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Author(s)	Minato, Masao
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ON THE LOWER CARBONIFEROUS FOSSILS OF THE KITAKAMI MASSIF, NORTHEAST HONSHU, JAPAN

By

Masao MINATO

Contribution from the Department of Geology and Mineralogy,
Faculty of Science, Hokkaido University, Sapporo. No. 398.

This paper records some of the fossils from formations thought to range from the oldest to the younger Lower Carboniferous age in the Kitakami Massif. Brief stratigraphical sequence of the Lower Carboniferous deposits in the said area is given below in a descending order:

Onimaru Series : Chiefly of limestone, with rich coralian remains. Thickness ca. 300 m.

~~~~~ Unconformity ~~~~~

|                   |   |                  |                                                                                                                                                                                                                    |
|-------------------|---|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ohdaira<br>Series | { | Kozubo Stage :   | The lower part consists chiefly of an alternation of fine and coarse grained schalstein, and the upper part mainly of various kinds of fine grained sandstone, slates, impure limestones etc. Thickness ca. 500 m. |
|                   |   | Maide Stage :    | The Upper part of this stage is represented by massive schalstein, and the lower part with an alternation of schalstein and slate. Thickness ca. 400 m.                                                            |
| Arisu<br>Series   | { | Jumonji Stage :  | Consists chiefly of an alternation of schalstein and slate. The basal part is calcareous and fossiliferous. Thickness about 400m.                                                                                  |
|                   |   | Hinozuti Stage : | Consists of thick schalstein and slate. Thickness; more than 600 m.                                                                                                                                                |
| Hikoroiti Series: |   |                  | Consists chiefly of gray or black slate, greenish schalstein, lenticular limestones. Thickness more than 500 m.                                                                                                    |

The important fossils from various horizons are enumerated below.

**Onimaru Series**, Previously described and listed. (see: M. MINATO\*, 1943 a, 1943 b, 1944 etc.)

*Kueichouphyllum*, *Rhodopyllum*, *Siphonodendron*, *Dibunophyllum* and *Syringopora* are very rich in individuals. Some Brachiopods as *Gigantella*, *Productus* and *Spirifer* occur.

**Kozubo Stage**: In the Lower division of this stage, *Sugiyamaella carbonarium* YABE et MINATO occurs in a few localities usually with *Pustula* sp.

**Maide Stage**: The lower part is characterized by *Amplexus ohdairaensis* OISHI et MINATO, *Syringopora* sp., *Brachythyris nagaoi* MINATO, *Productus* sp., and *Spiriferina octoplicata* SOWERBY. In slightly higher horizon, *Spirifer* (*Brachythyris*) *pinguis* is found.

**Jumonji Stage**: The basal part of this stage is always fossiliferous. The fossils are: *Torynifer* (*Kitakamithyris*) *semicircularis* MINATO, *Schizophoria striatula* (SCH.), *Syringothyris transversa* MINATO, *Syringothyris jumonjiensis* MINATO, *Cliothyridina royssii* (L'EVILLE), *Spiriferina octoplicata* SOWERBY, *Actinoconchus lamellosa* (L'EVILLE), *Spirifer* (*Fusella*) *nippomotrigonalis* MINATO, *Spirifer* (*Fusella*) *nipponotrigonalis* var. *minor*, *Spirifer kozubensis* MINATO, *Platycrinus asiatica* MINATO, and some indeterminable blasotoids. *Syringothyris* and Blasotoidea, gen. et sp. indet are quite rich in individuals.

**Hinozuti Stage**: Locally fossiliferous, but not precisely investigated.

**Hikoroiti Series**: *Actinocrinus higuchisawensis* MINATO, *Actinocrinus ohmoriensis* MINATO, *Amphracrinus* sp., *Leptaena analoga* (PHILLIPS), *Leptaena convexa* WELLER, *L.* cf. *convexa* WELLER, *Schellwienella izirii* MINATO, *Schellwienella* ? sp., *Planoproducetus gigantoides* MINATO, *Productella* aff. *caperata* (SOWERBY), "*Spirifer*" cf. *logani* HALL., *Brachythyris kitakamiensis* MINATO, *Brachythyris* sp., *Torynifer* (*Kitakamithyris*) *tyoanjiensis* MINATO, *Torynifer* (*Kitakamithyris*) *hikorcitiensis* MINATO, *Actinoconchus planosulcata* (PHILLIPS), *Lithophaga* sp.

The fossils from the Hikoroiti series suggest that the series may

\* M. MINATO: New forms of *Kueichouphyllum* from the Lower Carboniferous Coral limestone of the Kitakami Mountainland, etc. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 1, 1943.

M. MINATO: Some Upper Visean Coral fauna from the Coral limestone of the Kitakami Mountainland, etc. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 2, 1943.

M. MINATO: Die Transgression der Ober-Vise-Stufe im Kitakami-Gebirge, Japan. Proc. Imp. Academy, Tokyo, vol. XX, p. 163, 1944.

be equivalent to the European Etroeungtian in stratigraphical position, and the Hinozuti-, Jumonji- and Maide stages may correspond to the Tournaisian and Lower Viséan.

That the Onimaru series is a correlative of the European Upper Viséan with its corallian fauna is beyond doubt, as already stated by the writer in many occasions.

### DESCRIPTION OF SPECIES

Phyllum Echinodermata  
 Sub-Phyllum Pelmatozoa  
 Class Crinoidea  
 Subclass Monocyclica BATHER  
 Order: Adunata BATHER  
 Family: Platycrinidae F. ROEMER  
 Genus *Platycrinus* MILL.

*Platycrinus asiatica* MINATO, sp. nov.

Pl. I, fig. 8; Pl. V, figs. 2a, 2b.

Three basals, as a whole, may be almost flat or saucer shaped (pl. I, fig. 2a- internal mould, fig. 2b- external surface). Of three basals, two plates large and almost of equal size and form, one is smaller and of different form. Edges between basals and radials (ill-preserved) intersect each other with angles of 130, 140 and 90 degrees. Whole surface of internal cast with growth lines encircling intersections of edges of three basals, and of pentagonal form. Majority of growth lines very fine but a few strongly impressed. External surface of basals with numerous pustles sub-regularly arranged in several rows. Fragmental stem-joints crowded, and surrounding basals.

**Remarks:** This species is comparable with *Platycrinus guttifer* SCHMIDT<sup>1)</sup> in several points. But the Japanese specimens lack the whole tegmen and the greater part of the calyx brought into strict comparison with the foreign species. However, the German species resembles the Japanese specimens in form, size and the ornamentation of the basals.

In the German species, the edges of the three basals intersect at

1) W. E. SCHMIDT: Die Echinodermen des deutschen Unterkarbons. Abhand. Preuss. Geol. L.A. N. Folge. Heft. 122, p. 10, pl. 2, figs. 3-6, 1930.

angles of 130, 140 and 90 degrees as in the Japanese specimen. The internal surface of the foreign has species similar striations and the external surface is provided with the same kind of characteristic pustles. However, in the German species these pustles are fewer and less regularly arranged compared with the Japanese specimens.

In Europe, there are several species which are allied to *guttifer* and also providing with numerous pustles on the external surface of the basals, such as, *granulatus*, *granosus*, *tuberculatus* etc., *Platycrinus wortheni* is the Mississippian ally of the German species. According to SCHMIDT, *Pl. guttifer* from the Etroeungtian in Germany may be the oldest known species among such types of Crinoidea. It is believed that other allied species occur generally from higher horizons. For the Japanese specimens, the writer wishes to propose the new name of *asiatica*; these specimens were collected from the Lower Carboniferous deposits in Japan, but a layer regarded to be in a horizon higher than the European Etroeungtian.

Hor.: Jumonji Stage

Loc.: Nasirosawa, Jumonji, Simoarisu-mura, Kesen-gun, Iwate Pref.

Coll.: M. MINATO.

Reg.: no. 16105, 16806 (Holotype).

Order Monocyclica camerata BATHER

Family: Actinocrinidae W. & Sp.

Genus *Actinocrinus* MILL.

*Actinocrinus higuchisanuensis* MINATO, sp. nov.

Pl. I, fig. 16.

Calyx only. Dorsal side of calyx saucer-shaped. Basals three, elongate hexagonal. Radials five, wider than long. First IBr quadrangle, wider than long: one of which is anomalous, parting into two narrow plates. Second IBr, and succeeding two II Br pentagonal; IIIBr in two rows, form unknown. Radial ridges on surface of II Br and succeeding plates. Anal plate pentagonal: succeeding two interbranchials sub-pentagonal. Interbranchials between radials hexagonal, and of small size.

Remarks: The general features of this specimen, recalls *Actinocrinus* cf. *asperrimus* M. & W. figured and described by SCHMIDT. The pentagonal anal plate, the quadrangle first IBr, and the wider than long radial plates in the foreign and Japanese forms resemble each other.

The writer is inclined to regard the specimen of SCHMIDT<sup>1)</sup> (fig. 20) as almost indistinguishable from the Japanese form. However, the Japanese specimen has the radials and first brachials devoid of any radial ridges, and further more the fossil is smaller than the German form.

The species described by SCHMIDT was collected from the Tournaisian limestone at Velbert, Wasserfall. In America the same species is said to have occurred in the Burlington in Illinois, and the Lower Burlington in Iowa and Quincy.

Hor.: Hikoroiti Series.

Loc.: Higutisawa, Hikoroiti-mura, Kesen-gun, Iwate Prefecture.

Coll.: M. MINATO.

Reg.: no. 16103.

*Actinocrinus ohmoriensis* MINATO, sp. nov.

Pl. V, fig. 5.

Calyx deformed, saucer-shaped. Basals three, roundly polygonal, elongate hexagonal in form,  $5 \times 2$  mm.: radials five, in contact except at anal side, hexagonal in form,  $5 \times 4$  mm. in size; first IBr hexagonal, wider than long, upper left and right edges very short; second IBr pentagonal? Anal plate subhexagonal, smaller than radials; two first IBr succeeding the special anal, form unknown. First interbrachials between radials hexagonal,  $5 \times 4$  mm. in size; two second interbrachials succeeding preceding plate; form probably hexagonal.

A few ridges which meet centrally are situated on each plates such as radials, first Interbrachials, first and second Brachials.

**Remarks:** The specimen comprises a part of the calyx but lacks the whole tegmen. The present form resembles *Actinocrinus polydactylus*? MILL. described and figured by W. E. SCHMIDT<sup>2)</sup> from the Lower Carboniferous of Germany, and by PHILLIPS<sup>3)</sup>. However, compared with the Japanese material, their specimen differs in the more complicated radial ridges, and different form of both the radial ridges on the radials and the first IBr.

According to SCHMIDT, species with radial ridges on plates as *A.*

1) W. E. SCHMIDT: Die Echinodermen des deutschen Unterkarbons. Abhand. Preuss. Geol. L. A. N. F. Heft. 122, p. 20, pl. 2, figs. 19, 20 1930.

2) W. E. SCHMIDT: Die Echinodermen des deutschen Unterkarbons. Abhand. Preuss. Geol. L. A. p. 21, fig. 4, 1930.

3) J. PHILLIPS: Geology of Yorksire, II, p. 206, pl. 4, figs. 17, 18, 1836.

*costatus* M'COY, *A. tenuis* DE KON. & LE HON., *A. icoidactylus* POSTL., *A. stellaris* DE KON. & LE HON., *A. dorsatus* DE KON. & LE HON., and *A. triadactylus* are very near to *A. polidactylus* in many points.

In Germany *A. polidactylus* is a guide species of the Tournasian Series, and in England<sup>1)</sup> this species occurs from horizon Z<sub>2</sub>, the Zaphrentis Zone of the Tournasian series.

Hor.: Hikoroiti Series.

Loc.: Ohomori, Hikoroiti-mura, Kesen-gun, Iwate Prefecture.

Coll.: M. MINATO.

Reg.: no. 15982.

### Genus *Amphracrinus* AUSTIN

#### *Amphracrinus* sp.

1934. *Amphracrinus* sp., YABE and SUGIYAMA: An Upper Paleozoic Crinoid from Japan. Jap. Jour. Geol. Geog., vol. XI, p. 349, pl. XLIV, figs. 1-5.

The anal plates of the present specimen is ill-preserved and each plate of it is strongly granular and thus it may belong to the genus *Amphracrinus* of the Actinocrinidae, as formerly insisted by YABE and SUGIYAMA. Those authors claim that this specimen is related to PHILLIP's *Actinocrinus gilbertsoni* MILLER, the genotype species of the genus<sup>2)</sup> *Amphracrinus*, although the radials and costals in that species are slightly different from the Japanese specimen. In the PHILLIP's<sup>3)</sup> short diagnosis runs as follows: "Costals shorter and wider than in other species; their surface corrugated."

In America, *Amphracrinus* ranges from the Chouteau to the Lower Burlington and in Europe it survives to a little higher stage, viz. the equivalent of the Upper Burlington; it becomes extinct in the Higher Carboniferous of both Europe and America. The Japanese specimen is considered to indicate the Lower Carboniferous age, rather than the Permo-Carboniferous as previously suggested by YABE and SUGIYAMA.

Loc.: Akazawa-mura, Siba-gun, Iwate Prefecture.

1) C. A. MATLEY: The Carboniferous rocks st. Rutn. Q.J.G.S. vol. 62, p. 296. The determination of the crinoidea was done by F. A. BATHER.

2) A. AUSTIN: Observations on the Cystoidea of M. Von Buch and the Crinoidea generally. Q.J.G.S. London, vol. 4, p. 292, 1848.

Class Blastoidea  
Order Eublastoidea  
Family Nucleocrinidae

Gen. et sp. indet

Pl. I, figs. 5a, 5b, 9, 12a, 12b; Pl. V, fig. 6.

A large number of well preserved specimens belonging to one species were collected from a few localities in the same stratigraphical horizon. This is the first representative of Blastoidea in Japan.

Hor.: Jumonji stage.

Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture (Reg. no. 16001).  
Nasirosawas, Jumonji, Simoarisu-mura, Kesen-gun, Iwate Prefecture, (Reg. no. 16056).

Hinozuti, Simoarisu-mura, Kesen-gun, Iwate Prefecture (Reg. no. 16169).

Coll.: M. MINATO.

Phylum Brachiopoda  
Order Neotremata  
Famslly Strophomenidae  
Genus *Leptaena*

*Leptaena analoga* (PHILLIPS)

Pl. III, fig. 1.

- 1836 *Productus analoga*, PHILLIPS: Geol. York. vol. 2, p. 215, pl. 7, fig. 10.
- 1860 *Leptaena rhomboidalis* var. *analoga* DAVIDSON: British Carbo. Brachiopoda, vol. II, p. 110, pl. XXIII, figs. 1-2.
- 1892 *Leptaena rhomboidalis*, HALL and CLARKE: Pal. New York, vol. VIII, Pl. 1, pl. VIII, fig. 9.
- 1899 *Leptaena rhomboidalis*, Girty: Mon. U.S.G.S. vol. XXXII, p. 525.
- 1909 *Leptaena analoga*, WELLER: Fauna of the Fern Glen Formation. Bull. Geol. Soc. America, vol. XX, p. 292, pl. XII, figs. 2, 3.
- 1914 *Leptaena analoga*, WELLER: The Mississippian Brachiopoda. Illinois State Geol. Surv., Mon. 1, p. 49, pl. II, figs. 1-10.
- 1927 *Leptaena analoga*, Girty: U.S.G.S. Prof. Pap., no. 153, p. 62, pl. XXII, figs. 6-7.
- 1930 *Leptaena rhomboidalis* (WILCKENS) var. *analoga*, PAECKELMANN: Die Fauna des deutschen Unterkarbon Teil. 1, p. 183, pl. X, fig. 3; pl. IV, figs. 2-3.
- 1934 *Leptaena analoga*, DEMANET: Les Brachiopodes du Dinantien de la Belgique. Mem. Mus. Roy. Hist. Nat. de Belgique, p. 61, pl. 5, figs. 1-14, text figs. 11-14.
- 1938 *Leptaena analoga*, BRANSON: Stratigraphy and Palaeontology of the Lower Mississippian of Missouri. pt. 1. Univ. Missouri Studies, pl. 24, pl. V, fig. 31.

Shell large, more or less transversely semicircular, or subquadrate in form, wider than long. Hinge-line straight and very long; cardinal extremities angular.

Ventral valve slightly convex at umbonal region, flattened both anteriorly and laterally, passing into rather abrupt geniculation. Cardinal area narrow. Delthyrium broadly triangular, sinus ill-defined.

Dorsal valve slightly concave near beak, becoming flattened or rather convex anteriorly.

Flattened surface of both valves with a series of slightly undulating and occasionally interrupted concentric corrugations crossed by numerous thread-like ribs, numbering 4 or 5 in a space of 1 mm.

Length, 34–38 mm, width, along the hinge line 55–58 mm.

**Remarks:** The writer believes that the specific distinction between "*analoga*" and the supposed long ranged species "*rhomboidalis*" lies in the number of corrugations and coarseness of the ribs.

In North America, *L. analoga* occurs only from the Lower Mississippian<sup>1)</sup>, and is unknown from formations younger than the Burlington.

DEMANET<sup>2)</sup>, also distinguishes *analoga* as a distinct species from *rhomboidalis*. According to him, *Leptaena analoga* is also common throughout the European Tournaisian. The range and distribution shows that *L. analoga* flourished in the lower part of the Lower Carboniferous on both sides of the Atlantic.

The present specimens closely resemble the specimens described and figured by Girty and Demanet, and are identified with them.

Hor.: Hikoroiti Series.

Loc.: Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture.

Coll.: M. MINATO.

Reg.: no. 16130.

#### *Leptaena convexa* WELLER

1914 *Leptaena convexa*, WELLER: Mississippian Brachiopoda, p. 52, pl. II, figs. 11–16.

Shell of medium size, semicircular in outline, wide than long, the greatest width of about 23 mm. at the hinge line; cardinal extremities slightly auriculate.

Surface markings with radial ribs, concentric striae and corrugations. Corrugations not deeply impressed as in other species of *Leptaena*.

1) S. WELLER: op. cit. p. 49.

G. H. Girty: p. 62.

2) F. DEMANET: p. 61.

Median sinus wanting.

Remarks: Unfortunately the internal characters of these shells could not be observed. The surface ornamentation of the present form is almost indistinguishable from *Leptaena convexa*, as described and figured by WELLER from the Kinderhookian of the Mississippi basin. This species differs from *L. analoga* in having less prominent corrugations, feeble radial ribs and weak geniculation of the valve.

Hor.: Hikoroiti Series.

Loc.: Ohmori, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, (Reg. no. 15982).  
Kasiwar, Setamai-mati, Kesen-gun (Reg. no. 16245).

Coll.: M. MINATO.

*Leptaena* cf. *convexa* WELLER

Pl. II, fig. 2.

The present specimen is a little longer than the preceding species, but its surface ornamentation is almost the same. The posterior flattened region of this specimen grades into the anterior and lateral borders with abrupt geniculation.

In external characters this specimen is intermediate between *convexa* and *analoga*. The writer regards the strength of corrugations and radial ribs to be more important than the degree of geniculation for specific distinction between *analoga* and *convexa*. Therefore, the writer believes, that the present form is closer rather *convexa* than *analoga*.

Hor.: Hikoroiti Series.

Loc.: Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture. Reg. no. 16243.

Coll.: M. MINATO.

Genus *Schellwienella* THOMAS

*Schellwienella izirii* MINATO, sp. nov.

Pl. V, fig. 3.

Shell large, elliptical in outline, broader than long, the greatest width a little posterior to middle; hinge-line straight, cardinal extremities obtuse by angular. The dimensions are: width 53, 4 mm, length 49, 3 mm. Ventral valve only.

Shell nearly flat, slightly convex at umbonal region, therefore gradually sloping to margins in all directions and slightly resupinate or almost flat at anterior portion.

Short dental plates subparallel in arrangement, with short, indistinct median septum inbetween.

Surface with very fine, sub-equal, radiating costae, which increase

their number by bifurcation and intercalation; 3-5 counted at space of 1 mm. Concentric sculpture ill-defined.

**Remarks:** Although the specimens are imperfect, their characteristic longitudinally elongate shell, very numerous radiating costae and lacking distinct concentric marking refer them to *Schellwienella*.

*Schellwienella crenistria* (PHILLIPS)<sup>1)</sup> is comparable with this form, but has coarser costae and a shorter shell. *Schellwienella planumbona*<sup>2)</sup>, described and figured by WELLER has more coarser costae than the Japanese.

Hor.: Hikoroiti Series.

Loc.: 808 m. hill, Okuninozuti, Simoarisu-mura, Kesen-gun, Iwate Prefecture.

Coll.: S. IZIRI.

Reg.: no. 16141, holotype.

*Schellwienella* ? sp.

This specimen is more or less related to the preceding species in shape, concavity of the valve, and numerous thread-like costae, but has longer dental plates and a more distinct and longer median septum. Further, the dental lamellae of the present form are diverge in arrangement. Therefore the affinity of this form to the preceding species may be superficial and the generic assignment of this form is provisional. The shape of the muscular impressions and dental plates suggests that, this species may belong to *Schizophoria*.

Dimensions: length of median septum 21.7 mm.  
length of dental plate 16.7 mm.  
width of shell ca. 45.0 mm.  
length of shell ca. 42.5 mm.

Hor.: Hikoroiti Series.

Loc.: 808 m. hill, Okuninozuti, Simoarisu-mura, Kesen-gun, Iwate Prefecture.

Coll.: S. IZIRI.

Reg.: no. 16142.

Family Productidae Gray

Genus *Planoproductus* STAINBROOK

*Planoproductus gigantoiles* MINATO, sp. nov.

Pl. II, fig. 3; Pl. III, figs. 5a, 5b, 6.

Shell subquadrate in outline, very large, far wider than long; hinge-line straight, very long, slightly shorter than the greatest width of the shell. The width of the holotype about 76 mm, its length 43 mm. Shell

1) T. DAVIDSON: British Carb. Brachiopoda, pl. XXVI, figs. 2, 4, 1858.

2) S. WELLER: The Mississippian Brachiopoda, p. 65, pl. III, fig. 19, 20, 1914.

slightly concave in longitudinal section, the umbonal part flat and gradually concave anteriorly. Median fold very low and grading into lateral portions; fold sometimes unnoticeable.

Median septum thin and low, extending from base of cardinal process to center of valve. Sub-elliptical, small but deeply impressed muscle scars situated on each side of septum. Anterior portion of internal surface marked by numerous elongate pustles as well as more or less corrugated concentric lines, the former showing sometimes spinose lines. Fine granular impressions are observable in some parts of internal anterior surface.

External surface covered with spinose lines and thin, interrupted concentric lines giving the appearance of incomplete reticulation at the umbonal region; no distinct spines present.

**Remarks:** Several large sized specimens were collected from various localities in the Kitakami Mountainland; these are regarded as dorsal valves as they possess a low median fold. Unfortunately none of the corresponding ventral valves were found. This species resembles the genotype<sup>1)</sup> of this genus, but is larger in size and the muscular area is more strongly impressed than the genotype.

Occurrence: Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Reg. no. 16110, (holotype: 16111), 16112.

Higutisawa, Hikoroiti-mura, Kesen-gun, Iwate Prefecture. Reg. no. 16113,

16114, Maide, Setamai-mati, Kesen-gun, Iwate Prefecture. Reg. no. 16233,

Kasiwari, Setamai-mati, Kesen-gun, Iwate Prefecture, Reg. no. 16235.

Coll: M. MINATO.

### Genus *Productella* HALL.

#### *Productella* aff. *caperata* (SOWERBY)

Pl. I, fig. 7; Pl. IV, fig. 3.

Compare:

1864 *Strophalosia productoides*, DAVIDSON: Brit. Devonian Brach., p. 97, pl. XIX, fig. 13.

1897 *Strophalosia productoides*, WHIDBORN: Devonian fauna, III p. 175, pl. XXI, figs., 7, 9, 10, 11.

1931 *Productella caperata*, PAECKELMANN: Die Productinae und Productusähnlichen Chonetinae, p. 62, pl. 2, figs. 6-8, 10-11; pl. 3, figs. 1-4.

The whole surface is covered by elongate pustles with round, small spine bases arranged somewhat quincunx. Concentric sculpture consists of numerous, fine, contiguous and interrupted striae.

1) M. A. STAINBROOK: Brachiopoda of the Percha shale of New Mexico and Arizona. Jour. Paleont., vol. 21, no. 4, p. 310, pl. 46, figs. 27-29, 1947.

Shell moderately and evenly convex, sub-orbicular, longer than wide; hinge-line unobservable, it may be shorter than the greatest width; no mesial depression.

**Remarks:** Fragmental specimens of both external cast and mould of the ventral valve were collected. These specimens are insufficient for specific identification. The reference of the material to the genus *Productella* is without doubt and they resemble the specimens, described and figured by PAECKELMANN as *Productella caperata*. The specimen in his fig. 7 in pl. 2 the writer thinks, is indistinguishable from the Japanese material.

*Productella caperata* (SOWERBY) is a good horizon marker for the Etroeungtian at Cromford in Ratinge, Germany, but it is believed that it first begins to appear at an earlier age, i. g., the Uppermost Devonian at other localities in Germany.

Hor.: Hikoroiti Series.

Loc.: Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture.

Reg.: no. 16466.

Coll.: M. MINATO.

Genus *Productus* SOWERBY

*Productus* sp.

Pl. I, figs. 4a, 4b.

This species has wide geological range in the Kitakami Mountainland, where it ranges from the Upper Hinozuti stage, the Lower Jumonji to the Maide Stage.

Family Spiliferidae

Genus *Spirifer* SOWERBY

*Spirifer* cf. *logani* HALL

Pl. II, figs. 4a, 4b; Pl. III, fig. 7.

Shell fairly large, hinge line 47 mm. in length. Ventral valve slightly more convex than dorsal. Beak of ventral valve small, but strongly incurved against hardly incurved obtuse beak of dorsal valve. Cardinal area by transverse striations. Delthyrium wide. Cardinal extremity acute. Median sinus of ventral valve shallow and ill-defined from other part of shell. Fold of dorsal valve not prominent at umbonal region; anteriorly much prolonged. Whole surface including the fold and sinus, covered with rather weak and fine rounded plicae which alternate with

narrow furrows. No dental plates nor median septum, except for delthyrial ridges. Muscle scars impressed in ventral valve, occupying relatively narrow area. Posterior adductor scars subelliptical in form; anterior adductor scars lanceolate. Short and very narrow ridge between the left and right anterior adductor scars. Ventral valve with granular ovalian impressions around the muscle scars. Spiralia preserved, its transverse section compressed elliptical in outline.

**Remarks:** Two specimen were found. From the incurved beak and anteriorly prolonged median fold these specimens are comparable with *Spirifer humerosa*. The specimen described and figured by I. HAYASAKA<sup>1)</sup> from the Ômi limestone may be conspecific with PHILLIPS'S<sup>2)</sup> species and the specimens illustrated by DAVIDSON<sup>3)</sup> under the same name. The specimens are related to the species figured by HAYASAKA, PHILLIPS and DAVIDSON, but may be distinguished from them in having a more distinctly developed median sinus.

Moreover, the present species have relatively longer hinge line than *Spirifer humerosa*. BUCKMAN<sup>4)</sup> mentioned that *Spirifer humerosa* belongs to the genus *Choristites*, and the writer follows BUCKMAN'S view. *Spirifer grimesi* HALL<sup>5)</sup> resembles the present specimens in form and general appearance, but the former has a shorter hinge line. The Japanese specimens seem to be referable to *Spirifer logani*, described and illustrated by WELLER<sup>6)</sup> from the Keokuk formation of the Mississippi valley region, but have smaller size of shell and relatively narrower muscle scars, but this may be merely individual variations. *Spirifer logani* resembles *Spirifer grimesi* in its large size and shell ornamentation but is distinct in possessing a relatively longer hinge line. The writer cannot find any specific distinctions between the Japanese specimens and *Spirifer logani*.

Hor.: Hikoroiti Series

Loc.: Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture.

Coll.: M. MINATO.

Reg.: no. 16000.

- 1) I. HAYASAKA: On the fauna of the Anthracolithic limestone of Omi-mura in the Western part of Echigo. Sci. Rep. Tohoku Imp. Univ., Sendai, Ser. 2, (Geol.) vol. 8, no. 1, p. 43, pl. VI, figs. 1-5, 1924.
- 2) J. PHILLIPS: Geol. Yorkshire, vol. II, p. 218, pl. XI, fig. 6.
- 3) T. DAVIDSON: British Carb. Brachiopoda, p. 23. pl. IV, figs. 15, 16.
- 4) S. S. BUCKMANN: Brachiopoda Homomorphs, *Spirifer glaber*. Q.J.G.S., vol. 64, p. 27, 1908.
- 5) HALL AND CLARKE: Paleontology of New York, vol. 8, pt. 2, pl. 30, figs. 8, 16-19.
- 6) S. WELLER: The Mississippian Brachiopoda of the Mississippi valley basin. Illinois State Geological Survey, 1914, Monograph, 1, pl. 361, pl. LI, figs. 1-2; pl. LII, figs. 1-4; Pl. LIII, figs. 1-2.

Genus *Brachythyris* McCoy*Brachythyris kitakamiensis* MINATO, sp. nov.

Pl. III, fig. 1.

Shell brachythyrid, transversely oblong, large in size. Hinge-line curved and much shorter than the greatest width of shell. Cardinal extremity much rounded. Lateral plications broad and flat, alternating with narrow furrows. Some plications especially near anterior margin, bifurcations observed. Lateral plications 7 on each side of median fold, become quite obsolete near cardinal extremities. Median fold broad at anterior margin, become abruptly narrower towards beak. Narrow sulcus upon fold extending from beak to anterior commissure; obacure sulci on each side of it attain one third of shell length. The surface, especially near anterior margin covered by many concentric growth lines.

Dimensions: Width 64 mm, Length 36 mm.

**Remarks:** Only a dorsal valve was found; it is much deformed and compressed by subsequent pressure. The nearest species to this form may be *Brachthyris subrotundata* (McCoy) figured by T. DAVIDSON (pl. X, fig. 12)<sup>1)</sup>, from which the present one is distinguishable in 1) the curved hinge line, 2) bifurcation on the lateral plications, and 3) presence of subordinate sulci on the median fold.

In the outline of shell, this species also resembles *Br. sulcata*, described by T. N. GEORGE<sup>2)</sup>, but the median fold of the British species is never so wide as in the Japanese species.

Hor.: Hikoroiti Series.

Loc.: Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture.

Coll.: M. MINATO.

Reg.: no. 16465.

*Brachythyris* ? sp.

Pl. V, figs. 2a, 2b.

Compare with

1864 *Spirifer undifera*, DAVIDSON: (non ROEMER, SCHNUR, SCUPIN), British Devonian Brachiopoda, p. 36, pl. VII, figs. 1-10.

Shell brachythyrid, with moderate convexity. Hinge-line curved. Length almost equal to width. Sinus fairly wide, rather shallow, developing from top of beak, 11 mm. wide at anterior commissure. Radial plicae deficient, widest near sinus, diminishing in width and strength gradually toward cardinal angles; all radials alternate with narrow inter-

1) T. DAVIDSON: Carboniferous Brachiopoda. pl. X, fig. 12.

2) T. N. GEORGE: Studies in Avonian Brachiopoda, I. The genera *Brachythyris* and *Martinia*. Geol. Mag. vol. 64, p. 109, 1927.

spaces; bifurcation and intercalation lacking.

Growth lines ill-preserved.

Remarks: Only a ventral valve of this shell was found; its apical part is fractured. Although the internal structure is not observable it is deemed that this shell may be devoid of any apical plates. The present form is assignable to the so-called "ostiolatus group", and is closest to *Spirifer ostiolatus* SCHLOTHEIM.

The Japanese form is, the writer believes, closest to the specimens described by SCUPIN<sup>2)</sup> in his "*Spirifer Deutschlands*" (p. 30, text fig. 4) and by DAVIDSON, as *Spirifer laevicostata*<sup>3)</sup> (Pl. VII, figs. 4 and 5). However the presence of dental plates in the European species serve to distinguish it from the present form.

DAVIDSON's *Sp. undifer* (Pl. VII, figs. 4a, b, c) also resembles the present form, but the radial plicae of the former are stronger than in the later. The writer doubts, whether the specimens in figs. 4, 5 and 6 in the DAVIDSON's monograph are wholly conspecific with SCUPIN, ROEMER and SCHNUR's "undifer".

The present form is also comparable with *Brachythyris*<sup>1)</sup> *girty*, described and figured by BRANSON, but the latter is more transversely elongated than the former.

Hor.: Hikoroiti Series.

Loc.: 808 m hill, Okuhinozuti, Simoarisu-mura, Kesen-gun, Iwate Prefecture.

Coll.: S. IZURI.

Reg.: no. 16140.

### *Brachythyris* aff. *pinguis* (SOWERBY)

Pl. I, figs. 14, 15; Pl. III, fig. 8.

Compare with

1936 *Spirifer pinguis*, PHILLIPS: Illustrations of the Geology of Yorkshire. p. 218, pl. IX, figs. 18, 19.

1849 *Spirifer pinguis*, BROWN: Illustrations of the fossil Conchology of Great Britain and Ireland. p. 109, pl. L, figs. 13, 14.

1858-63 *Spirifer pinguis*, DAVIDSON: British Carb. Brachiopoda, p. 50, pl. X, figs. 1-7.

1900 *Spirifer pinguis*, SCUPIN: Die Spiriferen Deutschlands. Palaeont. Abhand. p. 103, pl. IX (XXXII), figs. 6a-d.

1911 *Spirifer pinguis*, RAYNOULDS and VAUGHAN: Faunal and lithological

1) H. SCUPIN: *Spirifer Deutschland*, 1900.

2) op. cit.

3) T. DAVIDSON: British Devonian Brachiopoda, 1864.

4) F. B. BRANSON: Stratigraphy and Paleontology of the Lower Mississippian of Missouri. The University of Missouri Studies, vol. XIII, no. 2, p. 66, pl. 9, figs. 31-33, 1938.

sequence in the Carboniferous limestone. Q.J.G.S. London, vol. 67, p. 311, listed.

- 1926 *Spirifer (Brachythyris) pinguis*, PARKINSON: The faunal succession in the Carboniferous Limestone etc. Q.J.G.S. London, vol. 82, p. 188, listed.

Shell small in size, longer than wide (originally probably much inflated). Beak of ventral valve strongly incurved over the hinge-line. Hinge-line shorter than maximum width of shell. Cardinal area not high. Fold and sinus rather narrow, but high and deep; almost smooth, except for feeble sulcation near the beak on fold and one or two deficient ribs on posterior part of sinus. Plicae flattend, 10 in each laterals.

**Remarks:** The present form, although deformed, resembles *Brachythyris pinguis* (SOWERBY) in several important points. According to BROWN, the specific diagnosis of SOWERBY's species is:

Gibbose, nearly globular, slightly transversely obovate; beaks rather close; cardinal area shallow, not so wide as the shell; with eight or nine rounded, longitudinal ribs, each side of the mesial fold; groove in the lower side corresponding to the mesial fold; but not sulcated; interveing furrows rounded at bottom.

His description fits the present specimens fairly well.

The present specimens are almost indistinguishable from *Spirifer pinguis* described and figured by DAVIDSON, in respect to the smooth fold and sinus, curved and shorter hinge line, narrower area, number of plicae and slightly incurved beak of the ventral valve.

*Sp. pinguis* figured by PHILLIPS and BROWN is more transversely elongated oval than "*ovalis*" and moreover, according to DAVIDSON, the sulcated nature on the fold is more commonly found in the specimens of "*pinguis*" than in "*ovalis*". SCUPIN, mentioned that his "*ovalis*" lacks the sulci on the fold.

*Sp. integricostata* PHILLIPS figured by DAVIDSON (Pl. X, fig. 2), resembles *pinguis* (Pl. X, figs. 4, 5, 6, 7, and 1, 2, 3 Young ?) in the shape of shell, but has stronger plications.

*Brachythyris pinguis* evidently has a very short geological range and a wide geographical distribution; it is restricted to the middle part of the Lower Carboniferous. According to RAYNOULD, VAUGHAN, PARKINSON and DOUGLAS<sup>1)</sup>, this is a marker for C horizons.

In North America *Brachythyris* is prevalent in the Mississippian. *Br. chouteaunensis* WELLER described and figured by WELLER<sup>2)</sup> and

1) D. A. DOUGLAS: The Carboniferous Limestone etc. Q.J.G.S. London vol. 65, p. 538, 1909.

2) S. WELLER: The Mississippian Brachiopoda, p. 373, 1914.

BRANSON<sup>1)</sup>, and *Br. peculiaris* SCHUMARD are allied to the British *Br. pinguis*.

Hor. : Maide Stage.

Loc. : Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture.

Reg. : no. 16011, 16014, 16012, 16250, 16252 ; Maide, Kesen-gun, Reg. : no. 16253.

Coll. : M. MINATO.

### Genus *Brachythyrina* FREDERICKS

*Brachythyrina nagaoi* MINATO, sp. nov.

Pl. I, figs. 2, 10 ; Pl. III, fig. 2 ; Pl. IV, fig. 4.

Shells spiriferoid, very transverse in form ; cardinal margin mucronate. Whole shell surface covered by distinct plicae, a few of which are bifurctaed. Plicae 13 to 14 in each laterals. Median fold distinguishable from other plicae, and provided with one long sulci in its middle. Rarely two or more, somewhat obscure sulcate lines at both sides of short median sulci.

Entire surface with fine, lamellose, concentric lines.

**Remarks :** From two localities, a few specimens were collected. Of them, the specimens which the late T. NAGAO collected at Kozubo are designated as the holotype. This species is related to *Spirifer strangwaysi* VERNENUILLI, the genotype of *Brachythyrina*, but is more primitive in type. *Brachythyrina* differs from *Fusella* in possessing strong plicae, although the internal structure is unknown. The Japanese form differs from the genotype in having a narrow fold, and simpler median complex of the fold. The Chinese species described and figured by CHAO<sup>2)</sup> as *Br. strangwaysi* has two, long distinct sulci on the fold, which begin to appear near the umbo and moreover, there is one more distinct sulcate line between them, though it is very short.

Hor. : Maide Stage.

Loc. : Kozubo, Yokota-mura, Kesen-gun Iwate Prefecture.

Coll. : T. NAGAO. Reg. : no. 15993, holotype ; Okuhinozuti, Simoarisu-mura, Kesen-gun,

Coll. : S. IZUMI. Reg. : no. 16178.

Note : Other specimens (Reg. no. 16009, 16246) were collected at the same locality as the holotype, but they are much deformed. In these forms, the sinus in the ventral valve develop from the top of the beak, gradually become broader toward the anterior commissure, where we find distinct median ribs, corresponding the sulci of the fold.

1) E. B. BRANSON : Stratigraphy and Paleontology of the Lower Mississippian. p. 65, 1938.

2) Y. T. CHAO : Carboniferous and Permian Spiriferids of China. Paleontologia Sinica, Ser. B vol. XI, fasc. 1. p. 61, pl. VIII, figs. 4-8, 1929.

Genus *Fusella* M'Coy, 1844

Indefinitely defined at present, because the internal structures of the genotype are unknown. It is distinguishable from *Spirifer* by the very transversely elongate form. Discussions about this genus will be given under *Fusella nipponotrigonalis*.

Genoholotype: *Spirifera fusiformis* PHILLIPS, 1836, Geol. Yorkshire, pt. 2, p. 217, pl. 9, figs. 10-11.

*Fusella nipponotrigonalis* MINATO sp. nov.

Pl. II, fig. 5.

Shell large in size, transversely-subtriangular in form, moderately (?) convex, (usually much compressed by subsequent pressure). Hinge-line straight, long, equal to maximum width of shell. Cardinal extremities blunt, acute. Fold strong, extending from beak to front margin and non-plicate except for weak sulci at umbonal region. Cardinal area of ventral valve moderate in height, delthyrium rather wide, its angle as large as 120 degrees. Defined from cardinal area by ridges on both sides of delthyrium. More than 20 plications on each side of shells, which become generally deficient both posteriorly and towards cardinal extremities. Entire surface with fine concentric striae.

Remarks: Although the internal characters and the outer features of the ventral valve are unknown, this species may belong to the genus *Fusella*. According to BUCKMANN<sup>1)</sup>, the diagnostic characters are:

Wide; extended hinge-line; ribs coarse laterally, tending to be deficient medianly. The type is in the smooth stage when usually all ribs been lost. Type, as indicated by the name; *Spirifera fusiformis*, PHILLIPS.

Since the internal structure of *Fusella* is unknown, it may be separated from *Spirifer* only by its outer form. BUCKMANN included the following species in his revised genus *Fusella*, namely: *Spirifer trigonalis*, *Sp. grandicostata*, *Sp. ornithornyncha*, *Sp. triangularis*, *Sp. rhomboidea*, *Sp. subconvoluta*, *Sp. convoluta*, *Sp. fusiformis*, *Sp. vespertilio*, *Sp. avicula* and *Sp. strangwaysi*. All these named species may be allied to each other in their transversely elongate form, but do not seem to be altogether congeneric, because two types are recognizable in their ornamentation of the folds and sinus: one is of the ostiolati-, and the other of the aperturati types, respectively.

*Spirifer triangularis* has a non-plicate fold, while *Sp. trigonalis*,

1) S. S. BUCKMANN: Brachiopoda Homoeomorphy "*Spirifer glaber*". Q.J.G.S. London, vol. 64, p. 29, 1908.

*rhomboidea*, *grandicostata* and *convoluta* including the genotype of *Fusella* have a plicate fold.\* These two types correspond to SCUPIN's<sup>1)</sup> "Gruppe des *Sp. triangularis*" and "Gruppe des *Sp. trigonalis*." Therefore, if the subgenus *Fusella* is to be regarded as valid, it should be further subdivided.

Although *Spirifer strangwaysi* was subsequently separated by IVANOW from the above group and given the name of *Anelasma*, it was found to be preoccupied for another group of animals, thus FREDERICKS proposed the name of *Brachythyryna*<sup>2)</sup> as a substitute. *Brachythyryna* is characterized by the presence of low delthyrial ridges in the pedicle valve, a feature which has not been recognized in the genotype of *Fusella*.

Another distinctive feature of *Brachythyryna* may be in the strong plications of the shell, against the indistinct radiating plications of the genotype of *Fusella*. However, if the internal structure of *Fusella* prove to be like *Brachythyryna*, these two types of spiriferoid shells should be distinguished and retained in generic or subgeneric rank, although the configuration of the shell is analogous with each other.

Judging from the surface ornamentation of the Mountain limestone species of the so-called *Fusella* as illustrated by DAVIDSON, it seems that three divisions are possible, if based upon the radial plications and ornamentations of fold and sinus, as follows:

- a) With distinct plications
  - ostiolati* ..... e. g.: *Sp. triangularis*
  - aperturati* ... e. g.: *Sp. trigonalis*
- b) With indistinct plications
  - aperturati* ... e. g.: *Sp. fusiformis*

However, all these species are quite ambiguous in their internal structures and their true generic status remains in doubt.

Here the writer provisionally uses the name of "*Fusella*" for the Japanese species.

The shape and ornamentation of the shell of the specimens referred to the *Fusella* group resemble the Devonian genus *Spinocyrtina* Fredericks 1916<sup>3)</sup>. STAINBROOK's<sup>5)</sup> *Spirifer* (*Spinocyrtia*) *iowensis* resembles the Japanese specimens now in question, but is generically distinct.

\*) After illustrations of T. DAVIDSON's Monograph of Brachiopoda.

1) H. SCUPIN.: Die Spiriferen Deutschlands, Paleontologische Abhand. 1900.

2) G. FREDERICKS.: Spiriferidae, Bull. l'Acad. des Science, URRS. p. 401, 1926.

3) G. FREDERICKS.: Comité géol. Mem., n. ser., liver, 156, p. 18, 1916.

5) M. A. STAINBROOK.: Spiriferacea of the Cedar Valley limestone of Iowa. Jour. of Pal. vol. 17, no. 5, p. 421, pl. 65, figs. 1-5, text-fig. 4-6, 1943.

In external form the Japanese species resembles *Sp. convoluta* var. *rhomboidea*<sup>1)</sup> figured by DAVIDSON but the latter has a plicated fold. *Spirifer triangularis* figured by DAVIDSON<sup>2)</sup> resembles the Japanese species in having a non-plicated fold, but has a different form and smaller shell. *Sp. triangularis* figured and described by SOMMER<sup>3)</sup> from the Culm Formation of Giessen shows affinity with the Japanese material in the form and features of the radial plications; however the German species is much smaller in size and has a narrower fold.

Spiriferoid shells of the "*Fusella*" type are widely distributed in the Lower Carboniferous of Europe and North America, and are most commonly found in the higher Lower Carboniferous.

The writer believes at present, that the ostiolati type of *Fusella* first appeared earlier than the aperturati. The Japanese species may be older in occurrence than any previously known.

Hor. : Jumonji Stage.

Occurrence : Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture, Reg. no. 16016, 16017, 16018 (holotype) 16019.; Nasirosawa of Jumonji, Simoarisu-mura, Kesen-gun, Iwate Prefecture, Reg. no. 16054.

Coll. : M. MINATO.

Genus *Torynifer* HALL and CLARKE

Subgenus *Kitakamithyris* MINATO, gen. nov.

Although the form, ornamentation and size of shell of these brachiopoda are indistinguishable from the shells of *Torynifer* HALL and CLARKE, the apical plates are different. *Torynifer* has dental plates and median septum in the ventral valve and always definite median septum in the dorsal valve, while the new subgenus has definite dental plates and median septum in the ventral valve but lacks apical plate in the dorsal valve.

Genotype : *Torynifer (Kitakamithyris) tyoanjiensis* MINATO.

*Torynifer (Kitakamithyris) tyoanjiensis* MINATO, sp. nov.

Pl. I, figs. 3a, 3b; Pl. IV, fig. 7.

Shell brachythyrid, suboval in outline, biconvex; ventral valve exceeding the dorsal in convexity. Hinge-line shorter than maximum width of shell. Beak of ventral valve slightly incurved. Cardinal area high and slightly arched, covered by fine striae. Delthyrium rather

1) T. DAVIDSON : Monograph of the Beirish Carboniferous Brachiophoda, pl. V, figs. 14, 15.

2) op. cit. pl. L, figs. 10-18.

3) K. SOMMER : Die Fauna des Culms von Konigberg bei Giessen. N. Jahrb. f. Min. etc. Beil. Bd. XXVIII, p. 634, pl. XXIX, fig. 1.

large, partly closed by arched deltidium. Median fold almost lacking in dorsal valve, while shallow but rather distinct median depression existing in ventral valve. Surface with closely set concentric lamellae and biramus spine bases.

Distinct dental plates and median septum in apical part of ventral valve; dental plates slightly diverge towards floor of valve.

Dimensions are as follows:

Length of shell: 30 mm.  
Width of shell: 50 mm.  
Height of area: 9 mm.  
Delthyrial angle: 65°  
Length of dental plate: 6 mm.  
Length of median septum: 9 mm.

**Remarks:** From the general features of the shell, this species resembles *Reticularia bellmanensis* GEORGE<sup>1)</sup> but has a different kind of apical structure. So far as the writer is concerned, species which may be safely referable to this genus, are the Mississippian species described by WELLER<sup>2)</sup> and others under the name of *Reticularia pseudolineata* and *salemensis*. Aside from the internal structures, the afore mentioned species can be easily distinguishable from the Japanese one, by their more incurved beak.

*Torynifer spinosus* (KINDLE) figured by STAINBROOK<sup>3)</sup> is allied with the Japanese form, but has a definite median septum in the dorsal valve and thus it may be different from the Japanese form.

Hor.: Hikoroiti Series.

Loc.: Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Reg. no. 15990 (holotype); 808 m. Hill, Okuhinozuti, Simoarisu-mura, Kesen-gun, Iwate Prefecture. Reg. no. 16161.

Coll.: M. MINATO.

The specimen from Natsuyama, Takozu-mura, Higasi-iwai-gun, Iwate Prefecture (Reg. no. 16214) is imperfect and fragmental but shows similar external characteristics and possess a similar sinistral depression.

*Torynifer (Kitakamithyris) hikoroitiensis* MINATO, sp. nov.

Pl. I, fig. 1.

Shell brachythyrid, biconvex, the ventral valve deeper than the

- 1) T. N. GEORGE: Carboniferous reticulate Spiriferida. Q.J.G.S. London, vol. 88, p. 554, pl. XXXI, figs. 3a-3b, 1932.
- 2) S. WELLER: The Mississippian Brachiopoda of the Mississippi valley sub. Illinois State Geol. Surv. Monograph. 1. p. 427, 1914.
- 3) M. A. STAINBROCK: Brachiopoda of the Percha Shale of New Mexico and Arizona. Jour. Pal. vol. 21, no. 4, p. 1325, pl. 47, figs. 38-42, 1947.

dorsal. Hinge-line shorter, than maximum width of shell. Cardinal area narrow, moderately high and slightly arched. Delthyrium fairly wide, occupying about one third of cardinal area. Sinal depression and median fold of ventral valve lacking. Two strong diverging plates and median septum between them in ventral valve, aseptate in apicals of dorsal valve. Surface with concentric bands and biramous pustles.

**Remarks:** Several deformed shells were obtained. This species is smaller in size than the former but the convexity of the shell is greater.

Hor.: Hikoroiti Series.

Loc.: Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Reg. no. 16187 (holotype).

Coll.: M. MINATO.

Genus *Syringothyris* WINCHELL.

*Syringothyris jumonjiensis* MINATO, sp. nov.

Pl. II, fig. 1.

Shell spiriferoid with high cardinal area. Shell large in size, ca. 130 mm. in width, area 50 mm. in height, and dorsal valve 32 mm. in length. Apical angle ca. 120°, delthyrial angle 18-20°. Hinge-line straight, cardinal extremities acute. Cardinal area flat. Entire area covered by horizontal striations parallel to the hinge-line, central portion on both sides of delthyrium bears, in addition, vertical striations. Central region of area bisected by a high triangular delthyrium, which is covered by a convex deltidium, not perforated by any foramen. Fold smooth. Lateral slope of shell with simple, depressed, radiating plications, numbering 5-6 in a distance of 10 mm, near fold; these become finer and more obscure towards cardinal extremities, interspace of each plications very narrow. Concentric lamellose lines observable on some parts of shell. Shell structure punctate. Internal structures unknown.

**Remarks:** This species is characterized by its large apical angle, relatively narrow delthyrium, and very high and flat cardinal area. *Syringothyris cuspidata* mut. *exolata* described and figured by NORTH<sup>1)</sup> shows some affinity to the Japanese species, but the former has a narrower area, which is sometimes reclined. WELLER's *Syringothyris halli*<sup>2)</sup> from the Kinderhookian has a similar apical and delthyrial angle as the Japanese species, but the former is far smaller in size and possesses a

1) F. G. NORTH: On *Syringothyris* WINCHELL, and certain Carboniferous Brachiopoda referred to Spiriferina D'Orbigny. Q.J.G.S. London vol. 76, p. 185, text-figs. 1d, 3e, 3f; pl. XI, figs. 4a-5b, 1920.

2) S. WELLER: The Mississippian Brachiopoda of the Mississippi valley basin. Illinois State Geological Survey. Monograph 1, p. 390, pl. LXXII, figs. 13-23, 1914.

much lower cardinal area.

*Syringothyris cuspidata* formerly reported by I. HAYASAKA<sup>1)</sup> from the Ômi-district has a large apical angle as large as 120° and may be related, the writer believes, to the species now in concern. However HAYASAKA's specimen has a less transversely elongate shell.

Hor. : Jumonji Stage.

Loc. : Nasirosawa, Jumonji, Simoarisu-mura, Kesen-gun, Iwate Prefecture, Reg. no. 15995 (holotype); Kozubo, Yokota-mura, Kesen-gun, Reg. no. 16062.

Coll. : M. MINATO.

*Syringothyris transversa* MINATO, sp. nov.

Pl. V, figs. 1a, 1b, 1c, 1d, 1e, 1f.

Shell large, transversely elongate, much broader than long, the greatest width at hinge-line, cardinal extremities blunt, acute. The dimensions of holotype are, length of hinge-line ca. 84 mm., length of dorsal valve 49 mm., thickness 33 mm., width of fold near anterior commissure 24 mm., height of cardinal area 22 mm., width of delthyrium at hinge-line 18 mm.

Ventral valve broadly subpyramidal in form, surface sloping from beak to cardinal extremities in nearly straight line, lateral slopes very short from front to beak, nearly straight from cardinal to front margins towards central portion of valve. Median sinus narrow and sharply defined at beak, becoming rapidly broader towards front, non-plicate, concave at bottom and produced anteriorly in a broad, rounded, linguiform extension of moderate length. Cardinal area high, concave, apical angle 140°, delthyrial angle 35°. Delthyrium rather broadly triangular, covered by convex deltidium; no foramen. Dental plates widely diverging: low median septum separating muscular scars, which are sub-ovate in outline with dendritic impressions. Syrinx observable at interior of delthyrium. Dorsal valve broadly subtriangular in outline. Lateral slope bearing about 17 simple, depressed, radiating plications, which become gradually obscure towards both hinge-line and cardinal extremities. Median fold non-plicate, well defined. Beak extending beyond hinge-line, cardinal area narrow. Shell substance minutely and closely punctate.

**Remarks:** This species is represented by several specimens from

1) I. HAYASAKA: On the fauna of the Anthracolithic limestone of Omi-mura in the Western part of Echigo. Sc. Rep. Tohoku Imp. Univ., Sendai, Japan, Second ser. (Geol.) vol. VII, no. 1, p. 45, pl. VI, figs. 10, 11, 12, 13, 1924.

four localities. It is comparable to *Syringothyris textus* (HALL)<sup>1)</sup>, a well known species of the Mississippian and well figured by WELLER<sup>2)</sup> (figs. 1-4, of plate LXX). The Mississippian species has a flat cardinal area, and possesses, in addition, less broad median fold in the dorsal valve.

Hor. : Jumonji Stage.

Loc. : Nasirosawa, Jumonji, Simoarisu-mura, Kesen-gun, Iwate Prefecture.

Coll. : H. TAKEDA, Reg. no. 16925 (holotype).; Hinozuti, Simoarisu-mura, Reg. no. 16017, 16018. Coll. : M. MINATO.

### Family Rhynchonellidae

#### Genus *Cliothyridina* BUCKMANN

#### *Cliothyridina royssii* (L'EVILLE)

1858 *Athyris royssii* DAVIDSON: British Carboniferous Brachiopoda, p. 84, pl. XVIII, figs. 8-11.

Shell of small size, biconvex, transversely subelliptical in outline. Ventral valve, moderately convex; beak not large, slightly pointed, incurved and truncated by a small circular foramen. Convexity of valves slightly greater umbonally but becoming somewhat flattened anteriorly. Hinge-line very short and curved. Cardinal area very narrow. Median sinus obsolete. Dorsal valve less convex than ventral, without a median fold. Whole surface regularly covered by numerous concentric ribs, which, when the surface characters are perfectly preserved develop into rows of closely set imbricating and flattened spines. Spirals preserved but pectinated structure not observed on their outer edges.

The dimensions of a nearly perfect individual are: length 18 mm, width 30 mm.

**Remarks:** The present form belongs to *Cliothryidina* from the shape of the shell and spinose surface, and moreover, it resembles *Athyris royssii* figured by DAVIDSON, which is a *Cliothyridina*.

*Cliothyridina royssii* is widely distributed not only in the Lower Carboniferous rocks of Europe as well as in the Mississippian of North America but is believed to occur also in the Devonian of Russia. According to FRECH and SOMMER<sup>3)</sup>, it occurs also in the Tournaisian near Bagdad in Asia Minor and the Culm formation of Königsberg in Ger-

1) HALL AND CLARKE: Pal. N. Y., vol. 8, pt. 2, pl. 26, figs. 9, 12; pl. 27, figs. 4-12, 1895.

2) S. WELLER: Mississippian Brachiopoda, p. 1399, pl. LXIX, figs. 6-9, Pl. LXX, figs. 1-4; pl. LXXI, figs. 1-2, 1914.

3) K. SOMMER: Die Fauna des Culms von Königsberg bei Giessen. N. Jb. f. Min. etc. Beil. Beil. Bd. 28, p. 911, 1909.

many. PARKINSON<sup>1)</sup> has reported its occurrence from the Etroeungtian and Tournaisian of Königsberg.

Meanwhile, VAUGHAN<sup>2)</sup> who studied the Lower Carboniferous of the Bristol area, reported the occurrence of *Cl. royssii* from the horizons M to Z. According to him, that species is especially abundant in the M horizon. SIBLY<sup>3)</sup> states that this species occurs also from M to C horizons in the Mendip area. Under the same name similar species was reported by GEORGE<sup>4)</sup> from the *Cleistopora* zone in South Wales.

Accordingly, *Cl. royssii* is a species which ranges from the Upper Devonian to C horizon, and was especially abundant in the Etroeungtian and the lower half of the Tournaisian.

By the name of *Cl. royssii* some Athyrids were reported from the Fusulina- limestone of Russia, the Salt Range,<sup>5)</sup> and Chichichun No. 1.<sup>6)</sup> However, they may be specifically distinct from the Lower Carboniferous species above mentioned. The Permian forms always have somewhat elongate oval form, against the more transversely elongata form of the Lower Carboniferous type. The same is the case with DAVIDSON's Permian *C. royssii*. (Pl. LIV, fig. 9).

Likewise the specimens occurring<sup>7)</sup> from and named by ABICH as "*royssii*" may be also different from the Lower Carboniferous species, as already pointed out by L DE KONINCK.

Hor.: Jumonji Stage.

Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture, Reg. no. 16019.

Hinozuti, Simoarisu-mura, Kesen-gun. Reg. no. 16027.

Coll.: M. MINATO.

### Genus *Actinoconchus* MCCOY

#### *Actinoconchus planosuleata* (PHILLIPS)

1836 *Spirifer planosulcata*, PHILLIPS: Geol. Yorkshire, vol. II, p. 220, pl.

- 1) H. PARKINSON: Ueber eine neue Culmfauna von Königsberg unweit Giessen und ihre Bedeutung für die Gliederung des rheinischen Culm. Zt. d. Deutsch Geol. Gesell. p. 363, 1903.
- 2) A. VAUGHAN: The Paleontological sequence in the Carboniferous Limestone of the Bristol area. Q.J.G.S. London vol. 1, p. 181, 1905.
- 3) T. F. SIBLY: On the Carboniferous limestone of the Mendip area.
- 4) T. GEORGE: The Carboniferous limestone (Avonian) succession of a portion of the North Crop of the South Wales Coalfield. Q.J.G.S. vol. 83, p. 43, 1927.
- 5) W. WAAGEN: Productus Limestone fossils. Paleontologia Indica. Ser. 13, p. 475, pl. XL, figs. 6, 12, pl. XXXIX, fig. 10, 1882.
- 6) C. DIENER: The Permocarboniferous fauna of Chitichun No. 1. Paleontologia Indica, Ser. XV, fol 1, part 3, p. 59, pl. X, figs. 1, 2, 3, 6.
- 7) L DE KONINCK: Faune du calcaire Carbonifère de la Belgique. Ann. Mus. Roy. d'Hist. nat. XIV, p. 35, 1887.

X, fig. 15.

1858 *Athyris planosulcata*, DAVIDSON: British Carboniferous Brachiopoda, p. 80, pl. XVI, figs. 2, 3, 4, 4a, 4b, 4c, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15.

1911 *Athyris planosulcata*, NEBE: Die Culmfauna von Haagen. N. Jb. f. Min. usw. Beil. Bd. 31, p. 446, pl. XII, fig. 14.

Shell of medium size, nearly orbicular, or obscurely pentahedral, nearly equally biconvex or the ventral valve slightly deeper than the dorsal, without definite fold and sinus, except very shallow, flattened part near anterior commissure of ventral valve. Beak very small. Surface of both valves with fine concentric lamelliform expansions, one kind fringes anterior margin of shell by prolongation of its plate, thereat 7 longitudinal striations in a distance of 5 mm. are found. Spiral appendages fill greater part of valves. Width ca. 40 mm, Length 32 mm.

**Remarks:** The present form is identified with *A. planosulcata*, the genotype of *Actinoconchus*. The genotype figured by PHILLIPS possess a distinct mesial depression while the majority of the specimens figured by DAVIDSON have very weak mesial depression; this may be the writer thinks, to represent variation within a species.

The Japanese specimen resembles the specimens figured by DAVIDSON (fig. 4a, 4b, 4c of plat XVI). Specimens comparable with *A. planosulcata* occur in horizon S<sub>1</sub> in the Mendip area, according to SIBLY.

Hor.: Hikoroiti Series.

Loc.: Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture.

Coll.: M. MINATO.

Reg.; no. 15973.

### *Actinoconchus* cf. *lamellosa* (L'EVILLE)

Pl. I, figs. 6a, 6b.

Compare with

1836 *Spirifer squamosa*, PHILLIPS: Geol. Yorkshire, vol. II, p. 220, pl. X, fig. 21.

1857 *Athyris lamellosus*, DAVIDSON: British Carboniferous Brachiopoda, p. 79, pl. XV, fig. 1; pl. XVII, fig. 6.

1906 *Athyris* (*Actinoconchus*) cf. *lamellosa*, SIBLY: Carb. limestone of Mendip area. Q.J.G.S. vol. 62, p. 374, pl. XXXII, figs. 1a, 1b.

1938 *Athyris lamellosa*, BRANSON: Lower Mississippian of Missouri University of Missouri Studies, vol. XIII, no. 3, p. 74, pl. 9, figs. 42, 43.

The specimens referred to this species are deformed but all resemble *A. lamellosa*. According to SIBLY, this species occurs in Ka-Z<sup>1</sup> horizons in the Mendip area in the British Islands, and BRANSON records it from the Chouteau stage in North America.

Hor. : Jumonji Stage.  
 Loc. : Hinozuti, Simoarisu-mura, Kesen-gun, Iwate Prefecture.  
 Coll. : M. MINATO.  
 Reg. : no. 16093.

Genus *Sugiyamaella* YABE et MINATO, 1944

In the original generic diagnosis given by Prof. H. YABE and the writer there were unfortunately several misprints. Therefore, the writer wishes to revise the previous diagnosis, as follows:

Das Korallenstock ist einfach, klein, hornförmig, einwenig gebogen. Der Kelch ist tief. Sie haben dicke Mauern, kompakte Saulchen und ausgezeichnete Fossulae. Die Septen im dem Hauptquadranten, besonders in der Nähe der Hauptfossulae stehen immer dichter aneinander als jene des Gegenquadranten. Auch die Septen II. Ordnung sind hier und da entwickelt. Die bilaterale Anordnung der Septen ist sehr bemerkenswert. Dissipimenten und Tabulae fehlen vollkommen.

*Sugiyamaella carbonarium* YABE et MINATO

Pl. I fig. 13; Pl. III fig. 4.

- 1941 *Lophophyllidium* ? sp., M. MINATO: On the Lower Carboniferous deposits at Setamai-mati, Kesen-gun, Iwate Prefecture. Jour. Geol. Soc. Japan vol. 48, p. 477.  
 1944 *Sugiyamaella carbonarium*, YABE et MINATO, gen. et sp. nov. aus den unterkarbonischen Ablagerungen des Kitakami-Gebirges, Japanese. Jour. Geol. Geogr. vol. XIX, p. 143, pl. XII, figs. 1-9, Text fig. pl. figs. 1-9a, Text figs. 1-4.  
 1947 *Sugiyamaella carbonarium* MINATO: (par.) New locality of *Sugiyamaella carbonarium*. Jour. Geol. Soc. Japan. vol. LIII, p. 22.

Hitherto only two localities were known for this species as will be mentioned latter on. The so-called *Lophophyllum* sp. of Y. ONUKI from his Kanenokura-stage at Higuchisawa, which the writer once suggested as belonging to this species,\* may be a different species.

Hor. : Kozubo Stage.  
 Loc. : Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture. Reg. no. 15126-15135.  
 Usagisaw, Setamai-mati, Kesen-gun, Reg. no. 15883, 16003.  
 Coll. : M. MINATO.

Phylum Mollusca

Class Pelecypoda

Order Prionodesmacea

Superfamily Mytilacea FERUSSAC

Family Mytilidae FLEMING

Genus *Lithophaga* MEG.

*Lithophaga* sp.

Pl. III, fig. 9.

\*) 1947 M. MINATO: Jour. Geol. Soc. Japan, vol. 53, p. 22.

Shell elongate, slightly convex anteriorly, compressed posteriorly. Umbonal region convex, but compressed both posteriorly and ventrally. Posterior end almost flat, much expanded, and wider than the anterior one. Dorsal margin almost straight from middle to posterior end of shell; ventral margin curved gently at anterior and strongly at posterior parts. Shell substance originally very thin; surface with very fine, closely set regular lines, and stronger ones with which they occasionally alternate.

**Remarks:** Although the muscular impression is not observable, the surface sculpture is well preserved on the anterior part of the shell; and this shell may be edetulous. The specimen at hand is imperfect; it is characteristically flat, probably owing to subsequent deformation. The so-called *Lithodomus lingualis* PHILLIPS described and illustrated by HIND<sup>1)</sup>, seems to be allied to the Japanese specimen, but the state of preservation of the present material does not permit detail comparison.

Hor.: Hikoroiti Series.

Loc.: Tyoanji, Hikoroiti-mura, Kesen-gun.

Coll.: M. MINATO.

Reg.: no. 16112.

Phyllum Arthropoda  
Class Crustacea  
Subclass Trilobita  
Order Poisthoparia  
Family Proetidae  
Genus *Phyllipsia* PORTLOCK

*Phyllipsia* ? sp.

Pl. I, fig. 11.

Only one specimen lacking the greater part of the cephalon was found. This trilobite has nine segments in the thorax, and possesses segmentation of pleural lobes extending mainly to the margin.

Hor.: Maide Stage ?

Loc.: Maide, Yokota-mura, Kesen-gun, Iwate Prefecture.

Coll.: M. MINATO.

Reg.: no. 15984.

1) W. HIND: A Monograph of the British Carboniferous Lamellioranchiata. Pal. Soc. 1896.

## Plate I

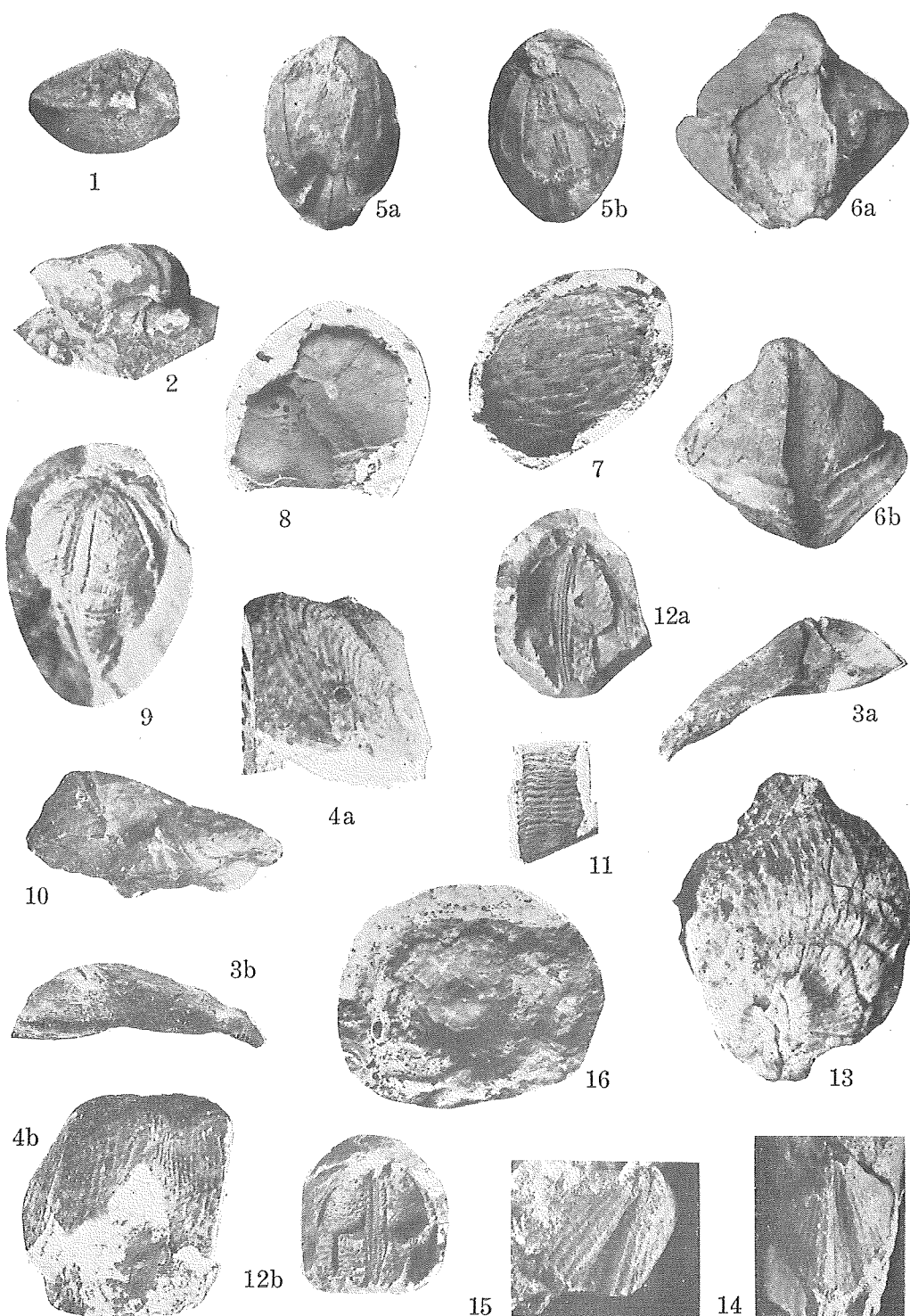
## Explanation of Plate

(All figures approximately natural size)

### Plate I

- Fig. 1. *Torynifer (Kitakamithyris) hikoroitiensis* MINATO. sp. nov.  
Hor.: Hikoroiti Series.  
Loc.: Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg.: no. 11187.
- Fig. 2. *Brachythyris nagaoi* MINATO. sp. nov.  
Hor.: Maide Stage.  
Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg.: no. 16246.
- Fig. 3a, 3b. *Torynifer (Kitakamithyris) tyoanjiensis* MINATO. sp. nov.  
Hor.: Tyoanji Series.  
Loc.: Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg.: no. 15990.
- Fig. 4a, 4b. *Productus* sp.  
Hor.: Jumonji Stage.  
Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg.: no. 16008.
- Fig. 5a, 5b. *Blastoidea*, gen. et sp. indet.  
Hor.: Jumonji Stage.  
Loc.: Hinozuti, Simoarisu-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg.: no. 16169.
- Fig. 6a, 6b. *Actinocoenecus* cf. *lamellosa* (L'ÉVILLÉ)  
Hor.: Jumonji Stage.  
Loc.: Hinozuti, Simoarisu-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg.: no. 16093.
- Fig. 7. *Productella* aff. *caperate* (SOWERBY).  
Hor.: Hikoroiti Series.  
Loc.: Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg.: no. 16466.
- Fig. 8. *Platycrinus asiatica* MINATO. sp. nov.  
Hor.: Jumonji Stage.  
Loc.: Nasirosawa, Jumonji, Shimoarisu-mura, Kesen-gun, Iwate Prefecture,  
Coll. H. TAKEDA.  
Reg.: no. 16806.
- Fig. 9. *Blastoidea*, gen. et sp. indet.  
Hor.: Jumonji Stage.  
Loc.: Kozubo, Yokota-mura Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg.: no. 16001.

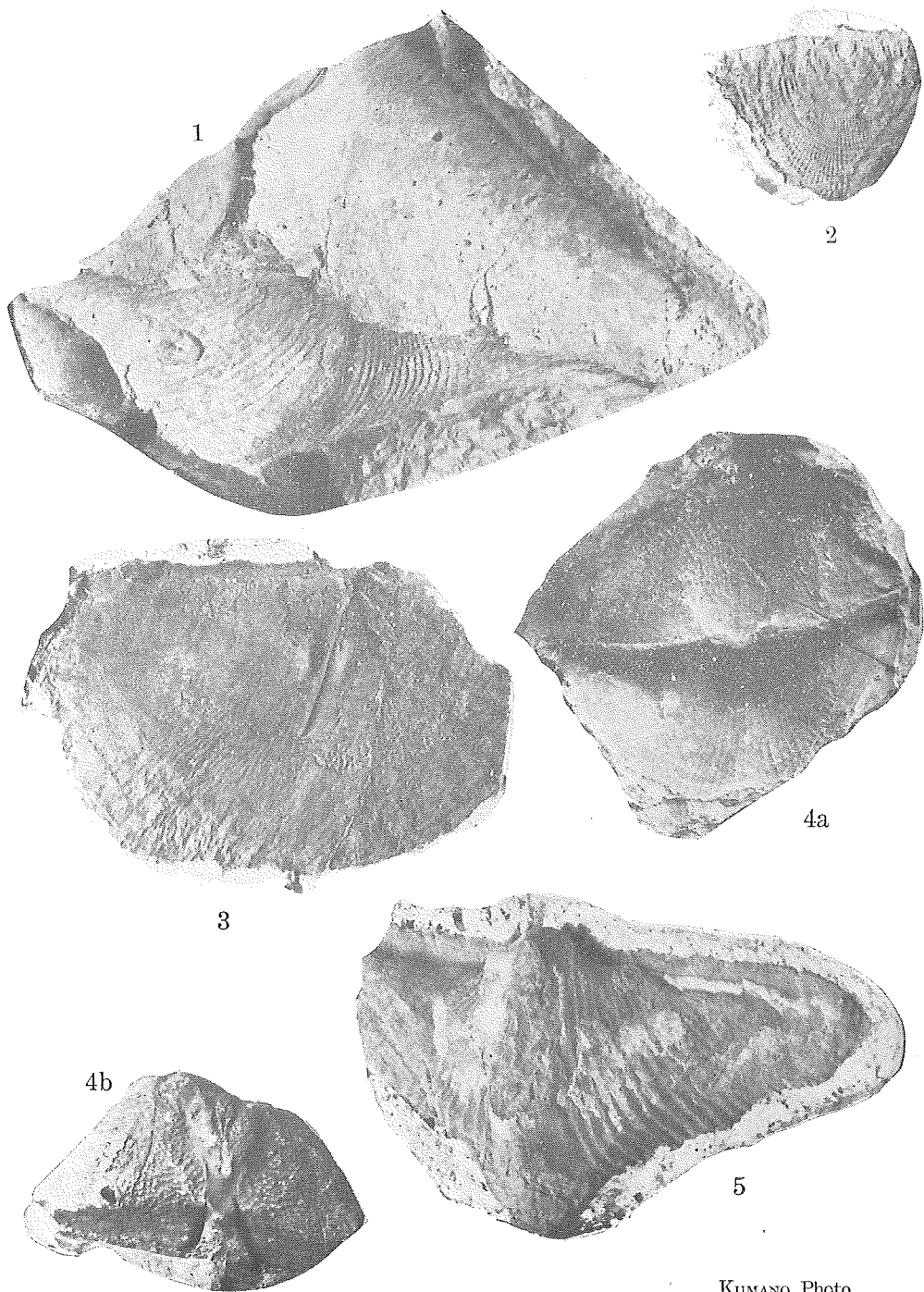
- Fig. 10. *Brachythyrian nagaoi* MINATO, sp. nov. deformed specimen.  
Hor.: Maide Stage.  
Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg.: no. 16009.
- Fig. 11. *Phyllipsia* sp.  
Hor.: Maide Stage ?  
Loc.: Maide, Yokota-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg.: no. 15984.
- Figs. 12a, 12b. *Blastoidea* gen. et sp. indet.  
Hor.: Jumonji Stage.  
Loc.: Nasirosawa, Jumonji, Simoarisu-mura, Kesen-gun, Iwate Prefecture,  
Coll. M. MINATO.  
Reg.: no. 16056.
- Fig. 13. *Sugiyamaella carbonarium* YABE et MINATO.  
Hor.: Kozubo Stage.  
Loc.: Usagisawa, Setamai-mati, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg.: no. 16003.
- Fig. 14. *Spirifer (Brachythyris)* aff. *pinguis* (SOWERBY).  
Hor.: Maide Stage.  
Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg.: no. 16011.
- Fig. 15. *Spirifer (Brachythyris)* aff. *pinguis* (SOWERBY).  
Hor.: Maide Stage.  
Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg.: no. 16252.
- Fig. 16. *Actinocrinus higuchisawensis* MINATO, sp. nov.  
Hor.: Hikoroiti Series.  
Loc.: Higutisawa, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg.: no. 16103.



## Plate II

## Plate II

- Fig. 1. *Syringothyris jumonjiensis* MINATO sp. nov.  
Hor. : Jumonji Stage.  
Loc. : Nasirosawa, Jumonji, Simoarisu-mura, Kesen-gun, Iwate Prefecture,  
Coll. M. MINATO.  
Reg. : no. 15995.
- Fig. 2. *Leptaena* cf. *convex* WELLER.  
Hor. : Hikoroiti Series.  
Loc. : Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 16243.
- Fig. 3. *Planoproductus gigantoides* MINATO. sp. nov.  
Hor. : Hikoroiti Series.  
Loc. : Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 16110.
- Figs. 4a. 4b. "*Spirifer*" cf. *logani* HALL.  
Hor. : Hikoroiti Series.  
Loc. : Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 16000.
- Fig. 5. *Spirifer (Fusella) nipponotrigonalis* MINATO. sp. nov.  
Hor. : Jumonji Stage.  
Loc. : Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 16016

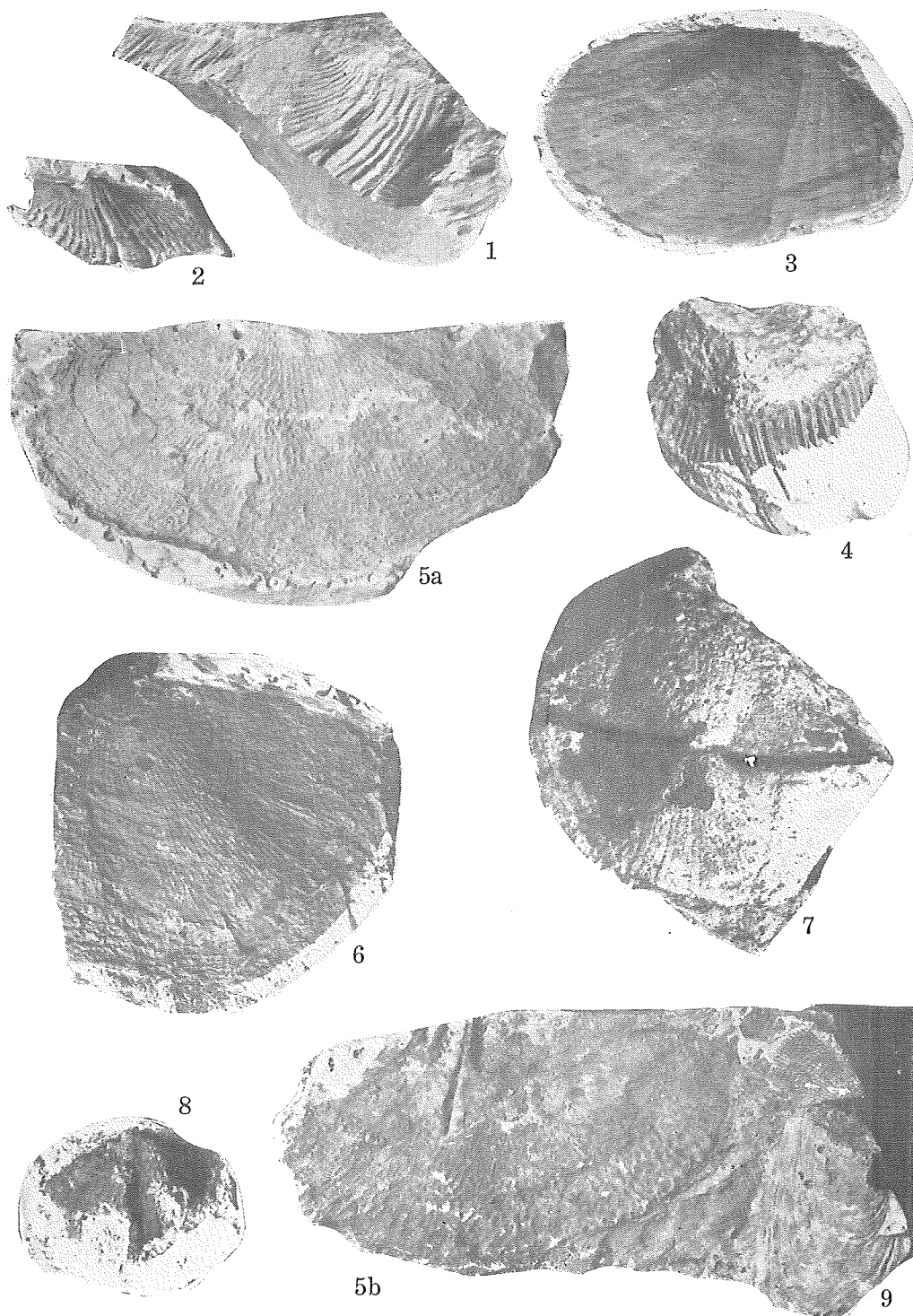


KUMANO Photo

## Plate III

### Plate III

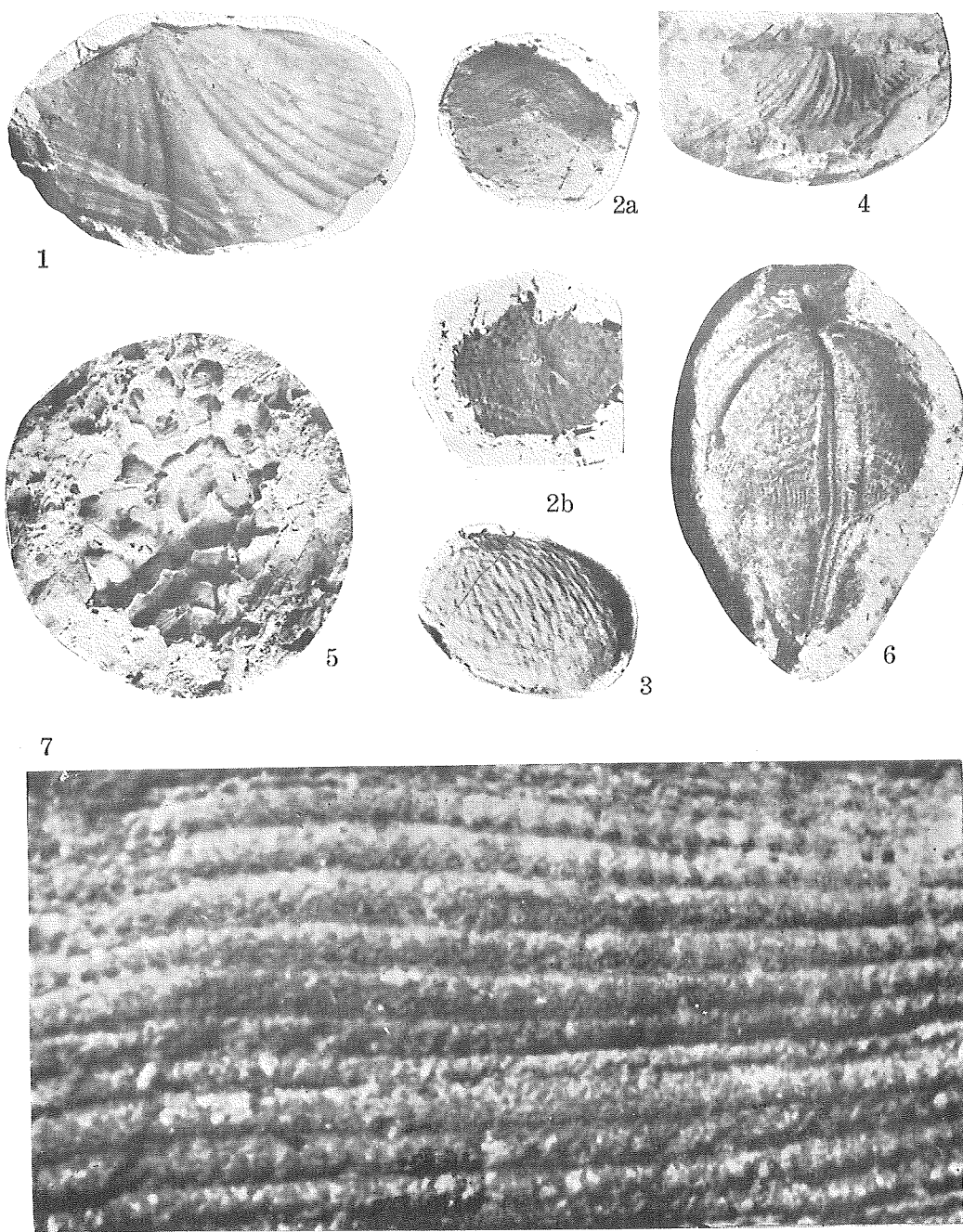
- Fig. 1. *Leptaena analoga* (PHILLIPS).  
Hor. : Hikoroiti Series.  
Loc. : Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 16130.
- Fig. 2. *Brachythyris nagaoi* MINATO. sp. nov.  
Hor. : Maide Stage.  
Loc. : Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture, Coll. T. NAGAO.  
Reg. : no. 15993.
- Fig. 3. *Brachythyris kitakamiensis* MINATO. sp. nov.  
Hor. : Hikoroiti Series.  
Loc. : Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 16465.
- Fig. 4. *Sugiyamaella carbonarium* YABE et MINATO.  
Hor. : Kozubo Stage.  
Loc. : Usagisawa, Setamai-mati, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 16003.
- Figs. 5a, 5b. *Planoproductus gigantoides* MINATO. sp. nov.  
Hor. : Hikoroiti Series.  
Loc. : Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 16111.
- Fig. 6. *Planoproductus gigantoides* MINATO. sp. nov.  
Hor. : Hikoroiti Series.  
Loc. : Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 16110.
- Fig. 7. "*Spirifer*" cf. *logani* HALL, gypsum model.  
Hor. : Hikoroiti Series.  
Loc. : Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 16000.
- Fig. 8. *Brachythyris* aff. *pinguis* (SOWERBY).  
Hor. : Maide Stage.  
Loc. : Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 16038.
- Fig. 9. *Lithophaga* sp.  
Hor. : Hikoroiti Series.  
Loc. : Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 16112.



## Plate IV

## Plate IV

- Fig. 1. *Brachythyris kitakamiensis* MINATO. sp. nov.  
Hor. : Hikoroiti Series.  
Loc. : Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 16465.
- Figs. 2a, 2b. *Platycrinus asiatica*, MINATO. sp. nov.  
Hor. : Jumonji Stage.  
Loc. : Nasirosawa, Jumonji, Simoarisu-mura, Kesen-gun, Iwate Prefecture,  
Coll. M. MINATO.  
Reg. : no. 16105.
- Fig. 3. *Productella* cf. *caperata* (SOWERBY).  
Hor. : Hikoroiti Series.  
Loc. : Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 16466.
- Fig. 4. *Brachythyrina nagaoi* MINATO. sp. nov.  
Hor. : Maide Stage.  
Loc. : Okuhinozuti, Simoarisu-mura, Kesen-gun, Iwate Prefecture, Coll. S. IZIRI.  
Reg. : no. 16173.
- Fig. 5. *Actiuocrinus ohmoriensis* MINATO.  
Hor. : Hikoroiti Series.  
Loc. : Ohmori, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 15983.
- Fig. 6. Blastoidea, gen. et sp. indet  
Gypsum model  
Hor. : Jumonji Stage.  
Loc. : Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 16001.
- Fig. 7. *Torynifer* (*Kitakamithyris*) *tyoanjiensis* MINATO. sp. nov.  
Showing the ornamentation of shell, much enlarged.  
Hor. : Hikoroiti Series.  
Loc. : Tyoanji, Hikoroiti-mura, Kesen-gun, Iwate Prefecture, Coll. M. MINATO.  
Reg. : no. 15990.



## Plate V

## Plate V

Figs. 1a, 1b, 1c, 1d, 1e, 1f. *Syringothyris transversa* MINATO. sp. nov.

Hor. : Jumonji Stage.

Loc. : Nasirosawa, Jumonji, Simoarisu-mura, Kesen-gun, Iwate Prefecture,  
Coll. H. TAKEDA.

Reg. : no. 16925.

Figs. 2a, 2b. *Brachythyris* sp.

Hor. : Hikoroiti Series.

Loc. : 808 m hill, Okuhinozuti, Simoarisu-mura, Kesen-gun, Iwate Prefecture,  
Coll. S. IZIRI.

Reg. : no. 16140.

Fig. 3. *Schellwienella izirii* MINATO. sp. nov.

Hor. : Hikoroiti Series.

Loc. : 808 m hill, Okuhinozuti, Simoarisu-mura, Kesen-gun, Iwate Prefecture,  
Coll. S. IZIRI.

Reg. : no. 16141.

