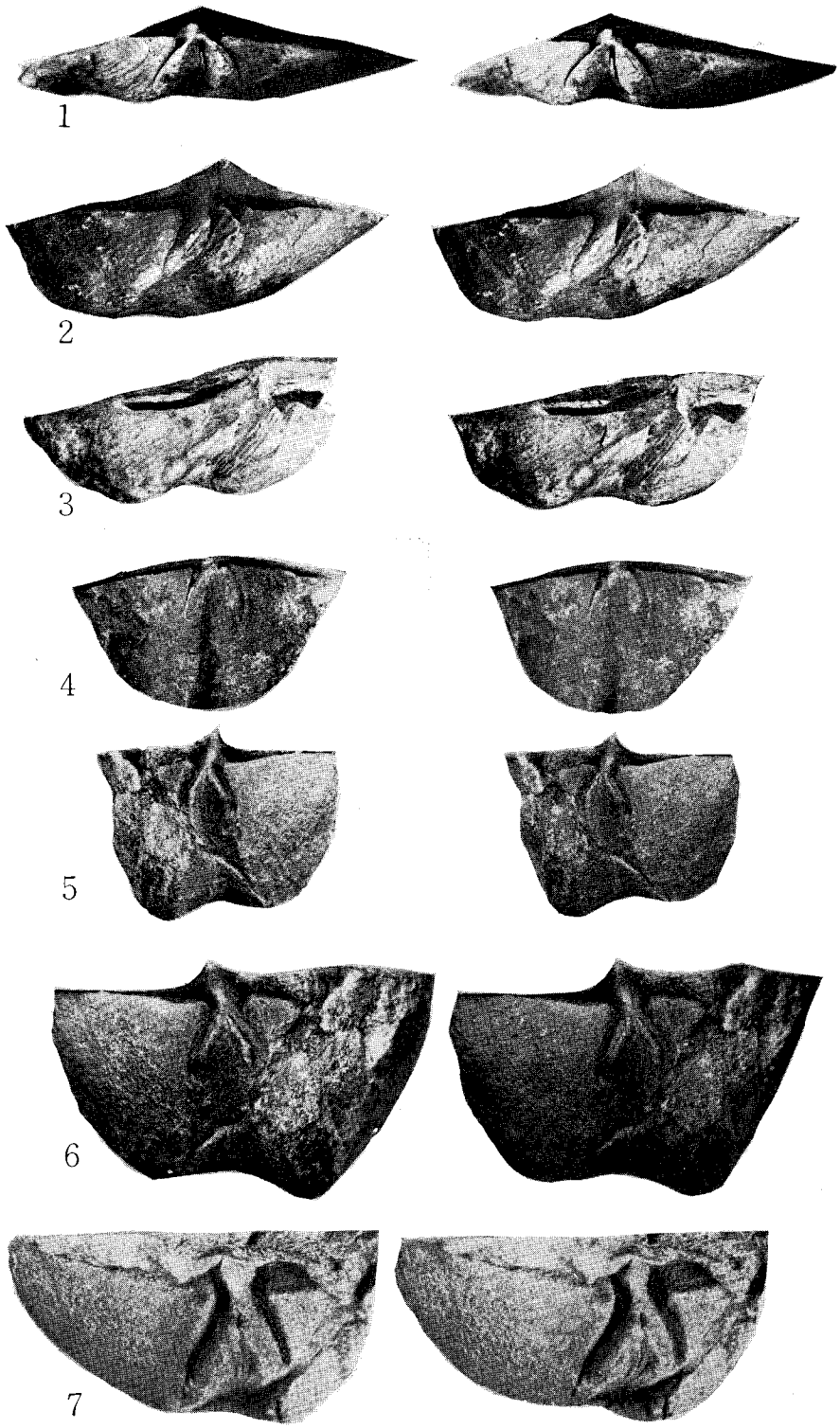

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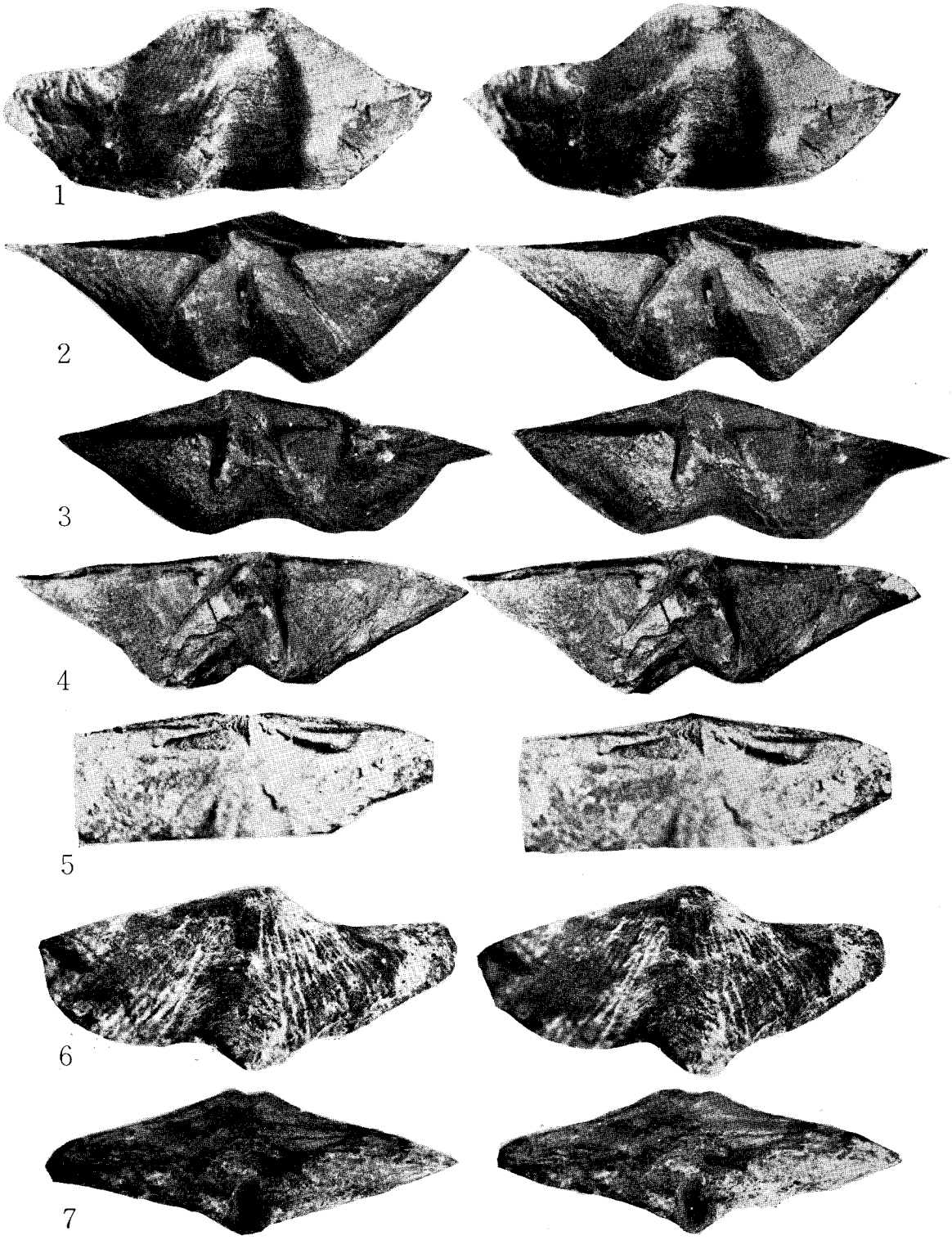

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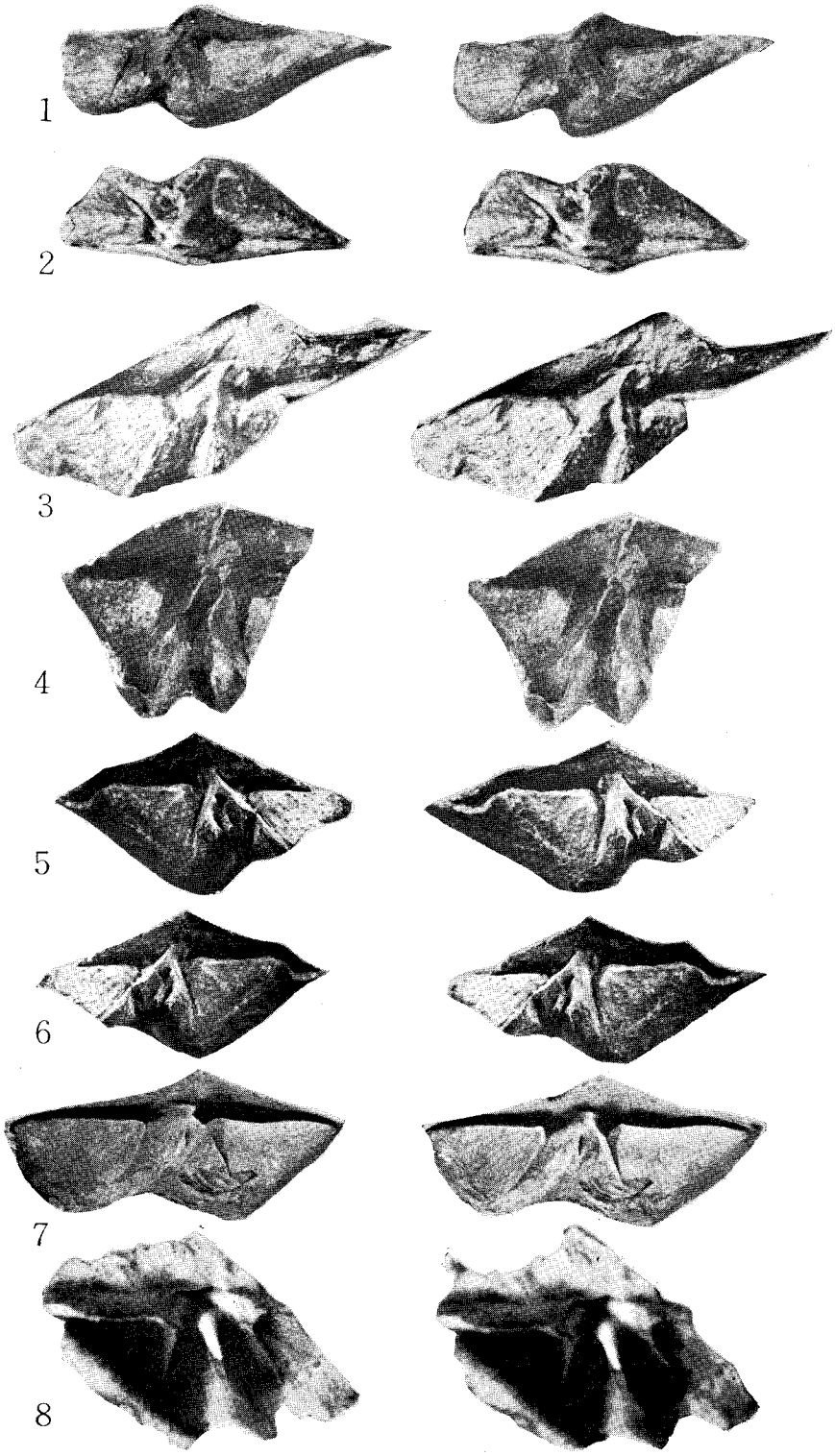

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